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(Zhu et al., 2004 ) and ( Barramundi *lates calcarifer*) (Tian and Qin, 2003 ) .

Re-feeding after deprivation has been reported to improve the feeding efficiency and induce growth in various fish species (Hayward et al., 1997; Rueda et al., 1998 ; Wu et al., 2002; Tian and Qin, 2003; Zhu et al., 2004; Johansen and Oveturf, 2006 ). The (T/C ratio) was lower in both starvation and re-feeding groups, and the (T/C ratio) after 2 days of re-feeding was much lower than that of the starvation groups. Our studies showed that the activity of trypsin (T) in fish subjected to a short starvation period was lower than that of fish fed normally, whereas chymotrypsin (C) activity increased the (T/C ratio) decreased with starvation time, indicating the possibility that the growth of tilapia is inhibited by starvation ( Chi-Ru et al., 2008 ). Increasing the pre-slaughter starvation period 10 to 25 days gave no significant reduction in any of the digestive enzyme activities measured ( Asbjorn , 2004 ) in both starved and re-feeding was much lower than that of the starved groups . However, the contributions of an extending period of re-feeding to the recovering and activation of growth rate in common carp are interesting and need to be investigated in the future.

The activity of trypsin in fish subjected to short starvation period was decreased but chymotrypsin activity increased. The (T/C ratio) decreased with starvation time, revealing the potential for inhibited growth of carp. Furthermore, re-feeding after starvation increased the activities of trypsin and chymotrypsin, and decreased the (T/C ratio) compared to those before and after re-feeding. These results reveal that 2 days of re-feeding after starvation is insufficient to lead to the recovery and activation of growth in carp.

rates (Sunde et al.,2001). According to the relationships of growth and the (T/C ratio),the growth of carp was inhibited with short fasting periods based on a reduction in the T/C ratio. However no growth inhibition was found in this work-more work is required to investigate the effects of starvation on the growth of carp.

Methods for increasing growth have been explored for years in many studies. One of these methods, food starvation and re-feeding result in increasing various extents of growth (Johansen and Overturf,2006). The activity of trypsin and chymotrypsin increased after re- feeding table (3). The results indicated that re- feeding caused a rise in the protolithic activity in carp with short starvation period. In previous studies exposing gible carp (*Carassius auratus gibelio*) to a single period of food deprivation and re- feeding , the deprived fish exhibit similar growth rates to control fish during the re- feeding period (Qian et al.,2000 ; Xie et al.,2001). Long- term fasting in Atlantic cod (*G.morhua*) led to a fall in metabolic enzyme activities in the pyloric caecum and intestine , as well as trypsin , which are all largely restored upon re-feeding (Belanger et al.,2002). In the channel catfish (*Ictalurus punctatus*), overcompensation has been reported for deprivation periods of 1, 2 and 3 days (Chatakondi and yant, 2001). Overcompensation of various parameters upon re-feeding is noted in rainbow trout (*Salmo gairdneri*) (Weatherley and Gill , 1981). Atlantic salmon (Krogdahl and Bakke -Mckellep, 2005) and Atlantic cod (Belanger et al., 2002), and has been proposed as a mechanism for compensatory growth. The gross growth efficiency of deprived fish is marginally higher than normally fed Chinese long snout catfish (*Leiocassis longrostris*)

to provide more amino acids for vital body function ( Navarro and Gutierrez, 1995 ).

Previous studies have revealed that starved fish for period of 1-2 days have little effect on body mass or length (Faster and Moon,1991; Bleanger et al., 2002). Intestinal tissue protein degrade more intensely than other tissue protein in well- nourished fish during the early phase of starvation (Houlihan et al.,1988 ; Krogdahl and Bakker-Mckellep,2005). In rainbow trout ( *O mykiss* ) feeding a meal after a 6 day fasting period , fractional rates of protein synthesis in the intestine are higher than that 3 h after feeding , and these were brought about by an increase in protein synthesis per unit of R N A (Mckillan and Houlihan,1989 ; Krogdahl and Bakke- Mckellep,2005 ). Our study found that the stomach and intestine weight to body weight percentages increased after short term starvation. It is possible that a greater decrease in body weight occurred than for the GI tract.

### Trypsin

Cleaves protein on the carboxyl side of the basic amino acid, Lysine and arginine show higher digestibility than other amino acids ( Espe et al .,1993). Previously, relationships between the food conversion efficiency [and / or specific Growth rate], and trypsin specific activity (Lemieux et al., 1999; Sunede et al., 2001) are observed in different fish species. Trypsin is a sensitive key protease under condition favoring growth( Rungruangsak – Torrissen et al.,2006).

By contrast to the decrease trypsin activity ratio, the activity of chymotrypsin increased with starvation time (4 and 6 days) table (3). The (T/C ratio) seems to be more sensitive and representative than trypsin – specific activity for comparing between fish with potentially different growth

Enzyme	CONTRO L	2 day starvation		4 day starvation		6 day starvation	
		starved	Re-fed	Starved	Re-fed	Starved	Re-fed
Trypsin (T) (U/mg protien)	0.39 c	0.36 D	0.46 A	0.34 D	0.34 b	0.36 D	0.43 b
Chymotrypsin(C)(U/mg protien)	0.80 c	0.79 c	1.16 B	0.83 C	1.2 b	1.29 B	2.04 a
T/C *	0.48 a	0.45 a	0.39 ab	0.40 Bc	0.28 b	0.27 Cd	0.21 D

\*The T/C ratio value was calculated as the ratio of trypsin to chymotrypsin ,a,b,c,d Different superscript letter indicate a significant difference between values on a given raw ( $p \leq 0.05$ ).

### Discussion:

Recent studies have demonstrated that variable food intake and re-feeding to increase in tissue mass, protein content ,and enzyme activities synchronous with the response to fasting ,is possibly due to a combination of increase cellular proliferation { Harpaz ,2005},higher rates of protein synthesis, and lower level of protein degradation (Houlihan et al., 1988 ; Kroghahl and Bakkellep,2005 )

The weight of starvation carp showed no significant changes. The relative stomach weights of starved groups were significantly higher than those of the control group , furthermore the relative intestinal weight of the starved group after 6 days of starvation and the relative intestinal weight recovering after 4 days of starvation table (1). It has been recently reported that fasting caused extensively rapid decrease in tissue mass, protein, and enzyme capacities of Atlantic (Kroghahl and Bakke-Mckellep, 2005 ).However, intestinal wasting lows down during long – term starvation particularly white muscle , apparently level up at such a time

**Enzyme assay:****Trypsin:**

There are significant difference ( $P \leq 0.05$ ) of between treatments in intestine trypsin activity increase after 2 days starvation, and decrease

with re-feeding after 4 and 6 days starvation compared with control group, table (3).

**Chymotrypsin:-**

The intestinal chymotrypsin activity showed no significant differences after 2 and 4 days of starvation compared to the control group, but the intestinal chymotrypsin activity significantly increased after 6 days of starvation. This result in a significantly reduced activity ratio of trypsin to chymotrypsin (T/C ratio), with increase time from 4 and 6 days of starvation table (3). Re-feeding caused the intestinal chymotrypsin activity to increase after 2, 4 and 6 days of starvation, and levels were higher than those of the control group. The intestinal chymotrypsin activity was higher in the re-fed group after 6 days of starvation than those of the other groups. In addition, the intestinal (T/C ratio) with re-feeding after 4 and 6 days were lower than those of the control group. The decreasing tendency

was greater with re-feeding after 6 days of starvation in contrast. The (T/C ratio) of the re-fed group did not significantly differ from the fasting group. The results of re-feeding were compared with the control, there was significant decrease in both re-feeding after 4 and 6 days of starvation groups table (3).

Table 3: Actives of trypsin, chymotrypsin, and the ratio of trypsin to chymotrypsin (T/C) carp fish after various period of starvation and re-feedings after various period of starvation.

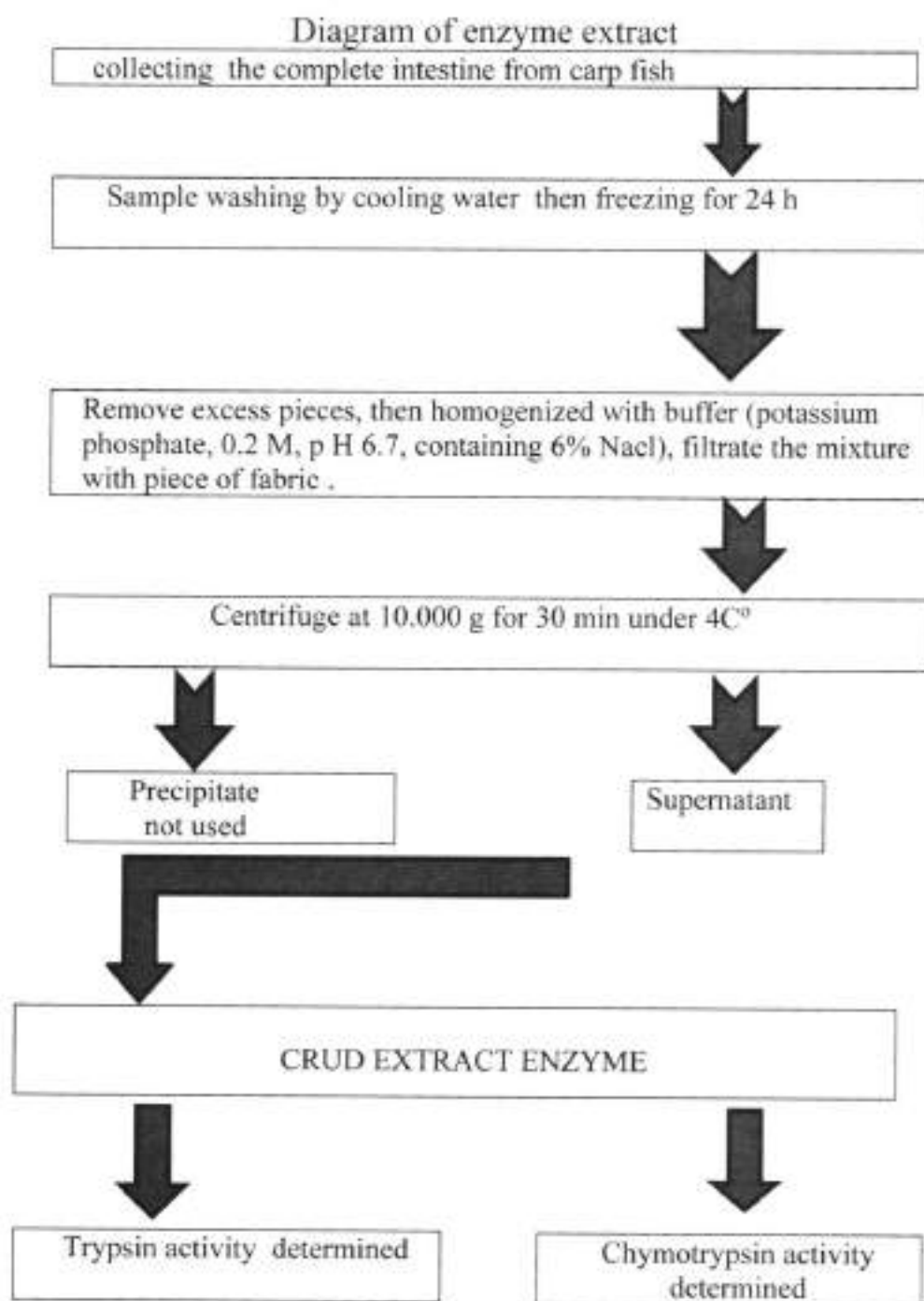
**Results:**

During the experimental period, no fish died in any group. The relative stomach weight of starvation group for 2 and 4 days were significantly higher than that of control group. Additionally, 2 days of re – feeding after 6 days of starvation resulted in an increase in the relative stomach weight (table 2). The relative intestinal weight of the starved group after 6 days of fasting was significantly higher than that of the control group. Moreover, 2 days of re-feeding after 4 days and 6 days of starvation resulted in a relative recovery of intestinal weight (Table 2).

Table 2. Alterations in stomach weight, and intestine weight after various periods of starvation and re-feeding after various period of starvation.

Factors	Control	2days starvation		4 days starvation		6 days starvation	
		Starved	Re-feed	starved	Re-feed	starved	Re-feed
Stomach weight(g)	0.20 C	0.23b C	0.21bc	0.25 a	0.22b C	0.20 c	0.25 ab
Intestinal weight (g)	0.36 C	0.37 C	0.36 c	0.36 c	0.40 Bc	0.45ab	0.47 a
Relative stomach Weight (g/ kg body weight)	4.9 C	5.8 B	5.28 c	6.36 a	5.57 bc	5.16 bc	6.45 ab
Relative intestine Weight ( g / k g body weight )	8.89 Bc	9.34 Bc	9.06 c	9.17 bc	10.14 ab	11.62 a	12.14 a

A,b,c ,different superscript letter indicate a significant difference between values on a given row ( $p < 0.05$ ).



The intestine, ground using blender, and then homogenized in flask using magnetic stirrer in ice path ( $4^{\circ}\text{C}$  for 6 h), by adding 1g intestine to 4 ml of buffer (potassium phosphate,  $\text{KH}_2\text{PO}_4 + \text{K}_2\text{HPO}_4$  of 0.2 M, pH 6.7, containing 6% NaCl). Then filtrate the mixture with a piece of fabric to remove the excess pieces (unhomogenized). The filtrate centrifuged at 12.000 g / 30 mint at  $4^{\circ}\text{C}$  (cooling centrifuge) to have the supernatant to be stored in freezing (Schwert et al., 1955).

#### **Enzyme assay:**

The protease (trypsin and chymotrypsin), were assayed by specific method as that of (Schwert et al., 1955).

#### **Trypsin:**

Trypsin substrate was 1.04 mM TAME {P- toluenesulfonyl – L- arginine methyl Este} in 0.01 M  $\text{CaCl}_2$ ,  $\text{H}_2\text{O}$  / 0.2M. Tris-HCL buffer p H 8.1. The temperature  $25^{\circ}\text{C}$  and the optical density was followed at 247 nm for 20 second.

#### **Chymotrypsin:**

Chymotrypsin substrate was 1 m M BAEE {N- Benzyole – L- arginine ethyl ester into methanol 2:3 (V: V). The reaction was performed into 0.1 M  $\text{CaCl}_2$ .  $\text{H}_2\text{O}$  / 0.1m Tris / HCL buffer p H 7.2, at  $25^{\circ}\text{C}$  and followed for 40 second at 256 nm .

#### **Statistical analysis :**

The statistical Analysis system – SAS Program (2012) was used to analyse data to the effect of days in study parameters. Duncan (1955) multiple ranges to significant compare is on between means

the change in trypsin and chymotrypsin before and after re-feeding.

#### Material and Method:-

Common carp ( *Cprinus carpio* L ) Average weight  $40\pm 45$  g were obtained from a local commercial farm ( Medial east ) transported to laboratory of AL-Mammon University College . The fish were adapted to fresh water for 15 days ( tap water ) .

At the start of the experiment, fish were starved for 3 days to empty the gut. Then fish were randomly divided into (aquarium  $30 \times 30 \times 30$  cm , 6 fish / aquarium, 6 treatments). Containing the normal feed group, groups subjected to 2, 4 and 6 days of starvation. The formulation of the experimental diet is shown in table (1).

Table1. Formulation of the experimental diet

Ingredients (g / kg diet)			
Soybean meal	350	Crude protein	240
.25			
Fish meal	200	Diethyl ether extract	550.6
Starch	200	Crud fiber	40.5
Maize oil	40	Ash	40.2
Vitamin (mix)	20		
Salt	5		
Rice particle	185		

The fish was then killed by ice anesthetic, and the intestines and stomach were collected for 2 days re-feeding after fasting, (fish was given free access to food for 48 h). After weighing, one fish was randomly caught from every aquarium of the various treatments, and intestine were removed, immediately frozen and stored at  $-4C^{\circ}$  .

A high protease activity (including trypsin) indicates protein catabolism, lipase activity is indicative of lipid use; amylase activity suggests carbohydrate (starch and glycogen) catabolism {Johnston, 2004}. Some studies indicate that starvation significantly decreases the activities (Garcia – Carreno,2002). These experiments employed different starvation periods, suggesting that digestive enzyme activities of crustaceans during starvation vary depending on the time of food deprivation. Recent data have demonstrated that starvation or a

shortage of food may lead to increase in enzyme activities in different sections of the Intestine (Harpaz et al.,2005; Krogdahl and Bakke, 2005). However, led to a drop in digestive enzyme activity levels in the pyloric caecum and intestine, as well as trypsin activity in pyloric caecum homogenates which are all mostly restored up on re-feeding (Belanger et al.,2002 ).A previous study showed that the activity of digestive protease is not significantly - reduced with increasing starvation period in Atlantic cod subjected to extended starvation for up to 25 days (Gildberg,2004). However, alterations of digestive enzyme in tilapia ( *O. mossambicus* ) particularly during different periods of a single phase of food deprivation and re-feeding are very interesting. The protease activities of test shrimps exposed to different periods of food deprivation were significantly (  $p < 0.05$  ) lower than those of shrimps under starvation control at the end of food deprivation of them showed a tendency to rapidly increase during re-feeding (*Fenneropenaeus chinensis*) , (Peidong et al ., 2010 ).

This work investigated the effect of various of starvation periods and re-feeding after various periods starvation on digestive enzyme activities in common carp and compared

**Introduction:**

The digestion of food to obtain nutrients for growth maintenance, motion, and reproduction is one of the most important functions in organism physiology. Analysis of digestive enzyme activity is an easy and reliable methodology for investigation of the nutritional requirements and feeding ecology of marine invertebrates (Fernandez et al., 2001). Decapod digestive enzymes are synthesized and secreted by specialized cell of the midgut gland or hepatopancreas (Tsai et al., 1986).

Digestive enzymes have been studied in various fish species (Soengas et al., 1996; Jonsson et al., 1997; Hidalgo et al., 1999; Lo and Weng, 2006). Studies of proteolytic enzyme in fish have provided knowledge for improving protein utilization and established the importance of trypsin as a key enzyme for food utilization and growth has role in the processes of protein digestion (Rungruangsak – Torrissen et al., 2006). Trypsin activity has been reported to be related to the growth rate of fish larvae fed High –quality diets, such as in goldfish (*Carassius auratus*) (Abiayad and Kestemont, 1994).

Trypsin is a key protease which activates other pancreatic including chymotrypsin in mammals and fish (Sunde et al., 2001). Trypsin specific activity and the protease ratio of trypsin to chymotrypsin (T/C ratio) increase as growth is promoted. Moreover, increase of chymotrypsin leads to a reduction in the growth rate, whereas fish with lower growth have a higher specific activity of chymotrypsin resulting in a lower (T/C ratio) (Rungruangsak – Torrissen et al., 2006).

## تأثير التجويع واعادة الاطعام على فعالية انزيم التربسين والكيموتربسين في امعاء سمكة الكارب العادي . *Cyprinus carpio*

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### المستخلص

تهدف هذه الدراسة الى تقييم تأثير التجويع واعادة الاطعام على التغيرات التي تحدث في نشاط الانزيمات الهاضمة للبروتينات ( التربسين والكيموتربسين ) في امعاء اسماك الكارب العادي *Cyprinus carpio* L. وزعت الاسماك الى مجاميع سيطرة ومعاملات تجويع لفترات مختلفة ( ٢ ، ٤ ، ٦ ) ايام ، ومن ثم اعادة اطعامها ، لدراسة تثبيط نشاط الانزيمات الهاضمة للبروتينات من القناة الهضمية لتلك الاسماك . بينت النتائج زيادة معنوية عالية للوزن النسبي للأمعاء بعد التجويع لستة ايام مقارنة بمجموعة السيطرة ، اضافة الى زيادة الوزن النسبي للمعدة بعد التجويع لفترة ( ٤ - ٦ ) ايام . اظهرت نشاطاً اعلى لأنزيم التربسين ( T ) في الاسماك الجائعة لفترة قصيرة يومان ، مقارنة بالاسماك ذات ، التغذية الطبيعية ومجموعة الفترات ( ٤ - ٦ ) ايام . بينما زادت نشاط الكيموتربسين ( C ) مع زيادة فترة التجويع . تراجعت نسبة ال ( T/C ) مع زيادة فترة التجويع والتي تؤثر عكسياً على النمو ، مما يشير الى امكانية تثبيط النمو بسبب التجويع .

وتشير هذه النتائج الى ان تجويع الاسماك لفترات طويلة تخفض نشاط التربسين والنسبة ( T/C ) والتي لها علاقة بنمو الاسماك ، وان اعادة الاطعام تحفز نشاط الانزيمات المعوية الهاضمة للبروتينات ، وهو موضوع يحتاج الى دراسات اكثر .

الكلمات المفتاحية : انزيمات ، هضم ، تربسين ، كيموتربسين ، كارب ، تجويع .

## Effect of Starvation and Re-feeding on of Trypsin and Chymotrypsin Activities in Common Carp ( *Cyprinus carpio* L . )

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### Abstract:

The aim of this study is to evaluate the effect of starvation and re-feeding on alteration of protease (trypsin and chymotrypsin) in common carp (*Cyprinus carpio*). Regulation of gastrointestinal protease becomes particularly important, when fish starved. In this work fish were distributed to control group and various treatments including starvation time {2, 4 and 6 days} of re-feeding after various starvation times to test whether food deprivation causes changes in protease activities in the gastrointestinal tract. The relative intestinal weight of the starved group after 6 days of starvation was significantly higher than that of control group. Besides, re – feeding resulted in the relative stomach weight increase after 4 and 6 days of starvation. The activity of trypsin (T) in fish subjected to a short starvation period 2 days was higher than that in fish fed normally and starvation period 4 and 6 days , whereas chymotrypsin (C) activity increased with increasing starvation period . The (T/C) ratio decreased with starvation time, which inversely effected growth, such that the possibility that the growth of carp is inhibited by starvation . These data suggest that long term starvation dampens trypsin activities and the(S T/C ratio) in relation to the growth of carp, and that re-feeding consequently stimulates the activities of intestinal proteolytic enzyme in carp and this subject would need more study .

**Keywords:**Enzyme,Digestive,Trypsin,Chymotrypsin,Carp, starvation.

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*Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Serratia marcescens* (27, 28); also the antimicrobial activity of leaf extraction of *Citrus aurantifolia* by Chloroform, ethanol, acetone, petroleum ether and hydro alcohol inhibited the growth of *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas spp*, *Aspergillus niger*, *Aspergillus fumigates*, *Mucor spp* and *Pencillium* (29). But the potency of *Citrus aurantifolia* fruit and the oil obtained from steam distillation of the fruit was investigated by Ibukun Aibinu and his colleagues in 2007 against many clinical isolates including Anaerobic facultative bacteria *Staphylococcus aureus*, *Salmonella paratyphi*, *Shigella flexnerii*, *Streptococcus faecalis*, *Citrobacter spp*, *Serratia spp*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli*; Fungi such as *Aspergillus niger* and *Candida albicans*; and Anaerobes which includes *Bacteroides spp*, *Porphyromonas spp*, and *Clostridium spp* (30).

There are many solvents used to extract the bioactive chemical compounds from plant parts like chloroform, ethanol, acetone, petroleum ether, hydroalcohol and water; but the extraction by water was used in this study because it has many advantages like being available, cheap, rapid and safe; whereas the disadvantages were summarized that bioactive compounds were not extracted totally with high purification or may be attributed to rigidity of seed structures than other soft parts of *C. aurantifolia*. Based on our results, it can be concluded that seeds of *C. aurantifolia* possess significant antibacterial activity recommending that their consumption could be useful in the prevention of diseases caused by different infectious microorganisms such as alternative for many synthetic antibiotics (31). Future researches are needed for the isolation and identification of active principles present in the extracts which could possibly be exploited for pharmaceutical use.

that play a major role in preventing chronic diseases, specifically flavonoids and limonoids which give bitterness in taste for acidity of Citrus being after kept for long time (20, 21). Citrus limonoids appear in large amounts in citrus juices and citrus tissues as water-soluble limonoid glucosides or in seeds as water-insoluble limonoid aglycones (22, 23). Results of HPLC analysis and using GC-MS reported by Jaiprakash in 2009 revealed that limonin was the major compound in lime seeds, followed by Isolimonexic acid and L-limonexic acid, and there are other compounds like D-limonene, D-dihydrocarvone, verbena,  $\beta$ -linalool,  $\alpha$ -terpinol, trans- $\alpha$ -bergamotene (24). All these chemical compounds being present in seeds or seed coats; probably function in the protection of seeds from microbial degradation until conditions are favorable for germination (25, 26). The protection role of chemical compounds in seeds was employed in this study to investigate their role in inhibition growth of different pathogenic bacteria in vitro that may threat human life; The variety of bacterial inhibition may attribute to many reasons such as reaction the bioactive compounds in seed extract with different compounds found in bacterial cell wall structure; this reaction may form new compound having bactericidal or bacteriostatic effect; also the bioactive compound may invade into bacteria and attack the important active molecules in cytoplasm such as DNA, ribosomes and others. The available reports that deal with employed seeds of *C. aurantifolia* in medicine field were rare and not documented, but there are many literatures that clearly point to the importance of root, leaf, flower and fruit of *C. aurantifolia* as drug; Jaiprakash and his co-workers observed ability of the leaf extract and leaf essential oil of *Citrus aurantifolia* to inhibit the growth of *Staphylococcus aureus* and use it to overcome dysentery, constipation, diphtheria, acne, dizziness, cough, and inflammation of the nose (11); whereas Joji Reddy reported the antibacterial activities for leaf extract of *Citrus aurantifolia* was investigated against different pathogens such as *Bacillus cereus*, *Enterobacter faecalis*, *Salmonella paratyphi*,

**Table 1: Zones of inhibition (mm) of organisms to crud watery extract of seeds of *C. aurantifolia* .**

Bacteria spp	Inhibition zone ( mm)		
	10%	20%	40%
<b>Gram positive</b>			
<i>Staphylococcus aureus</i>	20	21	23
<i>staphylococcus epidermidis</i>	19	21	22
<i>Enterococcus faecalis</i>	13	14	17
<b>Gram negaitive</b>			
<i>Proteus vulgaris</i>	15	18	24
<i>Klebsiella pneumoniae</i> ,	18	21	21

### Discussion:

The clinical isolates in this study were diagnosed by biochemical tests and API 20. These bacteria will cause various diseases for human like *Staphylococcus aureus* (pneumonia, impetigo, cellulitis, scalded skin syndrome, mastitis, chorioamnionitis and neonatal sepsis), *Staphylococcus epidermidis* (endocarditis, nosocomial, biofilms to grow on catheters, acne) *Klebsiella pneumoniae* (pneumonia, thrombophlebitis, urinary tract infection, cholecystitis, diarrhea, upper respiratory tract infection, osteomyelitis, meningitis), *Proteus vulgaris* (urinary tract infections), and *Enterococcus faecalis* can causes endocarditis and bacteremia, urinary tract infections , meningitis, and other infections in humans (17, 18 , 19). Citrus health promoting properties have always been associated with their content of vitamin C and several bioactive compounds

mm in diameter were punched in the culture media with sterile cork borer. The various concentrations of watery extract for seeds of *Citrus aurantifolia* were transported 100  $\mu$ l by micropipette into each well to fullness (16). The plates were kept in room temperature for 1 h before incubating at 37°C for 24 h. Zones of inhibition around the wells, measured in millimeters, were used as positive bioactivity.

### Results:

The results have shown that seeds watery extract of *C. aurantifolia* has inhibitory action when increased in concentration gradually against these bacteria; the inhibition zones 19, 20 and 18 mm in diameter for *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Klebsiella pneumoniae* at 10%, while for *Enterococcus faecalis* and *Proteus vulgaris* were shown 13 and 15 mm respectively; but at 20% the results have shown the same inhibition zone for *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Klebsiella pneumoniae* about 21 mm, while *Enterococcus faecalis* and *Proteus vulgaris* have shown 14 and 18 mm in their diameter of inhibition zone around wells. In contrast the sensitivity for *Staphylococcus aureus*, *staphylococcus epidermidis*, *Klebsiella pneumoniae*, and *Enterococcus faecalis* were recorded as inhibition zones 23, 22, 21 and 18 mm respectively, behavior of *Proteus vulgaris* showed higher sensitivity than other isolates reaching to 24 mm after treatment with 40% concentration of seeds watery extract of *C. aurantifolia*. (Figure 1 & table 1).



**Figure 1:** The agar diffusion method for the antimicrobial activity to crud watery extract of seeds of *C. aurantifolia* against pathogenic bacteria (a) *S. aureus*, (b) *S. epidermidis*, (c) *K. pneumoniae*, (d) *P. vulgaris*, (e) *E. faecalis*

**Bacterial strains and culture conditions:**

The tested bacteria used in this study were three gram-positive (*Staphylococcus aureus*, *Staphylococcus epidermidis* and *Enterococcus faecalis*) and two isolates belonging to gram negative (*Klebsiella pneumoniae* and *Proteus vulgaris*) were obtained from pathogenic bacteria laboratory in the Department of Biology, College of Science, University of Baghdad, and were collected previously from different hospitals in Baghdad city. These isolates were cultured on brain heart infusion broth at 37°C for 24 h (Oxoid), the pure colonies were selected and streaked on blood agar plates (blood agar base –Oxoid– supplemented with 5% of human blood). These isolates were identified by biochemical tests (13). APIE- 20 test (bio- Merieux) was employed for the confirmation of identification.

**Maintenance of strains:**

Bacterial strains were maintained on deep Nutrient agar slant (Oxoid) for 5-6 weeks with periodic subculture and nutrient broth (Oxoid) with 35 % glycerol at -20°C (14).

**Standardization of inoculum:**

Test organisms were sub-cultured onto fresh plates of nutrient agar (Oxoid) at 37°C for 24 h. Colonies from these plates were suspended in Mueller-Hinton broth (Oxoid) to a turbidity matching 0.5 mc McFarland standard (108 cfu/ml) for bacteria; all plates were incubated at 37°C for 24 h (15).

**Antimicrobial activity Assay:**

The agar diffusion method is used for the antimicrobial evaluations. Suspension of the bacteria  $1 \times 10^8$  cfu/ml was made in sterile normal saline. Each labelled medium plate was uniformly seeded with a test organism by sterile swab rolled in the suspension and streaked on the plate surface. Wells of 5

ovate, 2.5–9 cm (1–3.5 in) long, resembling orange leaves (the scientific name *aurantifolia* refers to this resemblance to the leaves of the orange, *C. aurantium*); the flowers are 2.5 cm (1 in) diameter, are yellowish white with a light purple tinge on the margins. Flowers and fruit appear throughout the year, but are most abundant from May to September in the Northern Hemisphere (12). The growing resistance of microorganisms to conventional antimicrobial agents is becoming a source of concern to clinical microbiologists all over the world. This study aims to investigate the potency of seed of *C. aurantifolia* against different pathogenic bacteria and may be used in traditional medicine as antimicrobial agent.

## Material and methods

### Lime fruits:

Lime (*C. aurantifolia*) fruits used in this study were brought from local markets in Baghdad and the seeds were collected to use in next steps.

### Preparation of Seed powder:

The seeds of *C. aurantifolia* were washed by distilled water and dried rapidly by air current at room temperature, then milled by mortar until get fine powder and kept without sieving in clean flask.

### Preparation of aqueous extract for seeds:

Watery extraction of seeds were prepared at 10, 20 and 40 % by mixing the required quantity of seeds powder with distilled water and kept for 2 hours at room temperature and then heated slowly at boiling degree 100 °C for at least 1 hour. The solution was cooled at room temperature for 2 hours and then centrifuged at 5.000 rpm; the supernatant was collected and used as crude extract and kept until testing their susceptibility against bacteria.

**Introduction:**

Usage of plants in medicines for a wide variety of human ailments has deep roots in man's history (1, 2), Infectious diseases account for high proportion of health problems in the developing countries (3). As the World Health Organization (WHO) report, 80% of the world population presently uses herbal medicine for some aspect of primary health care (4). Approximately 20% of the plants found in the world have been subjected to pharmacological or biological tests, and many new antibiotics introduced in the market are obtained from natural or semi-synthetic resources (5, 6). Many researches and practical experiences have shown that using medicinal plants is better than chemical and semi synthetic drugs because of their fewer side effects, relative low cost and effectiveness besides having synergistic effect; Medical plants are used in the treatment of different disorders such as malaria, diarrhoea, burns, gonorrhoea, stomach disorders and other infectious diseases(7,8).

One of such plants is *Citrus aurantifolia* (Lime fruit), it is very much employed in herbal medicine and their bioactive activities for cold fevers, sore throats, sinusitis and bronchitis, as well as helping asthma, suppress stomachache and it has been found to be an excellent cough relieving (9). It can be helpful for rheumatism arthritis, obesity and cellulite and has an astringent and toning action to clear oily skin and acne, helps with herpes, cuts and insect bites (10). Lime is also used to overcome dysentery, constipation, dizziness body odor, increased appetite, tonsils and nose inflammation, prevent hair loss, dandruff, too fat, and to induce apoptosis in human pancreatic cells was studied (11). *C. aurantifolia* is known as West Indian lime, bartender's lime, Omani lime, Mexican lime, dayap and bilolo; it belongs to Rutaceae family, it is a shrubby tree, to 5 m (16 ft), with many thorns; the leaves are

## الفعالية ضد مايكروبية للمستخلص المائي الخام لبذور النومي البصرة تجاه بعض أنواع البكتيريا الموجبة والسالبة لصبغة كرام خارج الجسم الحي

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### المستخلص:

أختبر تأثير المستخلص المائي الخام لبذور نومي بصرة ضد عزلات سريرية مختلفة والتي تضمنت

*Enterococcus faecalis* و *Staphylococcus epidermidis* و *staphylococcus aureus* . *Proteus vulgaris* و *Klebsiella pneumoniae* .

أن التأثير التثبيطي للمستخلص المائي نفذ بطريقة الانتشار في الحفر وتمثل بمناطق تثبيط النمو حول الحفر مقاسة بوحدة القياس الملمتر، ان كبر مناطق التثبيط مرتبطة بتركيز مستخلص البذور (١٠ و ٢٠ و ٤٠) %.

ان الفعالية ضد مايكروبية لمستخلص البذور الخام قد تعزى لمركبات حيوية موجودة فيه، النتائج التي تم الحصول عليها أظهرت ان المستخلص المائي الخام لبذور ثمرة النومي بصرة يمكن أن يعد مصدراً جيداً للمركبات الضد مايكروبية ويمكن استخدامها كعلاج بديل للعديد من الامراض المعدية ويمكن أن يهيئ بأشكال علاجية مختلفة.

الكلمات المفتاحية: بذور النومي بصرة ، البكتيريا الموجبة والسالبة ، صبغة كرام

## **Antimicrobial Activity for Crude Watery Extract of Seeds of *Citrus aurantifolia* (Lime fruit) against Gram Positive and Negative Bacteria In Vitro**

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### **Abstract:**

The effect of crude watery extract for seeds of *Citrus aurantifolia* (Lime fruit) was tested against different clinical isolates including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecalis*, *Klebsiella pneumoniae* and *Proteus vulgaris*. The inhibitory effect for watery extract was carried out by agar well diffusion method and represented as inhibition zones around wells and measured with millimeter unite; the large zones are linked with concentration 10, 20, 40 % of seed extract, the antimicrobial activity of crude seeds extract may be attributed to bioactive compound present in it. The results obtained shown that the crude seeds watery extract of *C. aurantifolia* fruit can be considered as good source of antimicrobial compounds and can be used as alternative therapy for many infectious diseases and can be incorporated into different drug formulations.

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## 6. Conclusion

In our work, the access control system is implemented based on the facial recognition. The face recognition algorithm is built using the Matlab program and interfacing with webcam using special command that read image from the camera and the result is sent to Arduino microcontroller that drives a gate. Wavelet transform was used as feature extraction to get the best information as shown in the result, Wavelet maximizes the distance for people outside the database while minimizes the distance for people in the database .It can be concluded that the format 160x120 with wavelet transform is the best format for recognition, Arduino controller is very simple to interfacing and can be used as educational tool to help the researcher and student to test their algorithms and proposed methods, also it is possible to use Matlab in real time interfacing with hardware devices.

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Table 2 Distance between input image and data base

Image	Eigenface		Wavelet transform	
	Image format 160x120	Image format 320x240	Image format 160x120	Image format 320x240
1	$0.72192 \times 10^8$	$2.9423 \times 10^8$	$3.269 \times 10^8$	$0.306 \times 10^8$
2	$0.72132 \times 10^8$	$2.9425 \times 10^8$	$3.26 \times 10^8$	$0.304 \times 10^8$
3	$0.72199 \times 10^8$	$2.9391 \times 10^8$	$3.353 \times 10^8$	$0.544 \times 10^8$
4	$0.911805 \times 10^8$	$3.6588 \times 10^8$	$14.961 \times 10^8$	$16.276 \times 10^8$
5	$0.910275 \times 10^8$	$3.65235 \times 10^8$	$14.928 \times 10^8$	$16.327 \times 10^8$
6	$1.06149 \times 10^8$	$4.2519 \times 10^8$	$15.09 \times 10^8$	$18.806 \times 10^8$

Table 3 Normalize distance between input image and data base

Image	Eigenface		Wavelet transform	
	Image format 160x120	Image format 320x240	Image format 160x120	Image format 320x240
1	0.9381	0.9527	0.7192	0.0347
2	0.9373	0.9527	0.7171	0.0344
3	0.9382	0.9516	0.7377	0.0616
4	1.18485	1.1847	3.2915	1.8442
5	1.18275	1.1826	3.2843	1.8501
6	1.37925	1.3767	3.3199	2.131



Figure 6 Traing Images

Table 1 Average of distance between data base and test images

Method	Eigenface		Wavelet transform	
	160x120	320x240	160x120	320x240
Image format	160x120	320x240	160x120	320x240
Average distance	$0.77 \times 10^8$	$3.09 \times 10^8$	$4.55 \times 10^8$	$8.83 \times 10^8$



Figure 7 Test Images

format 160x120) is  $7.70 \times 10^7$  while it equal to (with image format 320x240) is  $4.55 \times 10^8$  as shown in table 1.

To test the proposed method, different image is input to the system (image 1 to image 3 belong to the data base while image 4 to 6 do not belong to the database) using webcam and find the distance between it and database, table 2 shows some of this distance using different methods and different values of image format, the value is normalized by dividing the result distance on average distance as shown in table 3.

From table 3 it is found that image format 320x240 with wavelet is better to represent the image since it gives high distance if the person does not belong to the database.



**D) Output command :** the output command is sent to the Arduino using the command interface, such a. `digitalWrite (pin, value)` put the value in port number pin [7]. In fig. 5 the motor support three wire ground, power and signal. The power line has color red and must be connected to pin Vcc pin of the Arduino. The ground wire , usually brown, must be linked to the GND pin of the Arduino. The signal line usually orange, it connects to pin 9 in our work. This set as output port in Matlab command.

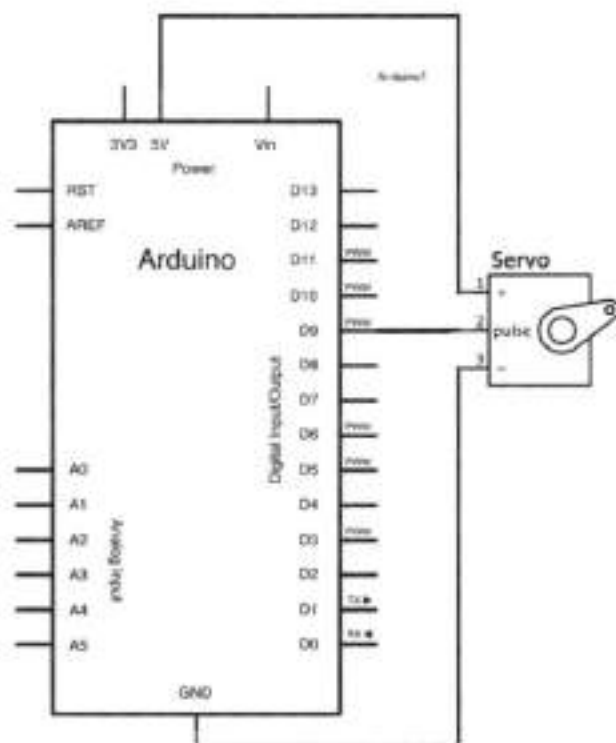


Figure 5 Arduino microcontroller pins connection

## 5. Experimental Result

After building a database (fig. 6 shows some of these images), several images of person in the data base with different posture are input to the system and determine the distance, it is found in PCA the average distance (with image

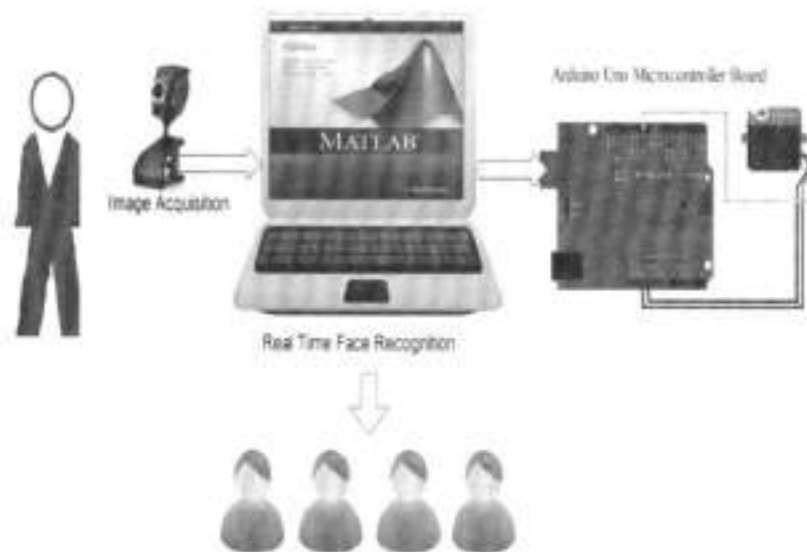


Figure 3 proposed system

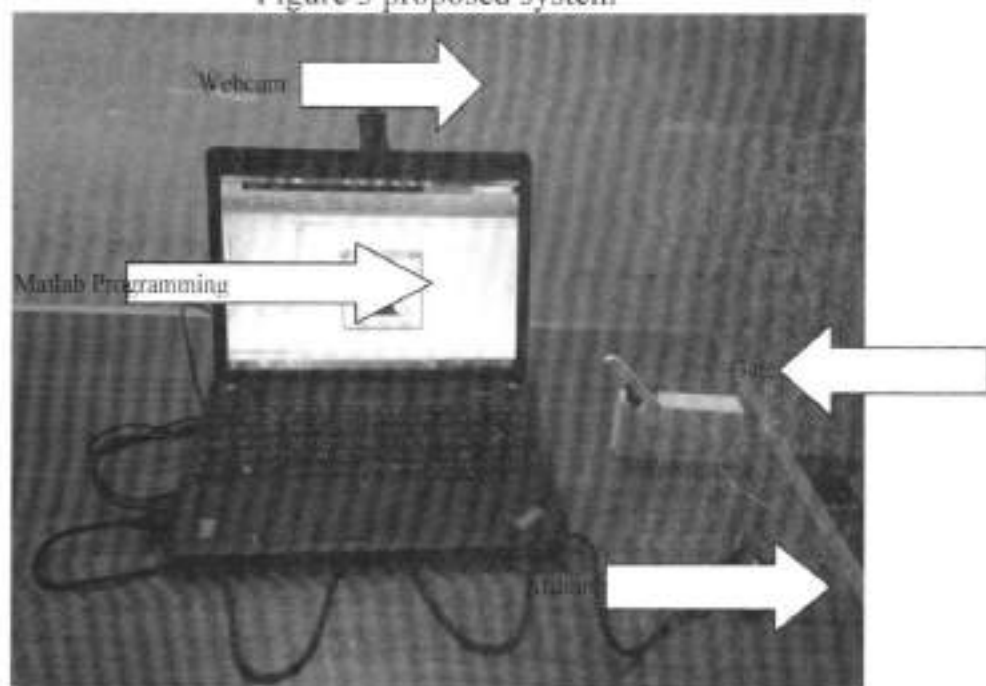


Figure 4 Actual systems

### A) Acquisition System

Read image from webcam to matlab with videoinput command .The type of webcam used in this work is havit-usb-hvs-n635 as shown in Figure 1. With matlab, it can read the image from webcam using special command such videoinput ( winvideo ,ID,format) ,where , Winvideo is video object that connects image source with matlab ,ID is a number that represents the device ,Format represents the size of image .At first some images are taken to build data base using matlab command to obtain matrix such as  $X_1, X_2, \dots, X_N$  ,the size of the image is [ row col]

**B) Data Base :** in this stage the data base is built using the following step:

- 1) Apply wavelet transform to each image  $,W_1, W_2, \dots, W_N$  with different levels then take the low pass information
- 2) Convert the matrix to vector  $V_1, V_2, \dots, V_N$  length row\*col
- 3) Constrain a matrix  $A = [V_1 \ V_2 \ \dots \ V_N]$
- 4) Perform the principle component analysis on matrix A to get PCA matrix that have dimension [N N]. At this stage the data base is constricted.

**C) Distance Measure:** read some images which belong to data base and apply the same producer in stage B then find the distance with PCA matrix .This distance consider as reference ,if the distance is of input face exceeds this value the input face is considered out of data base.



Figure 2 Arduino microcontroller

The major benefits of using Arduino in educational setting are : Easy Setup ,Running on Windows, Linux, and Mac , Low cost devices - to build or buy start using the program ,Low-cost-free – the low cost of maintenance ,Students can consider it a model that can be quickly programmed ,It can be programmed with different languages such C matlab [8].

The Arduino Uno type is used in our work, the system unit ATmega the Council on the basis of 328 it has 14-pin Digital Input Output (6 can be used PWM outputs and inputs analog), 6, 16 Mhz crystal oscillator, USB connection, the power socket, ICSP head, the reset button. It has all the necessary traib to support the control unit. Simply connect it to your computer using a USB cable or with AC to DC or the battery [9].

#### 4. Proposed System

The proposed system contains the following stages (shown in fig.3) with hardware component :Web Cam (Acquisition system) ,PC (Building data base and send the output command ) ,Arduino microcontroller ,Servo Motor



Figure 1 Wavelet Transform Decomposition

#### 4. Arduino Microcontroller

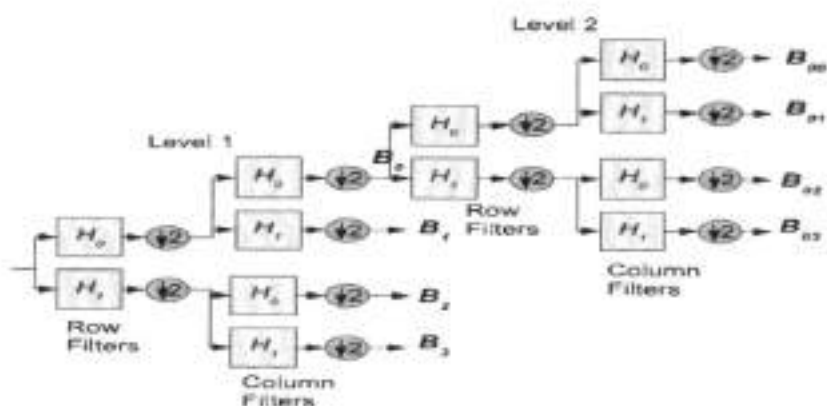
Arduino is an open source of the browser electronics of hardware and software components. The basic objective of the design Arduino platform is to suit the needs of artists and designers of the amateurs, any person interested in creating an interactive environment. The Arduino can receive inputs from the sensors and it can therefore be the use of indicators and the hinge assemblies, sensors and other components [7].

It can be programmed by different ways. Such IDE software can also be programmed by matlab using special function, it has analog and digital input output pins

small, we say the images are similar and we can decide the most similar image in the database [4].

### 3. Discrete Wavelet Transform

Wavelet transform is multi resolution that provides a subband of frequency for input image through different filters. It is better for it in the analysis of the signals. Wavelet Two dimensional transform converts the image from the spatial domain to frequency domain. The picture is divided on the horizontal and vertical represents the first ordered the wavelet transform, the image of the separation with four parts of those Low-Low, Low-High, High-Low, and High-High [5]. The two-dimensional signals, such as pictures quad tree structure , is shown in Figure 1. At each levels of implementation are inseparable from a tree quad consists of two phases of filtering. The first phase of the filtering of the subsidiary samples picture grades generates a pair of traffic horizontal low rise of photos of the Sub-Commission. The second phase of the Currency filtering without taking samples of the pillars of the filtering of the reference to produce row pictures of the four subprograms under the symbol  $B_0 \dots , B_3$ . Similar to the 1D the  $B_0$  image obtained in previous stage, it becomes a new entrance to the next level of currency [6].



The principal component analysis is one of the most popular ways to reduce the dimension in the face recognition. In the PCA, it is represented as a linear object a combination of eigenvectors likely also called Eigenfaces. It is obtained this eigen-vector of covariance Matrix image training group also called on the function of the basis. Eigen faces has a number that will be equal access for number of images in the training group. Faces Eigen takes advantage of the similarity between the pixels between images in the data set through the covariance matrix of their own. This Vector produces a new face area where the images an actress. To fix the required notation, let's offer the following symbols.

Let's set the image (IM1, IM2... IMN) that consists of training images each with [I J].

- 1) Converts all the pictures in a column dimensions I\*J Vector.

$$V = [IM1, IM2... IMN] \quad (1)$$

- 2) calculated covariance of group training matrix image Using the equation

$$C = \frac{1}{N} \sum_{i=1}^N (IM_i - AV)^T (IM_i - AV) \quad (2)$$

Where AV is the average of all the vector images in training image.

- 3) Find the eigenvectors of covariance matrix EV
- 4) Project EV on IM to get eigenface.

The recognition of the unknown face image or test normalized subtracting means the transmission of all photos in training. After the Feature (weight vector) to test found on a picture, the next step in the reclassification. Next step is to classify it. For the classification task we could simply use Euclidean distance classifier  $n = 1, 2, \dots, N$ . If the distance is

## 1. Introduction

At present, it has become automatic identification in the popular access control using biometrics data instead of using passwords or pattern cards. Some of the biometrics data must be collected using special devices such as palm print scanner fingerprint scanner, and, the target objects to touch it with the required hardware in the data collection phase. The advantage of this system is that facial recognition does touch with any device. It was detected face automatically using the face detection technology and is finished to recognize the entire face without touching with any device. Face detection is the first step of facial recognition system [1].

Several work applied to face recognition system, [2] used a combination of PCA to data redundancy, with Wavelet Transform used to decompose the input image. Our work tries to implement the complete face recognition system based matlab and arduino in real time using webcam as source of image .At first the data base is built by taking different images from webcam then applying the recognition algorithm and give the output a command to arduino.

## 2. Eigenfaces

Full Eigenface calculated using the PCA technique include data preparation, put the medium, and the calculation of covariance matrix, and find Eigenvalues and eigenvectors for covariance matrix and choose the main components. Faces of training and sample test are taken from the webcam. Images are allowed to be training a group  $G_1, G_2, \dots, G_M$ . Average picture must have been  $AV$  calculated and subtracted from each facial image to get  $AVG$ . At end the eigenvectors and eigenvalues of the covariance matrix are calculated [3].

## Real Time Face Recognition Based on Matlab and Arduino Microcontroller

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AL- Mustansiriyah University, Electrical Engineering Department

### Abstract

Recently the access control problem has drawn more attention in our lives. Biometric is one of these techniques specially face recognition, which is considered a better method. In this paper the real time face recognition system is implemented using hardware devices webcam as input device and arduino microcontroller as output device. While the Matlab is used as a programming tool in software part, it provides wide area and flexibility of algorithm. Wavelet transform is used as feature extraction with principal component analysis which provides data redundancy. The system is tested with real images taken through webcam and a good result is obtained. The proposed system can be used in our lives.

### كشف الوجه في الزمن الحقيقي باستخدام الماتلاب ومسيطر الاردوينو

د. عباس حسين مري

الجامعة المستنصرية – كلية الهندسة

#### المستخلص:

أصبحت أنظمة الدخول من الأمور المهمة وخاصة البيومترية في حياتنا العملية واكتشاف الوجه هو أحد هذه الطرق المهمة. في هذا البحث يتم استخدام منظومة عملية لاكتشاف وجه باستخدام الويب كام لإدخال الصور ومتحكم الوردوينو لإخراج الإشارة بينما تم استخدام الماتلاب كأداة لتطبيق الخوارزمية للتمييز. تم استخدام تحويل المويجة لاستخلاص المعلومات الموجودة في الصورة حيث يمتاز بجودة تمثيله للمعلومات وأخيراً استخدمت الشبكات العصبية للتمييز. وهذا النظام المقترح تم تطبيقه على مجموعة من الأشخاص وأثبت فاعليته وأصبح من الممكن استخدامه بشكل عملي.

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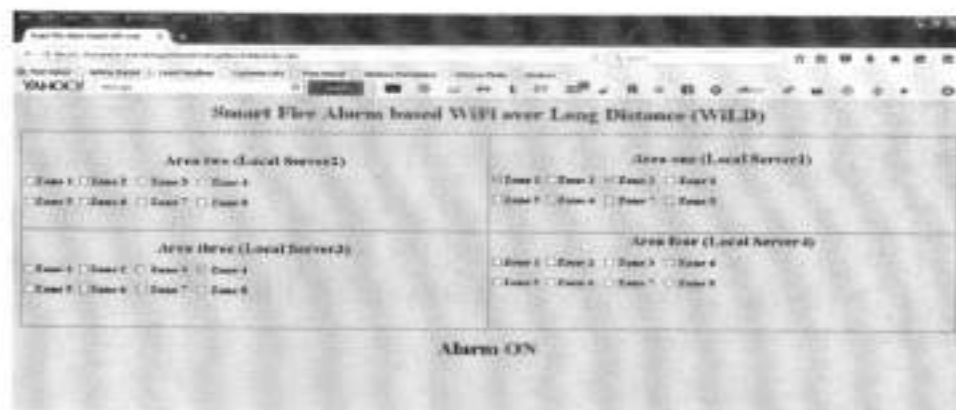


Figure14: User interface web page

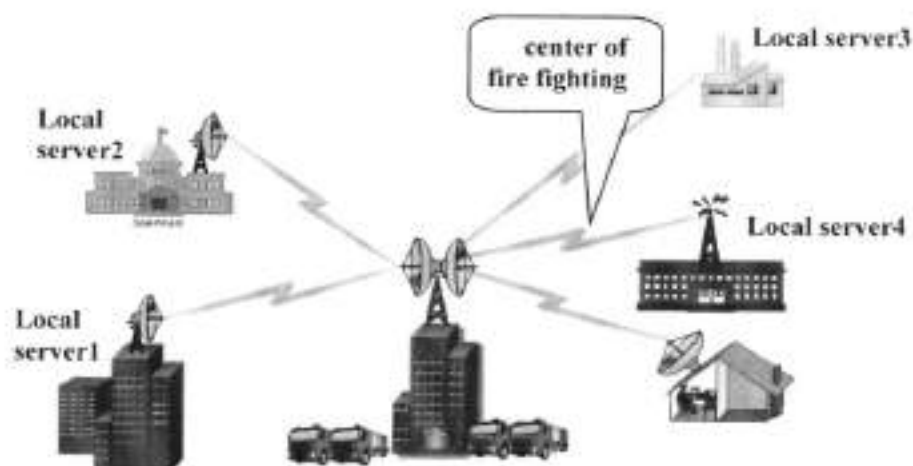


Figure15: Fire alarm system based WiLD

## 6. User Interface

The User Interface communicates to the server via Ethernet and displays the result in a web browser. It shows the data from every sensor via Web page in HTTP Response. Arduino works as a Web-Server to generate HTTP page which is displayed by the web browser as shown in figure 14.

In this research a prototype of Addressable Fire Alarm based WiLD is shown in figure 15.

## 7. Conclusion

In this research a prototype of a Smart Fire Alarm based Wi-Fi over Long Distance (WiLD) has been Designed and Implemented based microcontroller and Xbee as sever, detecting the occurrence of fire in different locations using fire detecting system. The fire indicator indicates the location of fire and produces alarm in the fire location and the center of fire fighting based WiLD signal is transmitted from fire location to the center of fire fighting.



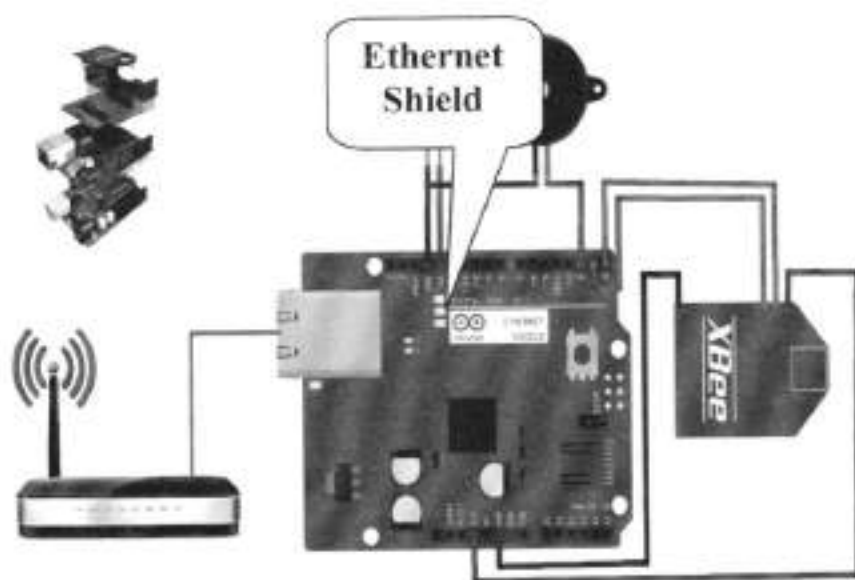


Figure12: central server(coordinator) of Fire alarm system

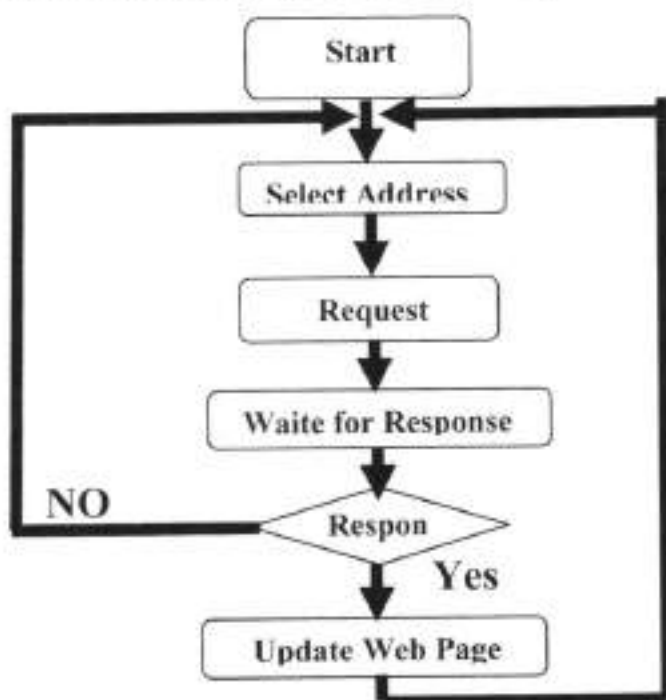


Figure13: flowchart of central server(coordinator)

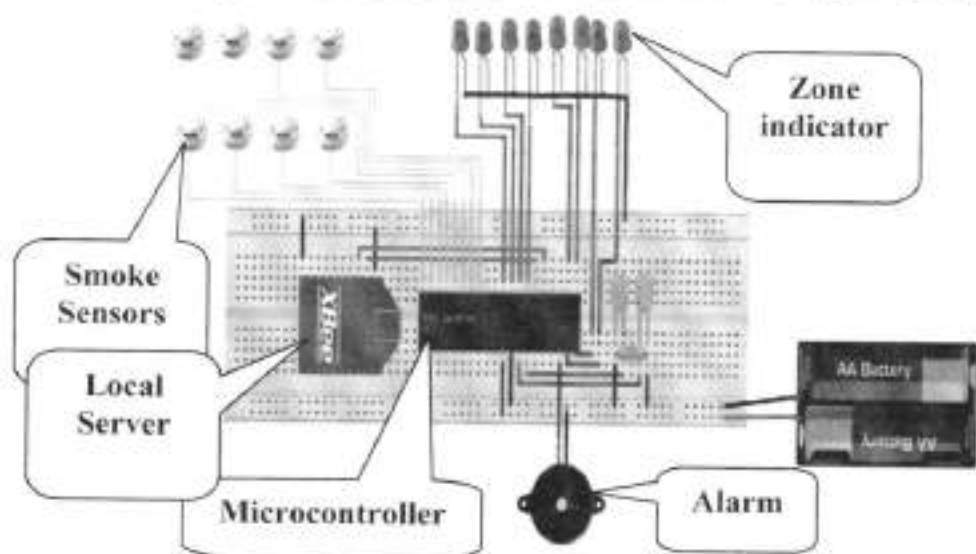


Figure 10: Interfacing PIC16f877A with local server

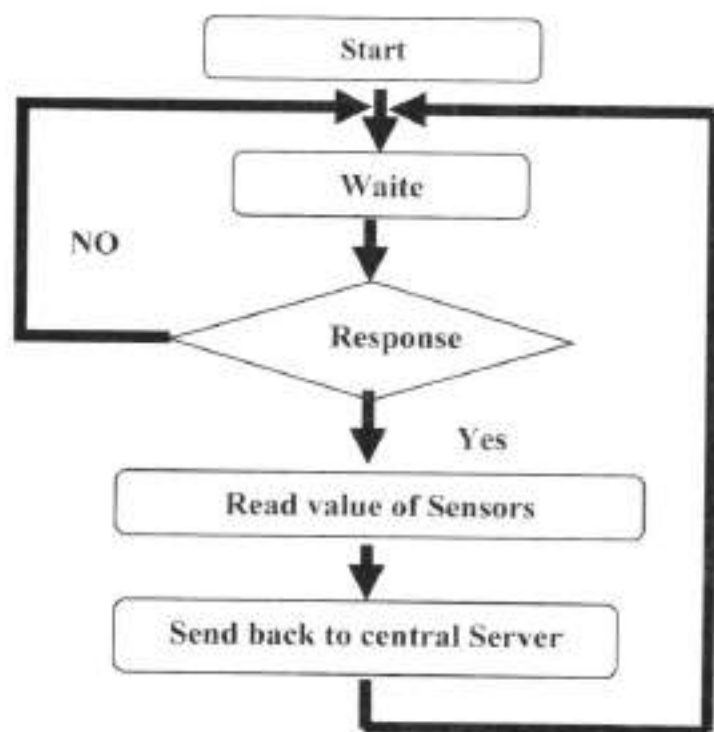


Figure11: flowchart of Local server(End Device)

## 5. Central Server

The central server is located in the fire fighting center ,where the local servers send the status of each area under monitoring continuously with specific algorithm. The central server is operated as coordinator. It collects sensor readings from the sensors back to the user. The function of the collector is divided into two parts: Web-Server and Xbee Interface. These two functions are implemented on the Arduino board. The hardware of the coordinator consists of an Arduino USB Board, Xbee Shield, Alarm indicator and Ethernet Shield, as shown in Figure 12. The Web-Server function uses the <Ethernet.h> library, while the Xbee Interface uses the <Xbee.h> library. The flowchart of the coordinator is shown in Figure 13.



Figure8: Fire Alarm Control Unit without Server

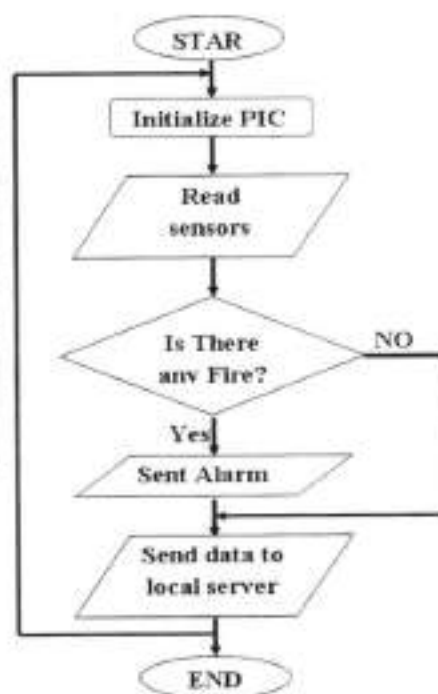
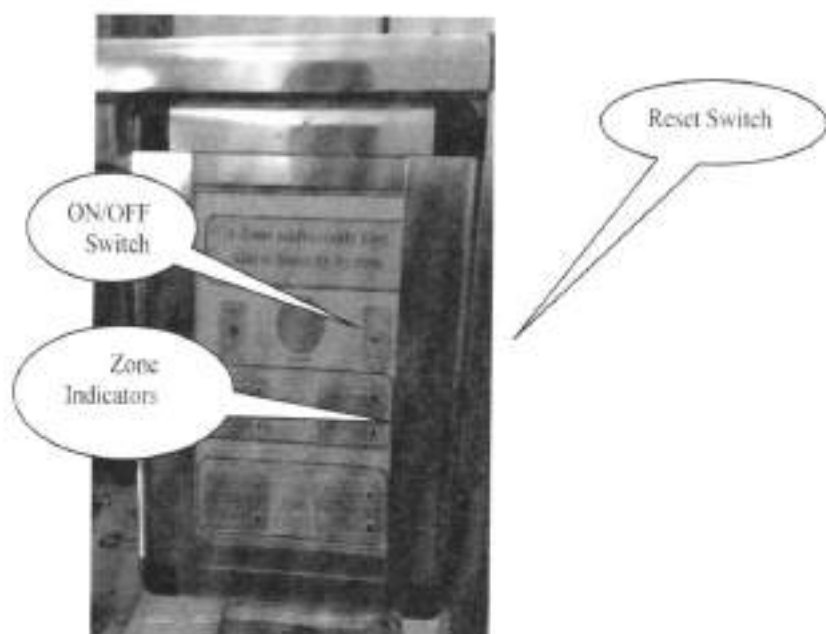


Figure9:Fire alarm system algorithm

The control panel used for controlling and monitoring zones state in the system asre shown in figure 7.



**Figure7: Fire alarm control panel**

The fire detectors have been used to indicate the status of the system where they send signals to the microcontroller (PIC16F877A). The microcontroller (PIC16F877A) output indicates on a simple LED diode for each zone and two switches; one for resetting the system and the other for power control as shown in figure 8 and the algorithm of the fire alarm system is shown in figure 9. The microcontroller (PIC16F877A) is interfaced with local server (xbee) via USART serial port Each local sever operates as end device. The device waits for data reading request (i.e., polling) from the Coordinator and then responses with the value from the sensors, as shown in figure 10, and the algorithm of local server is shown in figure 11.

server indicates alarm and provide the location of the fire to the center of fire fighting.

#### 4. Fire Alarm Control Unit

Each location has a fire alarm control unit which was detect the fire and send a status signal of the location to the server via WiFi. In this research both heat and smoke detectors have been used and divided in to eight zones for fire detection as shown in figure 5, and the smoke sensor is shown in figure 6.

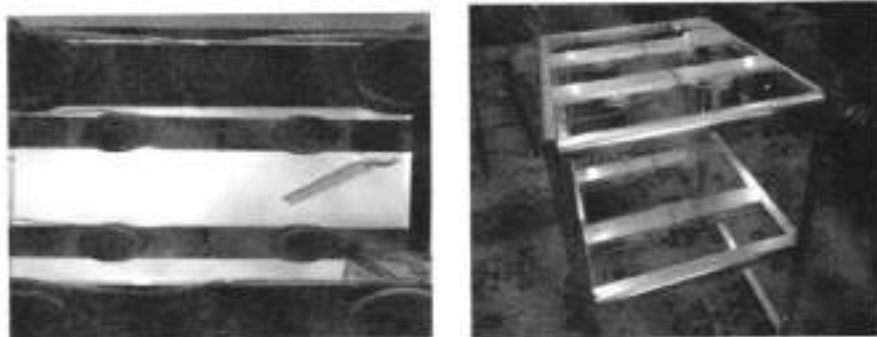


Figure5:Eight Zones Fire alarm system

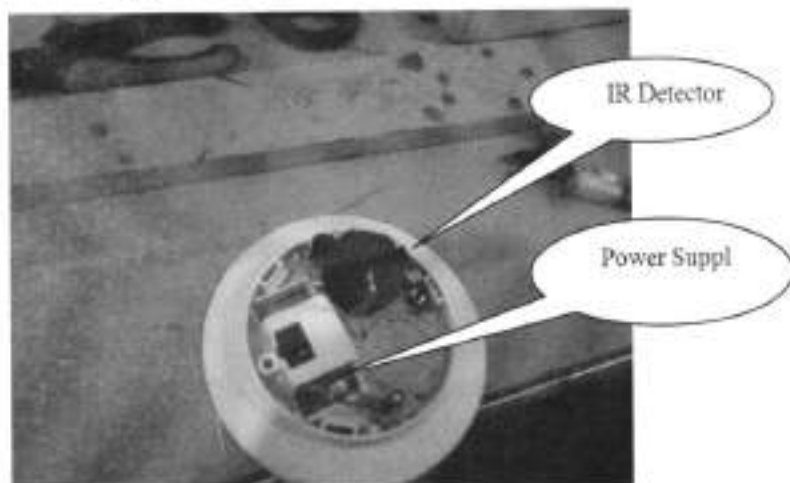


Figure 6: Smoke sensor

typically powered with reliable sources because they must be dependable. Thus, a data-aggregation node would be a good choice for the router radio mode.

- End device: An end device is a node that sends or receives information to the router nodes and the coordinator. It has an advantage in that less processing is going on, so power consumption is lower. End devices support a sleep mode to reduce power requirements still further. Most of the sensor nodes will be configured as end devices[10], as shown in figure 4.

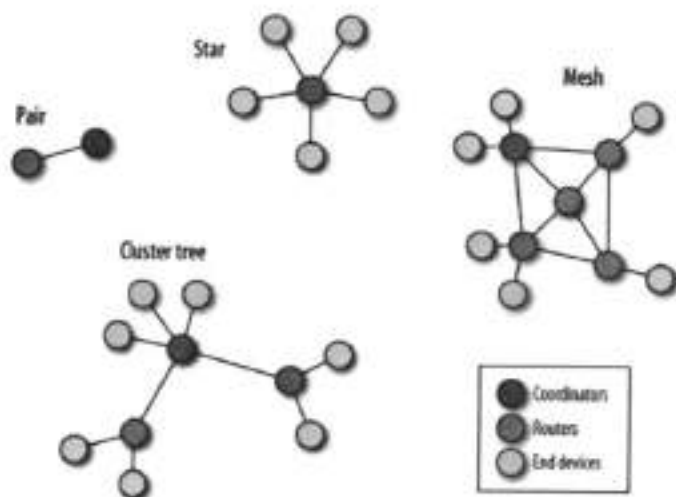


Figure 4: ZigBee network topologies

### 3.SYSTEM ARCHITECTURE

The requirement for this research is to design and create a functional smoke detector. After detecting smoke or a high temperature (potential fire), the detector sets on the appropriate alarm sound. The control unit also transmits a control signal to the local server in the network so that this server sends a status message to the central server continuously where the central



**Figure 3. XBee address printed on the back of the module**

ZigBee networks are based on a predefined network stack where each layer in the stack is responsible for a specific transformation of the data messages. Also like other networks, ZigBee networks support message routing, ad hoc network creation, and self-healing mesh topologies. Thus, the radio address and the PAN address are needed to support these features. Support for mesh topologies is made possible with the addition to the different roles that each node (radio) can perform in the network. The following list describes each role in more detail, starting from the most complex.

- **Coordinator:** A single coordinator is needed for each network. This node is responsible for administering addresses and forming and managing the network. All other nodes search for the coordinator and exchange handshake information at startup.
- **Router:** A node that is configured as a router is designed to pass on (route) information to other radios. Routers enable the healing of mesh networks by joining networks and exchanging messages from other nodes. Routers are

### 3.4 XBee

An XBee is a self-contained, modular, cost-effective component that uses radio frequency (RF) to exchange data between XBee modules. XBee modules transmit on 2.4 GHz or long-range 900 MHz and have their own network protocols. The XBee module itself is very small about the size of a large postage stamp making it easy to incorporate in small projects like sensor nodes. The modules are also low power and can use a special sleep mode to further reduce power consumption. Although the XBee isn't a microcontroller, it does have a limited amount of processing power that you can use to control the module. One of these features, the sleep mode, can help extend battery life for battery-powered (or solar-powered) sensor nodes. You can also instruct the XBee module to monitor its data pins and transmit the data read to another XBee module. XBee modules can link a sensor node to a data-aggregator node. While the XBee can be used to read sensor data, its limited processing power may mean it is not suitable for all sensor nodes. For example, sensors that require algorithms to interpret or extrapolate meaningful data may not be suited for using an XBee alone. You may need to use a microcontroller or computer to perform the additional calculations[9].

The XBee modules are branded with a specific serial number or address located on the bottom of the module. This is a bit inconvenient given that you normally cannot see the back of the module when it is mounted. However, you can find the address using either the Digi configuration application or a simple serial terminal application. Figure 3 shows the underside of an XBee module. Notice the numbers printed under the model number.

fire detector devices, they also are the slowest in fire detecting. A heat detector is best situated for fire detection in a small confined space where rapidly building high-output fires are expected, in areas where ambient conditions would not allow the use of other fire detection devices, or when speed of detection is not a prime consideration. Heat detectors are generally located on or near the ceiling and respond to the convected thermal energy of a fire. They respond either when the detecting element reaches a predetermined fixed temperature or to a specified rate of temperature change. In general, heat detectors are designed to operate when heat causes a prescribed change in a physical or electrical property of a material or gas, as shown in figure 2.



**Figure2: Temperature sensors**

### **3.3 Control Unit [8]**

The control unit contains the microcontroller which is the heart of the system. It receives inputs from the receiver, temperature sensor, smoke sensor, and low battery sensor, as well as outputting the appropriate signals and bits to the tone generator and transmitter.

and to transmit more accurate information to fire-fighter and remote monitor[5].

### 3.Fire Detection and Alarm System Basics

The fire alarm system consists of :

1. Fire detectors (with can be smoke detector, heat, or Infra-Red detectors),
2. control unit ,
3. alarm system

#### 3.1 Smoke Sensor

The smoke sensor provides a mean to detect smoke and to serve as an early fire warning. The basis of the smoke sensor is a T-shaped chamber figure 1 with an infrared LED that emits a beam of light across the horizontal portion of the chamber. When smoke enters the chamber, however, the smoke particles scatter the light and some amount of light hits the sensor .[6]

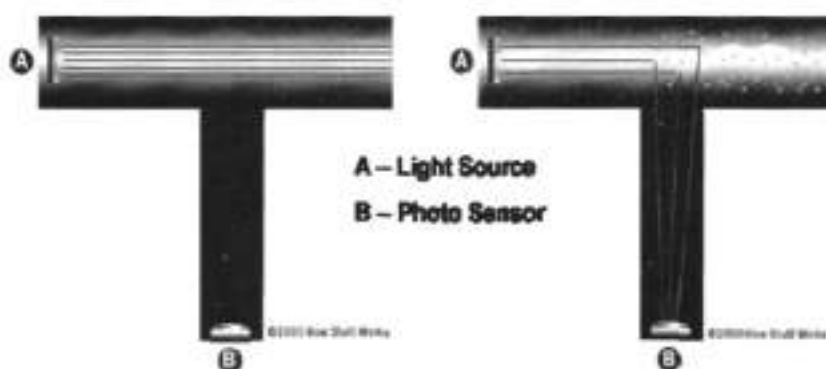


Figure1: Smoke sensor

#### 3.2 Temperature Sensor[7]

Heat detectors are the oldest type of automatic fire detection device. They began development of automatic sprinklers in the 1860s and have continued to the present with proliferation of various types of devices. Heat detectors that only initiate an alarm and have no extinguishing function are still in use. Although they have the lowest false alarm rate of all automatic

device is missing or if the wrong type of device is installed. Conversely, the conventional system will show a trouble condition and the zone where the trouble occurred. Also, when a device reaches the alarm level, the conventional system will give the area of alarm, the addressable system will tell what device is in alarm and where that device is located. Smoke detection has become a fundamental component of the active fire protection strategy of most modern buildings, particularly residential occupancies.

## 2. Background and Related Work

Forest fires are one of the main causes of environmental degradation nowadays. The current surveillance systems for forest fires lack in supporting real-time monitoring of every point of the region at all time and early detection of the fire threats[3]. In rooms of Sharda University, Greater Noida, India the design and deployment of wireless sensor network is used for campus monitoring. With the help of Passive Infrared (PIR) sensor, temperature sensor, and humidity sensor, an effective utilization of energy resources has been implemented. The security of campus against intruders moving in laboratories, class rooms, staffrooms or washrooms etc. after working hours and fire alarm are also provided by this system[4]. Indonesia has been suffered from forest fires. The recent fires in logger-over forest, peat land, and plantation should be classified into one of human-made disasters. In recent years, fires in Indonesia occurred mainly in peat land area and become one of international serious issues due to haze and CO<sub>2</sub> emission. One strategy to detect and monitor peat-forest fires in Central Kalimantan, Indonesia is to use a Wireless Sensor Networks (WSNs), which contains miniature sensor nodes to collect environmental data such as temperature, relative humidity, light and barometric pressure,

(microcontroller) الذي يرتبط بالخادم المحلي ليبلغه عن حالة الموقع. يهدف البحث الى تطوير نظام لتحسس الحرائق و ابلأغ مركز اطفاء الحرائق في وقت مبكر عبر الشبكة اللاسلكية لتقليل الخسائر الناتجة عن الحرائق.

## 1. Introduction

Addressable fire alarm systems assign each initiating device a discrete and unique identification (address). In addition to the address, the panel will usually have the ability to have a tag to further identify the address (i.e. Address 1, Front Lobby, back door, hallway, etc). Some addressable systems consider each point as a separate zone. Addressable devices are similar to conventional devices in that they are either in alarm or in a normal condition.

Addressable systems utilize a Signaling Line Circuit (SLC) to communicate with detectors, modules and auxiliary devices to complete the system. These types of systems have more versatility and features compared to the conventional systems. Modules and additional circuit boards allow the addressable systems to expand and perform more remote relay functions, dry contact monitoring, remote power control, releasing service and conventional zone monitoring. [1][2]

The addressable systems also allow for mapping of inputs to outputs. This allows the end-user to control the panel in such a way that specific smoke detectors can control certain output functions.

Addressable fire systems have a number of advantages over conventional systems. The wiring for each zone must return to the panel on conventional systems, whereas the addressable systems use a single pair of wires and connect to all of the initiating devices and control modules on the addressable system. In addition, when a trouble occurs with the addressable system, the information from the panel will help the installer determine where the problem has occurred, if a

## Design and Implementation of a Smart Fire Alarm System Based of Wi-Fi over Long Distance (WiLD)

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### Abstract

This research is developed for the users to sense the occurrence of fire in different locations such as factories, houses, ....etc, using fire detecting system. The fire detector indicates the location of fire and produces alarm in the fire location and the center of fire fighting based WiLD. The signal transmitted from fire location to the center of fire fighting, where a fire sensor connected to the microcontroller that was interfaced to the local server which will transmit the status of the location continuously to the central sever in the center of fire fighting.

**Keywords:** Xbee, Fire alarm system, Microcontroller, WiLD

### تصميم و تنفيذ منظومة انذار الحرائق الذكية بالاعتماد على الشبكة اللاسلكية للمسافات الطويلة

م. احمد علي راضي

كلية المأمون الجامعة / قسم هندسة تقنيات الحاسوب

### المستخلص:

تم تطوير نظام يتحسس الحرائق في المواقع المختلفة مثل المصانع و المنازل ...الخ، باستخدام نظام تحسس الحرائق. يعمل هذا النظام على تحديد منطقة الحريق في الموقع الواحد و اصدار منبه الحريق و كذلك يصدر منبه الحريق في مركز اطفاء الحرائق و عن طريق ارسال رسالة عبر الشبكة اللاسلكية (WiLD) (من الخادم المحلي ( local server ) الى الخادم المركزي (central sever) في مركز اطفاء الحرائق و ترتبط متحسسات الحرائق بالمسيط الدقيق

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Since anemometer was available to measure the flow velocity, the applied fan voltage  $V_{fan}$  (V) is used for quantification of the flow velocity. For all measurement in this chapter, the fan voltage is set to  $V_{fan} = 10$  V.

## 5. Conclusions

The purpose of an OTG is to add calibrated optical turbulence to the wave-front incident on the telescope, and here a certain number of properties and scaling laws must be considered because these define the OTG specifications. Because the atmosphere follows Kolmogorov statistics, this behavior has to be reproduced by the OTG which ensures realistic simulation and comparability with model predictions.

Wave-front correction is an important issue when dealing with coherent communication. Based on measurements of the bit error rate with a coherent receiver in downlink experiments from TerraSAR-X, it can be shown that, without a deformable mirror but tip-tilt correction, for a working coherent system the ratio between aperture size and Fried parameter may be up to  $D/r_0 = 2$ , provided that scintillation and incident mean power lie in tolerable magnitudes.

and other matter dealing with atmospheric propagation in the visible and infrared. However, due to the high cost, the wave-front sensor is supposed to be switchable, which means a mechanical interface is desired where the sensor can easily be docked on. Furthermore, the optical design of testbed is desired to be achromatic at the wavelengths 635 nm, 1064 nm, and 1550 nm. The latter two are important communication wavelengths that must be examined in the lab, the first one is for illustration, tests, and alignment purposes.

#### 4. Measurement arrangement

A calibration of the OTG is important to use for communication and adaptive optics systems tests without having to do turbulence measurements each time. Since the temperature difference  $T_{diff}$  determines the strength of turbulence, a calibration curve of temperature difference over dimmer scale of the power dimmer scale (DS) is recorded and illustrated in figure 4. The dependency of  $T_{diff}$  from DS is quite linear.

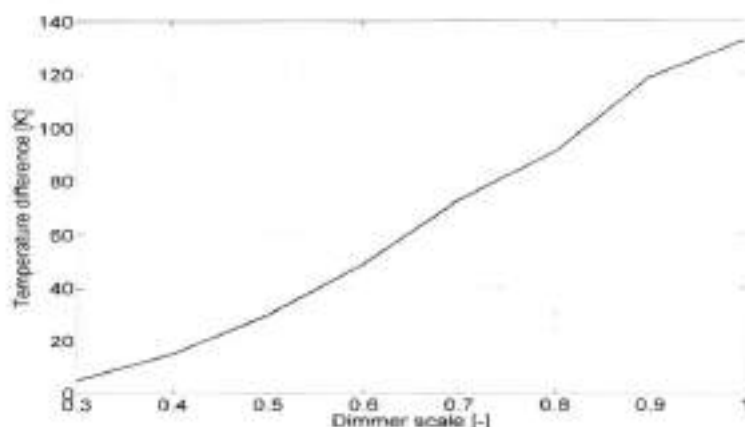
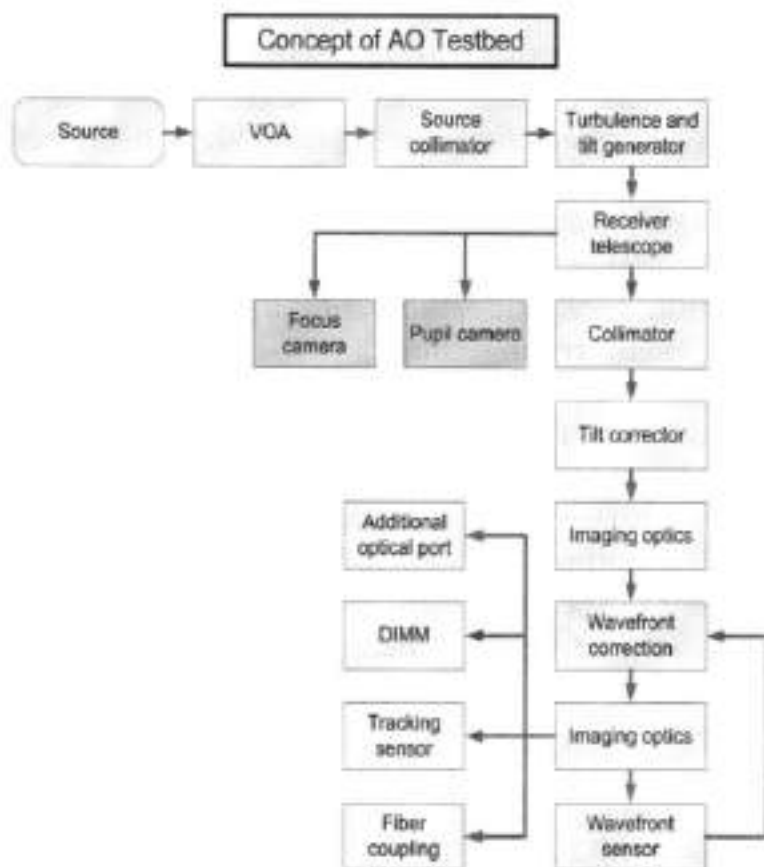


Figure 4: Dependency of temperature difference from dimmer scale for the hot-air OTG at  $V_{fan} = 10$  V.



**Figure 3: Flow design of the adaptive optics testbed. The blue elements denote the main optical path. The first four ones comprise the source, the last seven ones the receiver. The orange elements are to characterize and calibrate the artificial turbulence. The green ones contain elements for system tests and measurements behind the wave-front correction.**

The testbed itself shall be fixed in place. That means it is supposed to be an enduring development to supply a laboratory testbed to the scientist who might need to test not only techniques of adaptive optics and wave-front sensing but also communication modulation formats, tracking algorithms

**Table 2: Comparison of influence of AoA fluctuation on the spot movement in the image plane for same focus lenses. Because the significant ratios  $D/r_0$  and  $D/f_{eff}$  are the same, the resulting spot movement due to AoA fluctuations is the same (last line).**

Parameters	Testbed	TerraSAR Down-link
<i>Aperture <math>D</math></i>	<i>20 mm</i>	<i>40 cm</i>
<i>Wavelength <math>\lambda</math></i>	<i>1064 nm</i>	<i>1064 nm</i>
<i>Focal length <math>f</math> of focus lens</i>	<i>35 mm</i>	<i>35 mm</i>
<i>Effective focal length <math>f_{eff}</math></i>	<i>70 mm</i>	<i>1.4 m</i>
<i>Fried parameter <math>r_0</math></i>	<i>2.5 mm</i>	<i>5 cm</i>
<i>Ratio <math>D/r_0</math></i>	<i>8</i>	<i>8</i>
<i><math>D/f_{eff}</math></i>	<i>0.29</i>	<i>0.29</i>
<i>Standard deviation of angle-of-arrival <math>\alpha_{AoA}</math></i>	<i>225 <math>\mu</math>rad</i>	<i>11.3 <math>\mu</math>rad</i>
<i>Standard deviation of spot movement <math>x</math></i>	<i>15.8 <math>\mu</math>m</i>	<i>15.8 <math>\mu</math>m</i>

### 3.2 Concept of the testbed

The concept of the testbed is illustrated in Figure 3. In the main path of the sketch (bright blue), the source is a fiber-coupled laser modulated with the communication signal. The variable optical attenuator creates intensity fades directly behind the source. The source collimator with the source fiber located in its focus produces a collimated beam that propagates through the OTG and tilt generator. In that way, the wavefront of the beam is distorted dependent on the strength of the turbulence in the OTG and the angle-of-arrival is modulated respectively. The receiver telescope collects the power and the exit pupil, formed by the collimator element, is imaged on the tilt correcting element.

The statement of this law is that as long as this ratio is constant, the influence of spatial wave-front distortion is equal. In the case of a down-link from TerraSAR-X, the satellite has an orbit height of around 510 km, the communications wavelength is 1064 nm (Nd:YAG) and the aperture of the applied Cassegrain type telescope  $D = 0.40$  m. For this kind of scenario the Fried parameter for an overpass between  $5^\circ$  and  $45^\circ$  elevation amounts around 1 cm to 12 cm as measured in the experiment KIODO [14] with a wavelength of 847 nm, though. Because of  $r_0 \sim \lambda/5$ , the values for 1064 nm are higher by a factor of 1.3. Eventually, for the design guidelines of the testbed an  $r_0$  of 5 cm is chosen. Using this value results in  $D/r_0 = 8$  for the down-link scenario. Thus, by using a testbed telescope aperture of, for instance, 20 mm an  $r_0$  of around 2.5 mm produced by the OTG is desired.

The applicability of this scaling law combined with the fact that both optical systems must have equal numerical apertures is proven by examining the spot movement in the image plane of a focus lens behind the AO system of a communication system and the testbed system.

The one axis spot movement  $x_{\text{spot}}$  (m) for a small angle-of-arrival  $\alpha_{\text{AoA}}$  and focus length  $f$  is given by

$$x_{\text{spot}} = \alpha_{\text{AoA}} \cdot f \quad 16$$

The parameters of both scenarios are listed in table 2. Because the significant ratios  $D/r_0$  and  $D/f_{\text{eff}}$  in both scenarios are the same, whereas  $f_{\text{eff}}$  (m) denotes the effective focal length of the optical system, the resulting spot movement due to AoA fluctuations is the same too. If the focus lens represented a single element in the lenslet array of a Shack-Hartmann sensor the measured spot pattern would show the same statistics and so also the measured wave-front would. This is confirmed in the last line of the table.

### 3. Concept and design of the testbed

3.1 Theory and applicability of an optical turbulence generator  
There are some important specifications that have to be obeyed to perform realistic simulations that affect the design of the optical turbulence generators (OTG) as well as the testbed. The first requirement is the reproduction of the receiver telescope's output beam which includes reproducing its numerical aperture and exit pupil. This is important to ensure a correct reproduction of the wave-front sensing characteristics [13].

The numerical aperture  $N_{NA}$  can be calculated with

$$N_{NA} = n \sin(\theta) = n \sin \left[ \arctan \left( \frac{D}{2 \cdot f} \right) \right] \quad 14$$

where;  $\theta$  ( $^\circ$ ) is the acceptance angle of the lens, or respectively the considered optical system.

For the design of the testbed it is easier and more illustrative to keep in mind the ratio  $D/f$  than  $N_{NA}$ . Eventually, only telescopes of the same  $N_{NA}$  and pupil size can be compared.

For OTGs using turbulent-fluid boxes, Kolmogorov behavior is naturally occurring. For other solutions, care must be taken to ensure a basis in Kolmogorov statistics for the manufacture of the elements producing the wave-front distortion. Note that the effect of the outer and inner scales of turbulence does not fundamentally change the predictions of Kolmogorov-based AO models. Including their effect is simply a sophistication of the theory [12,13].

The testbed developed in the framework of this work should fulfill specifications that are applicable for simulating LEO satellite down-links, as they are possible from TerraSAR-X or OICETS. A very important scaling law in this context is [13]

$$\frac{D}{r_0} = const \quad 15$$

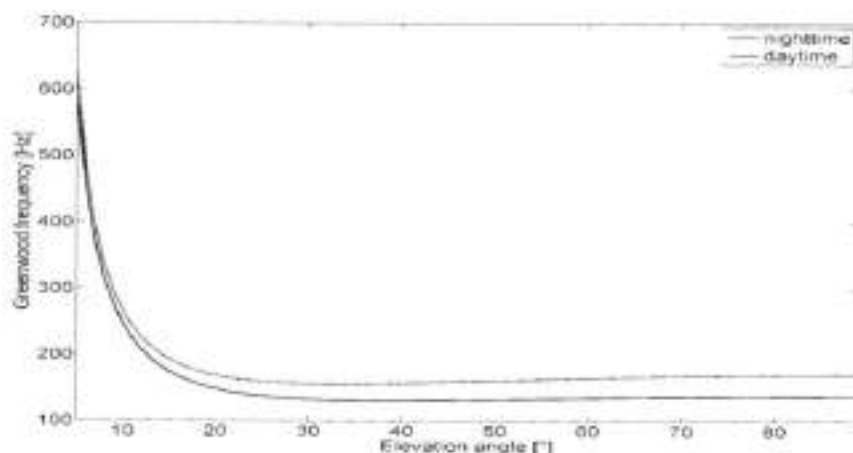
It is recommended that in practical system design at least four times this frequency is used for the servo bandwidth. For the Z-tilt this frequency is almost equal.

For the DM, also the Greenwood frequency can be used as a basis for the temporal specifications. By using equation 11 and 2 the necessary servo bandwidth of the DM control system dependent on the envisaged Strehl ratio and given Greenwood frequency and can be written as

$$f_{BW} = \frac{f_G}{(-\ln(S_{SR}))^{1/5}} \quad 13$$

For instance and again aiming at a Strehl ratio of 0.65 and the satellite down-link at  $5^\circ$  elevation (

Figure 2), a servo bandwidth of  $f_{BW} = 580$  Hz would be needed. If the "four times rule" is applied like in the case of the TM, the deformable mirror should come up with a speed of over 2.3 kHz.



**Figure2: Greenwood frequency over elevation angle of satellite overpass for night and daytime conditions of turbulence at a wavelength of 1064 nm and the turbulence profile of Modified Hufnagel-Valley profile.**

and the required actuator spacing is

$$r_c = r_0 \left( \frac{\ln S_{SR}}{-\kappa} \right)^{3/5} \quad 8$$

The required stroke of each actuator is determined by finding the maximum amount of atmospheric wave-front error across the aperture. It is assumed that global tilt is corrected by a dedicated TM. The residual wave-front error  $\sigma_{WF}$  due to atmospheric turbulence after tip-tilt correction across the aperture  $D$  is given  $\sigma_{WF} = 0.366 (D/r_0)^{5/6}$ . The peak to peak aberration across the aperture is about 5 times the standard deviation. If the DM moves 1 unit, the wave phase changes by 2 units. Thus the stroke  $S_{DM}$  (rad) of the DM is calculated with  $S_{DM} = 2.5 \cdot \sigma_{WF}$  9

### 2.3.2 Temporal requirements

The bandwidth and acceleration of the TM can be derived from the Greenwood frequency which is given as;

$$f_G = 2.31 \cdot \lambda^{-6/5} \cdot \left[ \int_{path} C_n^2(z) \cdot v(z)^{5/3} dz \right]^{3/5} \quad 10$$

The residual wave-front variance due to temporal evolution of the atmosphere associated with a fixed control bandwidth  $f_{BW}$  of an applied AO-system can be represented by the expression

$$\sigma_{temp}^2 = \left( \frac{f_G}{f_{BW}} \right)^{5/3} \quad 11$$

The Greenwood frequency depends on effective velocity of the inhomogeneous media, which moves transversal to the beam.

A TM should move to its commanded position and settle down with in its specified accuracy in less than half the time constant of the control system [2]. The temporal specification for a TM can be derived by using the fundamental tracking frequency of G-tilt  $f_{TG}$  given in [12]. It is calculated with

$$f_{TG} = 0.331 \cdot D^{-1/6} \cdot \lambda^{-1} \sec(\psi) \cdot \int C_n^2(h) \cdot V^2 dh \quad 12$$

## 2.3 Requirements of the adaptive optics system

The design of adaptive optics needs some primary requirements that can work together to improve the performance of optical systems by reducing the effect of wavefront distortions.

### 2.3.1 Spatial requirements

With knowledge of the expected wave-front aberrations the specifications of an adaptive optics system can be developed. The maximum atmospheric tilt  $M_{\text{tilt}}$  that the mirror should be able to remove is about 2.5 times the tip-tilt standard deviation [2],

$$M_{\text{tilt}} = \pm 2.5 \sigma_{\text{tilt}}, \quad 5$$

where  $\sigma_{\text{tilt}}$  is the standard deviation of wave-front tilt.

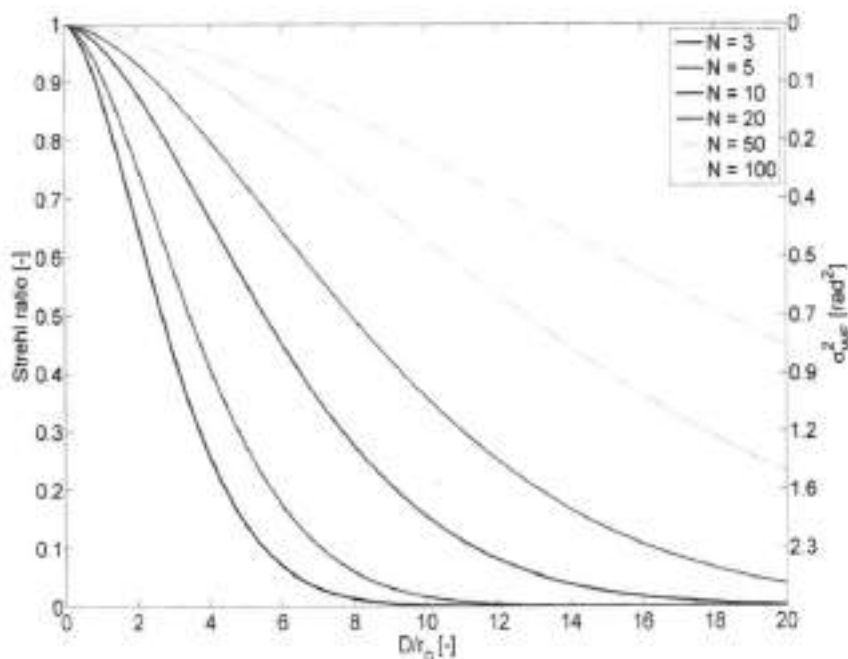
Because of the telescope transversal magnification  $M_T$  and with a factor of 0.5 and due to motion of the tip-tilt mirror results in twice the angular tilt motion of the beam, the total stroke  $S_{\text{TM}}$  of the tilt mirror should be at least [2];

$$S_{\text{TM}} = \frac{1}{2} M_{\text{tilt}} \left( \frac{D}{D_{\text{TM}}} \right) = \frac{1}{2} M_{\text{tilt}} M_T \quad 6$$

Here  $D_{\text{TM}}$  denotes the diameter of the Tip-tilt mirror (TM) covered by the light beam diameter. The aperture ratio  $D/D_{\text{TM}}$  equals the transversal magnification of the beam, though, only valid if the diameter of the beam equals the diameter of the TM.

Applying a DM, the resulting Strehl ratio  $S_{\text{SR}}$  is related to its actuator spacing  $r_c$  (m) of the deformable mirror,  $r_0$  and the constant  $\kappa$  which depends upon the type of deformable mirror. For most continuous faceplate DMs,  $\kappa = 0.35$  can be used. The Strehl ratio is then written as [2]

$$S_{\text{SR}} = \exp \left( -\kappa \left( \frac{r_c}{r_0} \right)^{5/3} \right) \quad 7$$



**Figure 1: Strehl ratio and wave-front variance over  $D/r_0$  for different numbers of corrected Zernike modes. The run of  $N = 3$  corresponds to the correction of piston, tip and tilt,  $N = 6$  adds removal of defocus and astigmatism.**

This value now may work as a reference for feasible coherent communication performance and so, it may be used with equation 4 to determine the number of modes needed to be compensated for a specific  $D/r_0$ . For instance, in case of the considered design scenario TerraSAR-X, the ratio is  $D/r_0 = 8$  and thus, 36 modes have to be corrected.

**Table 1: Zernike-Kolmogorov residual errors  $\sigma_{WF}^2$  for the first ten modes dependent on Fried parameter  $r_0$  and aperture size  $D$  [10].**

$\sigma_{WF,1}^2 = 1.0299 \cdot (D/r_0)^{5/3}$	$\sigma_{WF,6}^2 = 0.0648 \cdot (D/r_0)^{5/3}$
$\sigma_{WF,2}^2 = 0.582 \cdot (D/r_0)^{5/3}$	$\sigma_{WF,7}^2 = 0.0587 \cdot (D/r_0)^{5/3}$
$\sigma_{WF,3}^2 = 0.134 \cdot (D/r_0)^{5/3}$	$\sigma_{WF,8}^2 = 0.0525 \cdot (D/r_0)^{5/3}$
$\sigma_{WF,4}^2 = 0.111 \cdot (D/r_0)^{5/3}$	$\sigma_{WF,9}^2 = 0.0463 \cdot (D/r_0)^{5/3}$
$\sigma_{WF,5}^2 = 0.0880 \cdot (D/r_0)^{5/3}$	$\sigma_{WF,10}^2 = 0.0401 \cdot (D/r_0)^{5/3}$

Substituting equation 3 into 2 and writing down with respect to Zernike mode numbering index ( $j$ ) results in

$$j = \left[ \frac{-\ln(S_{SR})}{0.2944} \cdot \left( \frac{D}{r_0} \right)^{-5/3} \right]^{-2/\sqrt{3}} \quad 4$$

which can be used to determine the number of Zernike modes (as long as  $j > 10$ ) to be corrected for an aspired Strehl ratio and scenario specific  $D/r_0$ .

By using the tip-tilt corrected standard deviation  $\sigma_{WF}$  (rad) of atmospheric turbulence across the aperture  $D$  [10] and equation 2, this results in a necessary Strehl ratio of  $SSR = 0.65$ .

for the case of an incident wave with Gaussian distribution as it is the case by coupling from SMF to SMF through an arbitrary optical system [8].

The Strehl ratio  $S_{SR}$  can be calculated with the Maréchal approximation [9]

$$S_{SR} = \exp(-\sigma_{WF}^2). \quad 2$$

Where,

$\sigma_{WF}$  is the tilt corrected standard deviation of wave-front (rad).

This metric can also be used to evaluate the overall system performance when focusing on a diode or fiber face. The loss due to mode mismatch is neglected here. The relation between Strehl ratio and wave-front aberration is inverse which means that low aberrations give high Strehl ratios. Noll [10] is presented a connection between the number of corrected Zernike modes and the residual wave-front error where the formulas for correction of the first ten modes are listed in Table 1. For higher modes ( $j > 10$ ) the expression

$$\sigma_{WF,j}^2 = 0.2944 \cdot j^{-\sqrt{3}/2} (D/r_0)^{5/3} \quad 3$$

may be used where  $j$  is the Zernike mode index. These relations are evaluated and plotted in Figure 1 over the ratio  $D/r_0$ . Of course, the more modes are corrected the more the Strehl ratio increases and the more the residual wave-front variance decreases.

## 2.2 Wave-front correction of the communication signal

The wave-front correction of the incident wave, the communication signal carrier, is desired because receiver systems collect power by using small photo diodes or single mode fibers (SMF). Thus, the best possible focusing performance is aspired to collect as much power as possible. Furthermore, coherent detection systems have high demands on wave-front coherence for free-space superposition of the incoming beam with a local oscillator [5, 6]. Since state-of-the-art optical receivers usually apply SMF technology, the fiber coupling efficiency  $\eta_c$  is of major concern. It is defined as [7]

$$\eta_c = \frac{\langle P_c \rangle}{\langle P_a \rangle} = \left\langle \left| \int_A A_i(\mathbf{r}) \cdot A_m^*(\mathbf{r}) d\mathbf{r} \right|^2 \right\rangle, \quad 1$$

where

$\langle P_c \rangle$  is the average power coupled into the fiber and,  
 $\langle P_a \rangle$  the average power in the receiver aperture plane.

$A_i(\mathbf{r})$  is the incident optical field and

$A_m(\mathbf{r})$  is the mode profile of the fiber in the receiver aperture plane, normalized to the power of unity respectively and  $\mathbf{r}$  is the coordinate vector.

So, the maximum coupling efficiency becomes unity if both fields have the same shape. Since the mode shape of a SMF and the one of a plane wave, as it is the case on a LEO down-link, are not identical, the fiber coupling efficiency is below unity. In that special it amounts 82 % [7]. This value is the maximum fiber coupling efficiency without any wave-front aberrations for an incident plane wave.

Since there is no analytical expression known that relates the wave-front standard deviation to the fiber coupling efficiency, the metric of the Strehl ratio is used as an alternative. This is closely related to the fiber coupling efficiency and even equal

many kinds of wireless communication scenarios. Future applications may include networks of HAPS (high altitude platforms, hovering in the stratosphere), UAVs (unmanned aerial vehicles) and airplanes, whereas all this aeronautical objects can be optically connected amongst each other and/or additional satellites [2]. By now, there happen to be several optical communication terminals in orbit, either mounted on a GEO satellite, like ARTEMIS, or LEO satellites, like SPOT4, OICETS, NFIRE and TerraSAR-X [2].

## 2. Adaptive Optics in FSO Communications

Adaptive optics (AO) is a technique used to correct dynamic aberrations in an optical system. One of the applications of this technique is for line of sight free-space optical communication; also, applications include terrestrial and ground-to-satellite communication links.

### 2.1 Principle of adaptive optics (AO) systems

Accompanying the testbed development, research of how a usual AO system is working was necessary, and what influence it may have on communication performance. The task of the AO system is to correct the deformations of the incoming wave-front. There are several different approaches of how this goal can be achieved but in general, all follow the same way [3].

The entrance pupil of the optical system working to create an image on deformable mirror (DM) that, in the ideal case, forms an inversion of the aberrated wave-front. Behind the DM, the beam is guided to a wave-front sensor (WFS) that measures its shape.

Based on this measurement, a control system outputs the steering signals for the DM, which flattens the wave-front. This wave-front, in turn, is measured by the WFS again. That way, the AO control loop is closed [4].

## تحقيق وتحسين نموذج النظام المكيف لاتصالات الفضاء البصرية

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### المستخلص

أصبحت اتصالات الفضاء الخارجي (أو ما يسمى ببصريات الفضاء الخارجي) من العلوم ذات الأهمية المتزايدة خصوصاً في العقود الأربع الأخيرة لإتجاز الاحتياجات الضرورية لتطبيقات الطيران والفضاء الخارجي.

إن بصريات الفضاء الخارجي تعني بكل ما يتعلق بإرسال الموجات الكهرومغناطيسية ضمن الأطياف المرئية أو تحت الحمراء وبسبب التغييرات الحاصلة في طبيعة الفضاء الخارجي وسلوكه العشوائي فإن هذا يدفعنا للبحث المستمر بغية استكشافه.

تعد التغييرات المناخية مثل المطر وتقلبات درجات الحرارة وطبيعة الغيوم من العوامل المؤثرة في كفاءة الاتصالات الضوئية الفضائية داخل الغلاف الجوي الأرضي. كذلك يركز هذا العمل على إنتاج بيئة قريبة للغلاف الجوي الأرضي لإنتاج عدد من المخططات للإجراءات المحتملة وكيفية تصميم نظام مكيف للتغلب على هذه التأثيرات.

### 1. Introduction

The increasing need for high communication bandwidths all over the world pushes research and development to search new communication techniques and schemes that are most suitable for the particular areas of applications.

Similar to transmission with optical fibers, free space optics can offer high data rates but also the same flexibility as that of wireless microwave systems. The short wavelengths allow a more compact design of components and lower power consumption than microwave systems do, which is very important for aeronautical and space systems [1].

Furthermore, it is resistant of spying due to the very small convergence angle to the beam. All this presents free space optical communications to be an attractive alternative for

## Investigation and Improvement of Adaptive System Model for Free-Space Optical Communication

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### Abstract

Optical free space communications, often simply called free space optics (FSO), happened to be explored and further developed for the last four decades especially to fulfill the needs of aeronautical and space applications.

FSO is all about the transmission of modulated electro-magnetic waves in the visible and infrared spectrum through the atmosphere. Because the propagation path changes in space and time that leads to its random behavior must be of major concern of ongoing research.

Atmospheric effects such as rain, clouds and temperature fluctuations influence light propagation and may degrade the quality of transmitted signals severely.

The emphasis of this work lies on the development and test of the turbulence generator, the overall concept of the testbed. The testbed makes it possible to reproduce test scenarios with realistic ratios of aperture size over Fried parameter.

**Key words:** Satellite and optical communication modeling, Adaptive optics in free space optical communications.

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direct detection technique required fewer numbers of filters in the decoder. Therefore, the over-all system complexity was reduced. In addition, the system has been simulated using opti-system software and the simulation process results show the optical system performance with two and four subcarrier frequencies affected by the attenuation and dispersion of fiber length. In contrast, using MD code as a signature series for SCM/SAC-OCDMA system shows a promising solution to suppression the Multi Access Interference (MAI) as compared to the one using other SAC- codes and to carry a large number of multiplexed subcarrier and code words. In addition, this simple design can supply a large number of users compared with other codes like MQC or RD code with no overlapping chips between users.

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four wave mixing dispersion (i.e., 18 ps/nm km), and self phase modulation were specified and activated according to the typical industrial values for simulating the real environment as near as possible. In receivers, the generated noise was set to be random and totally uncorrelated. For each photo-detector, the thermal noise coefficient and current value were set to  $1.8 \times 10^{-23}$  W/Hz and 5 nA, respectively. The system performance was characterized by referring to the BER or probability of bit error.

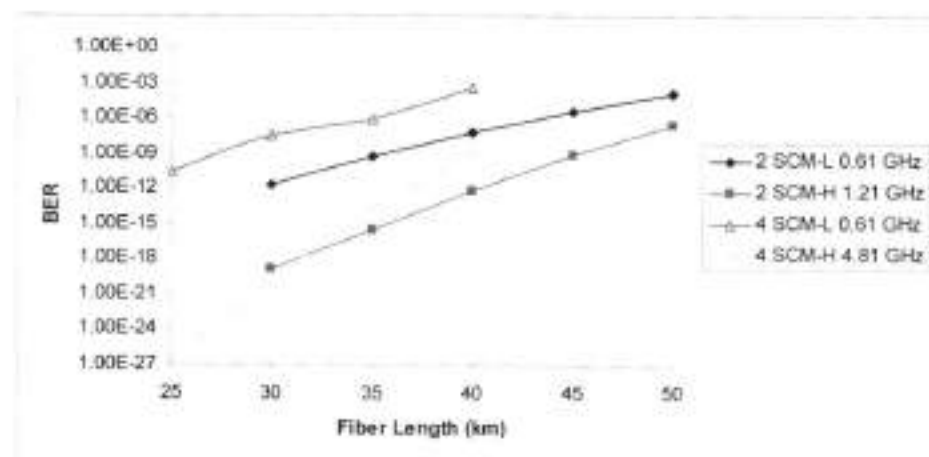


Fig.8 illustrates the variation of BER with respect to fiber length for hybrid SCM SAC-OCDMA

Figure 8 shows the fiber distance effect on the system performance with two and four subcarrier frequencies. It is clearly observed from the figure that the BER decreases as the fiber distance increases due to the attenuation and dispersion of fiber length. Furthermore, in the case of increasing the subcarrier channels the system performance is expected to be decreased as the fiber length increased. In contrast the  $BER \leq 10^{-9}$  has been achieved for 45 km with four subcarrier channel at 4.81 GHz.

## 5. Conclusions

In this paper, a SCM/SAC-OCDMA system was numerically analyzed, using MD code as a signature sequence code. The performance of the system was improved significantly because the total loss was reduced as

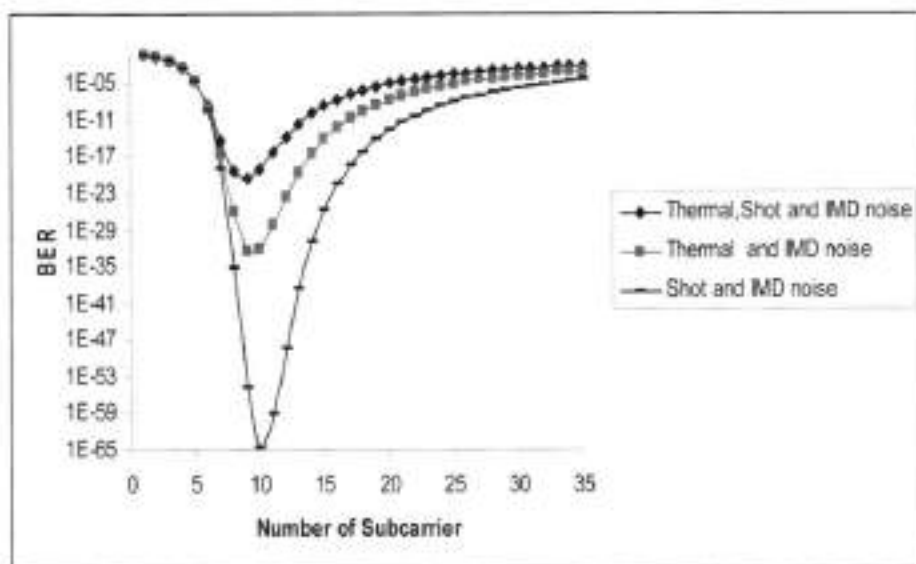


Fig.7 illustrates the variation of BER with respect to the number of carrier and subcarrier at  $P_{sr} = -10\text{dBm}$ .

Figure 7 illustrates the variation of BER with respect to the number of carrier and subcarrier under different noise conditions when  $P_{sr} = -10\text{ dBm}$ ,  $W = 4$  and the number of active users is 5 while the number of carriers is 7. We can easily recognize from Fig.7, the main factor limiter in the system performance is the thermal noise. We also observe that the effect of the shot noise is smaller compared with thermal noise at power source of  $P_{sr} = -10\text{ dBm}$ .

#### 4.2 Simulation analysis

The hybrid system was simulated using Opti-system ver. 9. The simulation design was implemented based on MD code for two and four subcarrier channels respectively. In addition, the data rate was carried out at 155 M bit/s for each sub-carrier channel and the subcarrier frequencies were set to  $\geq 2$  (Niquist frequency) times the bit rate. In contrast, each optical channel has spectral width of 0.8 nm. The simulation was carried out employing the ITU-T G.652 standard single-mode optical fiber (SMF). The attenuation ( $\alpha$ ) (i.e., 0.25 dB/km), non linear effects such as

better even the number of code words and number of the carriers are greater than that used in the system of hybrid KS code. So, it is achieved due to the several properties of MD code. However, the hybrid MD code system is improving the performance of the systems using hybrid SCM/SAC-OCDMA.

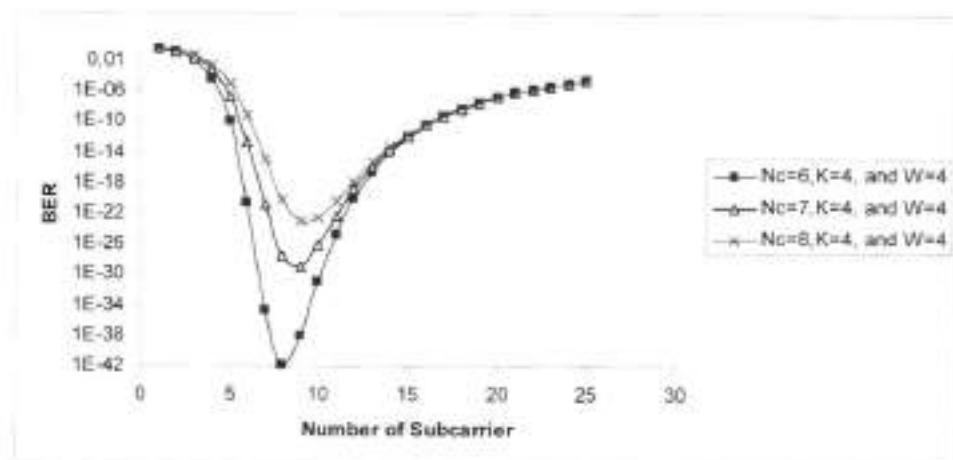


Fig 6 : BER against the number of subcarrier for hybrid system at  $P_{sr} = -10\text{dBm}$  employing MD code.

Figure 6 depicts the performance of the hybrid system using direct detection technique for various numbers of carrier and subcarrier. On the other hand, the number of weight of the MD codes is designed at fixed  $W = 4$ , while the number of users is 5 for observing the effect number of carrier and subcarrier on the hybrid system capability. It is clearly to observe that the variation of BER with the increase the number of carrier and subcarrier is resulting to the effect of two-tone third order and third-tone third order inter-modulation distortion. On the other hand, the subcarrier number with an acceptable BER (Maximum  $10^{-9}$ ) is 18 with the minimum carrier. It can be noted that, although the BER can be reduced to the value ( $10^{-42}$ ) when the number of carrier is 6, which is practically worthless; it does not contradict the objective of this work in comparing with the performance of the hybrid system when a number of carriers is more than 6.

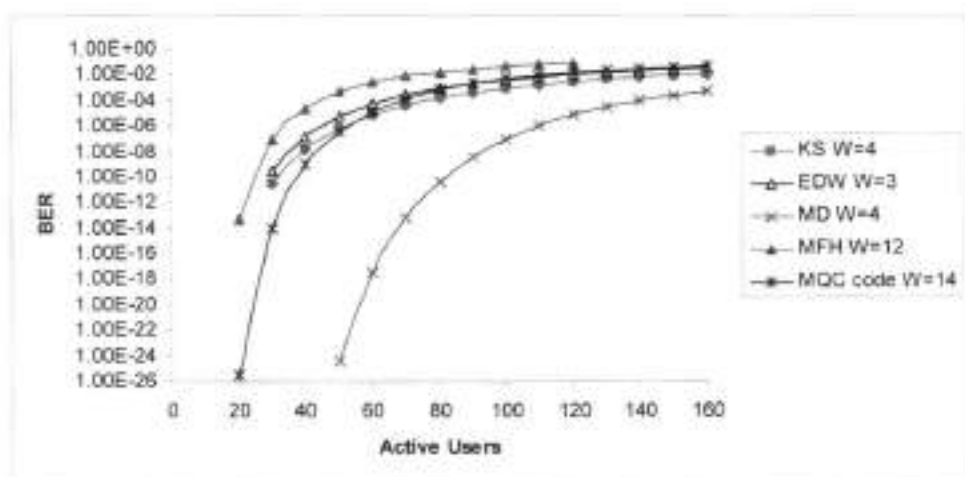


Fig 4 : BER against number of active users for various codes at employing the SAC-OCDMA technique.

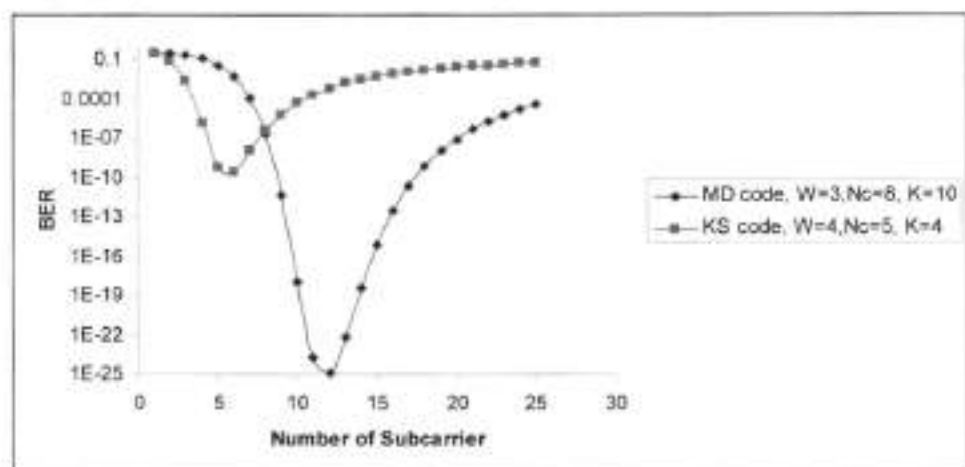


Fig 5 : BER against number of subcarrier for the hybrid system at  $P_{ST} = -10$  dBm employing MD and KS codes.

The variation of the BER against the number of subcarrier is shown in Figure 5 for MD and KS codes employing the SCM/SAC-OCDMA technique. It is shown that the performance of the MD code is better than the KS code even though the weight value of KS code is greater than the MD code weight. In addition, the performance of the MD code stills

Table 1 Typical parameter used in the numerical analysis calculation.

Symbol	Parameter	Value
$\eta$	Photo-detector quantum efficiency	0.6
$P_{av}$	Broadband effective power	-10 dBm
$B$	Electrical bandwidth	311 MHz
$\lambda_0$	Operating wavelength	1550 nm
$R_b$	Data bit rate	622 M bit/s
$T_n$	Receiver noise temperature	300 K
$R_L$	Receiver load resistor	1030 $\Omega$
$e$	Electron charge	$1.6 \times 10^{-19}$ C
$h$	Planck's constant	$6.66 \times 10^{-34}$ Js
$K_b$	Boltzmann's constant	$1.38 \times 10^{-23}$ J/K
$N_c$	Number of carrier	3-8
$N_s$	Number of subcarrier	2-26

Figure 4 shows the characteristic of BER versus the number of active users at various codes which are employing the SAC-OCDMA technique for different values of  $K$  (no. of active users). It is proved that the performance of using MD code is better compared to others even though the weight of other codes is equal or greater than the MD code weight. The critical acceptable BER of  $10^{-9}$  was achieved by using MD code with 92 active users compared to 43 active users achieved by MQC code, 39 active users by KS code, 34 active users by EDW code and 27 active users by MFH code. This is a good considering with the small value of weight used. This is evident from the fact that MD code has zero cross-correlation properties with a diagonal matrix design, while other codes have a variable cross-correlation between zero and 1 also very long code length. However, a few specific code parameters were chosen depending on the published results for these practical codes [6-9]. The calculated BER for KS code was  $W = 4$ , EDW code  $W = 3$ , MD code  $W = 4$ , MFH code  $W = 12$  and  $W = 14$  for MQC code.

And the thermal noise is given as [15]

$$I_{th}^2 = \frac{4K_b T_u B}{R_L} \quad (21)$$

where  $T_u$ ,  $K_b$ ,  $R_L$ , and  $B$  are Absolute receiver noise temperature, the Boltzmann Constant, Receiver load resistor, and Noise-equivalent electrical bandwidth of the receiver, respectively. The inter-mediation distortion is given as bellow [13, 14]

$$I_{IMD}^2 = P_{sr}^2 \eta^2 m_{u,K}^6 \left[ \frac{D_{1,1,1}}{32} + \frac{D_{2,1}}{64} \right] \quad (22)$$

where  $D_{1,1,1}$  is the three-tone third order inter-mediation at  $f_i + f_k - f_l$ , and  $D_{2,1}$  defines as the two-tone third order inter-modulation at  $2f_i - f_k$ . Lastly from Eq.(19), Eq. (20), Eq. (21) and Eq.(22) we can compute the average SNR of the SCM-SAC-OCDMA system for the MD code as:

$$SNR = \frac{I^2}{I_{th}^2 + I_{th}^2 + I_{IMD}^2} \quad (23)$$

with Gaussian approximation, the BER can be expressed as [8]:

$$BER = P_e = \frac{1}{2} \operatorname{erfc} \left( \sqrt{\frac{SNR}{8}} \right) \quad (24)$$

## 4. Results and Discussions

### 4.1 Analytical evaluation

The performance of MD code has been compared mathematically with the recent codes, such as KS code, MFH code, EDW code, and MQC code. The BER and SNR can be evaluated by using Eq. (27) and Eq. (28), respectively. The parameters used in our numerical calculation are reported in Table 1.

To compute the integral of  $G(v)$ , firstly, let us consider an example of the PSD (denoted by  $G'(v)$  of the received superimposed signal), which is shown in Fig. 3, where  $A(i)$  is the amplitude of the signal of the  $i$ th spectral slot with width of  $\frac{\Delta v}{N}$ .

The total incident power at the input of the photo-detector of Fig.2 is given by:

$$\int_0^{\infty} G(v)dv = \int_0^{\infty} \left[ \frac{P_{sr}}{\Delta v} \sum_{k=1}^K d_k(t) \sum_{i=1}^N C_k(i) C_i(i) \text{rect}(i) \right] dv = \left[ \frac{P_{sr} W}{N} \right] d_t \quad (16)$$

the photocurrent  $I$  can be found as:

$$I = \Re \int_0^{\infty} G(v)dv = \frac{\Re P_{sr} W}{N} \sum_{n=1}^{N_c} u_{n,K}(t) m_{n,K} \cos(w_n t) \quad (17)$$

where,  $\Re$  is the responsivity of the photo-detectors given by

$$\Re = \frac{\eta e}{h\nu_c} [10].$$

Here,  $\eta$  is the quantum efficiency,  $h$  is Planck's constant, and  $\nu_c$  is the original broad-band central frequency of the optical pulse. In the RF demodulator, the signal coherently mixed with a local oscillator by  $2 \cos(w_n t)$  [11]. Therefore, Eq. (20) will be expressed as:

$$I = \frac{\Re P_{sr} W}{N} \sum_{n=1}^{N_c} u_{n,K}(t) m_{n,K} \cos(w_n t) [2 \cos(w_n t)] \quad (18)$$

while, the double frequency component will be filtered out by using LPF, as a result the modulator output is:

$$I = \frac{\Re P_{sr} W}{N} u_{n,K}(t) m_{n,K} \quad (19)$$

When the probability of sending bit 1 for each user is 0.5 at any time, the noise power of shot noise will be written as [15]:

$$I_{sh}^2 = 2eB\Re \left[ \int_0^{\infty} G(v)dv \right] = \frac{2eB\Re P_{sr} W}{N} \quad (20)$$

$$d_k(t) = \sum_{n=1}^{N_c} u_{n,K}(t) m_{n,K} \cos(w_n t) \quad (13)$$

$u_{n,K}(t)$  is the normalized digital signal at the  $n$ -th subcarrier channel of the  $K$ -th codeword,  $w_n$  is the angular subcarrier frequency, and  $m_{n,K}$  is the modulation index of the  $n$ -th subcarrier of the  $K$ -th users.  $N_c$  is the number of the subcarrier channel on each code word and assume an identical modulation index for all subcarrier channels as [3, 13, 14]:

$$0 \leq m_{n,K} \leq \frac{1}{N_c}$$

The  $rect(i)$  function in Eq. (13) is given by

$$rect(i) = u\left[v - v_0 - \frac{\Delta v}{2N}(-N + 2i - 2)\right] - u\left[v - v_0 - \frac{\Delta v}{2N}(-N + 2i)\right] = u\left[\frac{\Delta v}{N}\right] \quad (14)$$

where  $u(v)$  is the unit step function that is expressed as:

$$u(v) = \begin{cases} 1, & v \geq 0 \\ 0, & v < 0 \end{cases} \quad (15)$$

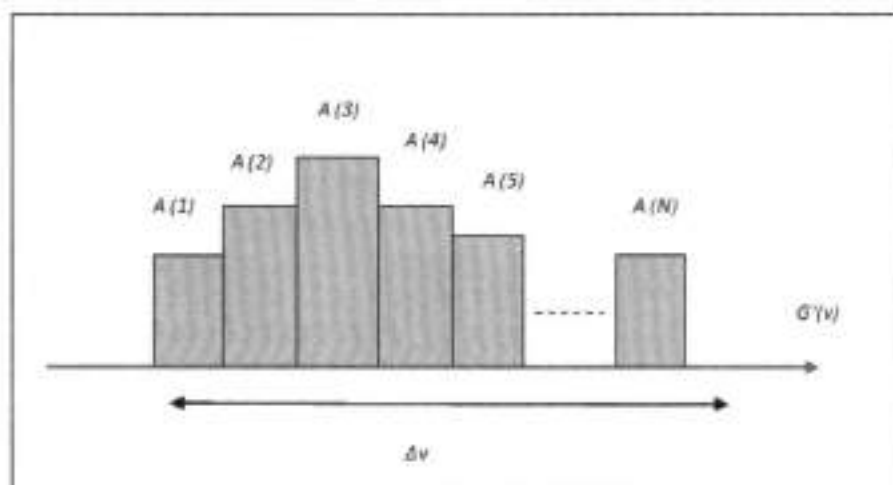


Fig.3 the PSD of the received signal  $r(v)$ .

shot noise ( $I_{sn}^2$ ) and Inter-Modulation Distortion ( $I_{IMD}^2$ ) in the photo-detector. The SNR of electrical signal is denoted as the average signal power to noise power  $SNR = \left[ \frac{I^2}{\sigma^2} \right]$ . Due to the zero cross-correlation property of MD code, there is no overlapping in spectra of several different users. For this reason, the effect of incoherent intensity noise has been ignored.

The photo-detector variation is the result of the detection for ideally unpolarized thermal light that is generated by spontaneous emission, so it is expressed as:

$$\sigma^2 = I_m^2 + I_n^2 + I_{IMD}^2 \quad (10)$$

Let  $C_k(i)$  denote the  $i$ th element of the  $K$ th MD code sequences, and according to the properties of MD code, the direct detection technique can be written as:

$$\sum_{i=1}^N C_k(i)C_l(i) = \begin{cases} W, & \text{For } K=l, \\ 0, & \text{Else.} \end{cases} \quad (11)$$

The following assumptions are made by [10, 11]:

- Each light source spectrum is ideally unpolarized and flat over the bandwidth  $[v_0 - \Delta v/2, v_0 + \Delta v/2]$  where  $v_0$  is the optical central frequency and  $\Delta v$  is the optical source bandwidth expressed in Hertz.
- Each power spectral component has an identical spectral width.
- At the receiver, each user has equal power.
- From each user, each bit stream is synchronized.

The previous assumptions are important for mathematical straight forwardness. To devoid these assumptions, it is difficult to analyze the system; for example, if the power of each spectral component is not identical at the receiver, each user has a different power.

So that, PSD of the received optical signals can be expressed as [12]:

$$r(v) = \frac{P_{sr}}{\Delta v} \sum_{K=1}^K d_K \sum_{i=1}^N c_K(i) \text{rect}(i) \quad (12)$$

where  $P_{sr}$  is the effective power of a broadband source at the receiver,  $K$  is the number of active users,  $N$  is the MD code length, and  $d_K$  is the modulation data of  $n$ th subcarrier channel on the  $K$ th optical codeword, which can be expressed as[3]:

### 3.1 SCM- SAC-OCDMA receiver based on direct detection technique

The hybrid SCM-SAC-OCDMA receiver using direct detection technique for two users is illustrated in Figure 2. Whereby, only one pair of decoder and detector is required compared with other techniques that require two branches of inputs to the receiver like those in complementary subtraction techniques. There is also no subtraction process involved. This is achievable for a simple reason that the information is assumed to be adequately recoverable from any of the chips that don't overlap with any other chips from other code sequences, since MD code is designed with no overlapping chips. Thus, the detector will only need to filter through the clean chips (no overlapping chips) to be detected by the photo diode as a normal intensity modulation with the direct detection scheme. The effect of MAI has been completely and successfully suppressed because only the required signal spectra will be filtered in the optical domain.

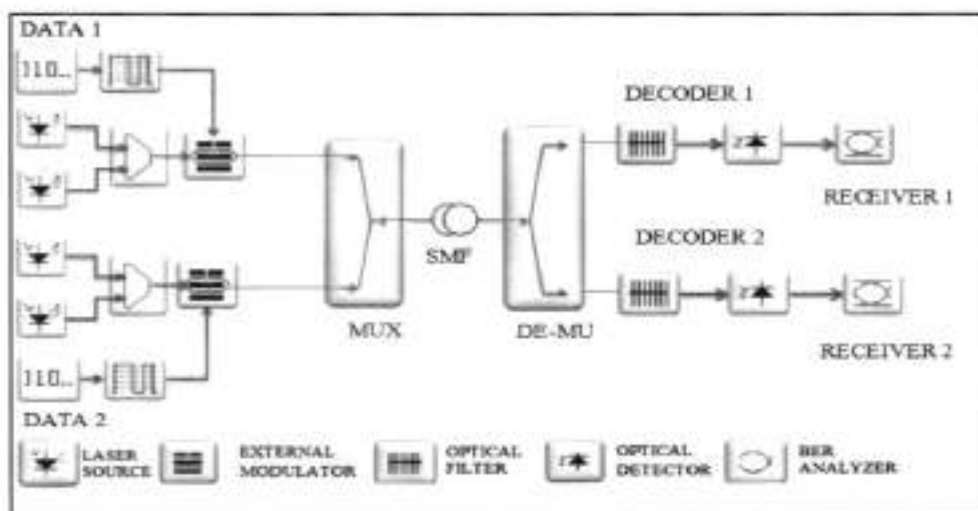


Figure. 2 Illustrates the block diagram of an MD code system at direct detection technique.

### 3.2 Analysis of hybrid SCM SAC-OCDMA system

#### 3.2.1 System Performance Analysis

To analyse our system, BER can be calculated by using Gaussian approximation [3, 4]. We considered the effect of thermal noise  $(I_{th}^2)$ ,

compared with other codes like MQC, RD codes. Furthermore, there are no overlapping chips for different users.

### 3. Hybrid SCM- SAC-OCDMA system based on MD code

In this section, we demonstrate a hybrid SCM- SAC-OCDMA based on the MD code. Figure 1 illustrates the schematic diagram of the SCM-SAC-OCDMA system. As shown in the figure 1 the electrical data are modulated with the subcarrier frequencies. Where, all the modulated subcarriers are combined using an electrical adder. The Optical External Modulator (OEM) is then used to modulate the combined modulated subcarrier frequencies with the distinct code sequence. On the other hand, each codeword of the SAC-OCDMA based on MD code consist of different wavelengths. An optical combiner used to combine all modulated code sequence and send out through optical fiber.

In the receiver side, demultiplexer is used to separate the different modulated code word. The received code sequence will be filtered out by using Fiber Bragg Grating (FBG) filter. In ADDITION, the electrical splitter, photo detector, and Band Pass Filter (BPF) are used to reject the unwanted signals and split the SCM signals. To retrieve the original sending data, a local microwave frequency of  $f_c$  is mixed electrically with the incoming signal, and filtered by Low Pass Filter (LPF).

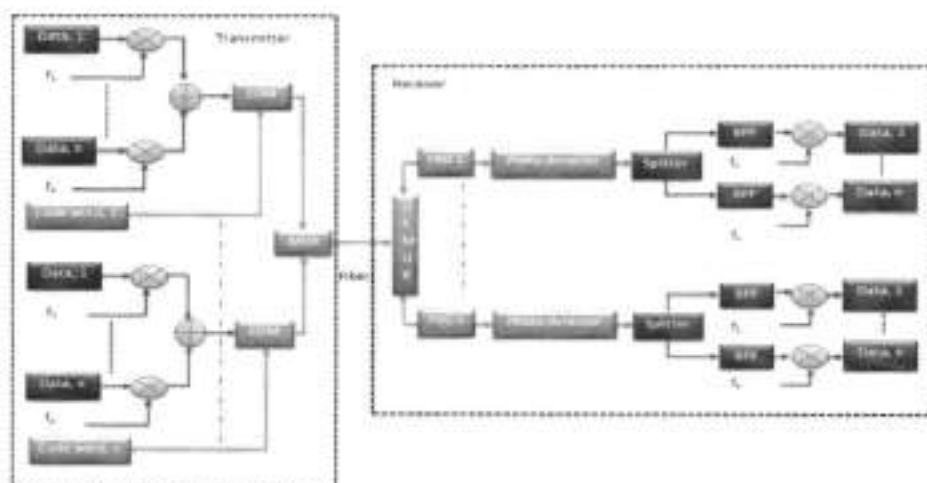


Figure. 1 The proposed block diagram of a SCM-SAC-OCDMA system using MD with direct detection technique.

when  $K=4$  and  $W=3$ . Therefore,  $i=1,2,3,4$ ,  $i_n+1=5$  and  $j_w=1, 2, 3$ . The diagonal matrices can be expressed as:

$$S_{i,1} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}, S_{i,2} = \begin{bmatrix} 4 \\ 3 \\ 2 \\ 1 \end{bmatrix}, S_{i,3} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} \quad (7)$$

The MD code sequence for each diagonal matrix is shown as:

$$T_{i,1} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}_{4 \times 4}, T_{i,2} = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}_{4 \times 4}, T_{i,3} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}_{4 \times 4} \quad (8)$$

The total MD code sequence will be:

$$MD = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}_{4 \times 12} \quad (9)$$

Where  $K=4$ ,  $N=12$ .

So, the codeword for each user according to the above example would be:

$$\text{codeword} = \begin{cases} \text{user1} \Rightarrow \lambda_1, \lambda_8, \lambda_9 \\ \text{user2} \Rightarrow \lambda_2, \lambda_7, \lambda_{10} \\ \text{user3} \Rightarrow \lambda_3, \lambda_6, \lambda_{11} \\ \text{user4} \Rightarrow \lambda_4, \lambda_5, \lambda_{12} \end{cases}$$

The MD code design depicts that changing matrices element in the same diagonal part will result in a constant property of zero cross correlation, and it is constructed with zero cross correlation properties, which cancels the MAI. The MD code presents more flexibility in choosing the  $W$ ,  $K$  parameters and with a simple design to supply a large number of users

$$S_{i,j} = \begin{cases} (i_n + 1 - i), & \text{For } j_W = \text{even number} \\ i, & \text{For } j_W = \text{odd number} \end{cases} \quad (2)$$

$$S_{i,1} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ K \end{bmatrix}, S_{i,2} = \begin{bmatrix} K \\ \vdots \\ 3 \\ 2 \\ 1 \end{bmatrix}, S_{i,3} = \begin{bmatrix} 1 \\ 2 \\ \vdots \\ K \end{bmatrix}, \dots, S_{i,W} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ K \end{bmatrix} \quad (3)$$

Any elements of the  $S_{i,W}$  matrices represent the position of one in  $T_{i,W}$  matrices with  $K \times K$  dimensions. Where  $T_{i,1} = [S_{i,1}]_{K \times K}$ ,  $T_{i,2} = [S_{i,2}]_{K \times K}$  and  $T_{i,W} = [S_{i,W}]_{K \times K}$ .

$$T_{i,1} = \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{bmatrix}_{K \times K}, T_{i,2} = \begin{bmatrix} 0 & \dots & 0 & 1 \\ 0 & \dots & 1 & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 1 & \dots & 0 & 0 \end{bmatrix}_{K \times K}, T_{i,W} = \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{bmatrix}_{K \times K} \quad (4)$$

### Step 3

So, the total combination of diagonal matrices (3) represents the MD code as a matrix of power  $K \times N$ .

$$MD = [T_{i,1} : T_{i,2} : \dots : T_{i,W}]_{K \times N} \quad (5)$$

$$MD = \begin{bmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,N} \\ a_{2,1} & a_{2,2} & \dots & a_{2,N} \\ a_{3,1} & a_{3,2} & \dots & a_{3,N} \\ \vdots & \vdots & \dots & \vdots \\ a_{i,1} & a_{i,2} & \dots & a_{i,N} \end{bmatrix} \quad (6)$$

From the above basic matrix (5), the rows determine the number of users ( $K$ ). Notice that the association between code weight ( $W$ ), code length ( $N$ ) and number of subscribers ( $K$ ) can be expressed as:  $N = K \times W$ . For example, to generate an MD code family according to the previous steps,

The notation which is sometimes used to concisely describe the diagonal matrices ( $I_N = \text{diag}(1,1,\dots,1)$ ), is used. An orthogonal matrix is a square matrix with real entries whose columns

and rows are orthogonal unit vectors. Equivalently, a matrix  $A$  is orthogonal if its transpose equals to its inverse ( $A^T A = A A^T = I$ , alternatively,  $A^T = A^{-1}$ ). A square matrix whose transpose is also its inverse is called an orthogonal matrix; that is,  $A$  is orthogonal if  $A^T A = A A^T = I_N$ , the identity matrix, i.e.  $A^T = A^{-1}$ .

The cross-correlation theorem states that cretin sets of complementary sequences have cross-correlation functions that sum to zero by using all pair wise permutations. Here, all cross-correlation function permutations are required in order that their sum be identically equal to zero. For example, if the rows and columns of a ( $K \times N$ ) matrix are orthogonal and all the columns except one sum to zero, then the sum of all cross-correlations between non-identical code words is zero. So if  $x_{ij}$  is an entry from  $X$  and  $y_{ij}$  is an entry from  $Y$ , then an entry from the product  $C=XY$  is given by  $C_{ij} = \sum_{k=1}^N x_{ik} y_{kj}$ . For the code sequences

$$X = (x_1, x_2, x_3, \dots, x_N)$$

and  $Y = (y_1, y_2, y_3, \dots, y_N)$ , the cross-correlation function can be

represented by:  $\lambda_c = \sum_{i=1}^N x_i y_i$ . When  $\lambda_c = 0$ , it is considered as the code

possesses zero cross correlation properties. The MD

code matrix consists of a  $K \times N$  matrix that functionally depends on the value of the number of users ( $K$ ), and code weight ( $W$ ). For MD code the choice of weight value is free, but should be more than 1 ( $W > 1$ ). So, the following steps explain how the MD code is constructed.

Step 1:

Construct a sequence of diagonal matrices using the value of the weight ( $W$ ) and number of subscribers ( $K$ ). According to these values,  $i$  and  $j_w$  will be set. Where  $K$  and  $W$  are positive integer numbers, ( $i = 1, 2, 3, 4, \dots, i_n = K$ ) are defined by the number of rows in each matrix, and ( $j_w = 1, 2, 3, 4, \dots, W$ ) will represent the number of diagonal matrices.

Step 2

Based on the next equations, the MD sequences will be computed for each diagonal matrix.

supporting large number of users with high data rate compared to other codes ;(5) no spectra overlapping at different users.

However, KS code [6] is proposed for the hybrid SCM /SAC-OCDMA system to reduce the system complexity and reduced the MAI. Nevertheless, KS code this code is suffered from various limitations, such as, the code construction limited by the code parameter, too long code length, , and the code could not support high number of simultaneous users.

In this paper, we proposed a new technique to improve the performance of SCM/SAC-OCDMA system. The proposed system is evaluated based on Multi Diagonal (MD) code, in order to mitigate the MAI effects. A direct detection technique is used to detect RF and the optical signals, with reducing the complexity, system cost, and improved the overall system performance. Furthermore, the performance of the hybrid system is numerically investigate and by using the optical simulator software "OptiSim<sup>TM</sup>" taking into account the effect of inter modulation distortion noise. The remainder of this research is organized as follows. In Section 2, we review the MD code construction. Section 3 is devoted to the system simulation model and performance analysis. Finally, conclusions are given in Section 4.

## 2. MD code design

The MD code is characterised by the following parameters  $N$ ,  $W$ , and  $\lambda_c$ , where  $N$  is the code length (number of total chips),  $W$  is the code weight (chips that have a value of 1), and  $\lambda_c$  is the in-phase cross correlation.

The Cross-correlation theorem could be defined as follows: In linear algebra, the identity matrix or unit matrix of size  $N$  is the  $N$ -by- $N$  square matrix with ones on the main diagonal and zeros elsewhere. It is denoted by  $I_N$ , or by  $I$  if the size is immaterial or can be trivially determined by the context.

$$I_1 = [1], I_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, I_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \dots, I_N = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \ddots & 0 \\ 0 & 0 & \dots & 1 \end{bmatrix} \quad (1)$$

## **1. Introduction**

Optical subcarrier multiplexing (SCM) is a promising system to solve the needs of telecommunication networks. The hybrid system could provide a necessary bandwidth of the transmission broadband data to end-users [1]. The hybrid SCM-OCDMA networks employs two efficient multiplexing techniques; namely the technology of subcarrier multiplexing (SCM) and SAC-OCDMA networks. However, SCM systems have advantages such as; the microwave devices are more mature than optical devices and the frequency selectivity of microwave filter are much better than their optical counterparts. In addition, the low cost system implementation of SCM has been proposed to transmit multi channel digital optical signals for local area networks [2].

In contrast, SAC-OCDMA systems recently get consideration due to its ability to allow many users share the same transmission medium asynchronously and simultaneously with a high level of transmission security [3-4]. However, SAC-OCDMA system suffers from various noises such as shot noise, thermal noise, dark current and multiple access interference (MAI) from other users. Among these noises, MAI is considered as a dominate source of system degradation performance. Therefore, the intelligent design of data code sequence is necessary to reduce the effect of MAI [5]. To overcome this problem in SAC-OCDMA systems several codes were proposed such as Random Diagonal code (RD), Khazani-Syed (KS) code [6], Enhanced Double Weight (EDW) code [7] Modified Frequency Hopping (MFH) code [8] and Modified Quadratic Congruence (MQC) code [9]. The former SAC-OCDMA codes suffered from many limitations such as; the length of the code is too long (e.g., EDW and KS codes), the code construction limited by the code parameter (e.g., MFH and MQC codes), or the cross-correlation is increased with increasing the weight number (e.g., RD code). In addition, the codes that have been proposed for SAC-OCDMA could not accommodate large number of simultaneous users and could not support the system on high data rate. Therefore, to overcome these problems, we present Multi Diagonal (MD) code. This is designed depending on combination of diagonal matrixes. The MD code have several advantages such as (1) zero cross-correlation code which is cancelling the MAI; (2) simple design; (3) flexibility in choosing  $W$  and  $K$  parameters over other codes such as MFH, MQC, and KS codes (4)

## تطوير كفاءة شبكات SCM SAC-OCDMA الهجينية باستخدام كود قطري متعدد

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### المستخلص

بالتحقيق الياطن للهجين المتعدد (SCM) وذلك بدمج السعة الطيفية في الترميز عن طريق تقسيم الرمز البصري في تكنولوجيا الوصول المتعدد (OCDMA SAC) سواء عن طريق المحاكاة والنموذج الرياضي. يتكون النموذج الهجيني من SCM/SAC-OCDMA

نظامين لتحقيق نظام هجيني قوي ضد التداخل في العمليات متعددة الوصول (MAI) لأجل تعزيز عمل القناة والحفاظ على معدل البيانات فيها. في هذا البحث تم تطوير الاداء الهجيني لنظام SCM/SCA-OCDMA وذلك بالاعتماد على ترميز سعة الطيف لقمع وتقليل تأثير

التأثيرات الموجودة وتحسين الأداء العام للنظام بزيادة حساسية كشف الاخطاء في BER وتصل الى  $10^{-1}$ . ونتيجة لذلك، فإن النظام المقترح على أساس الترميز القطري المتعدد (MD) ينتج أداء أفضل مقارنة مع الرمز التقليدي المستخدم في نظام OCDMA-SAC.

اضافة الى ذلك اجري تقييم باستخدام معاملات مختلفة تحت اقصى عدد من الحاملات الياطنية او الجزئية (١٨ حامل جزئي في كل قناة بصرية) المتضاعفة لدمج تكنولوجيا OCDMA مع تقنية البنية التحتية من الألياف اللاسلكية الموجودة في التعامل مع معدل بيانات ١٥٥ ميغابت بالثانية مع اختلاف في طول الألياف. وعلاوة على ذلك، ال  $BER \leq 10^{-9}$  قد تحقق على أساس النظام المقترح لمدى ٤٥ كم خلال الحزمة الترددية ٤.٨١ غيغاهيرتز.

الكلمات المفتاحية : الهجين المتعدد ، الهجين المتعدد لطريقة تقسيم الرمز البصري في تكنولوجيا الوصول المتعدد ، الترميز القطري المتعدد

## Performance Improvement of Hybrid SCM SAC-OCDMA Networks using Multi Diagonal Code

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### Abstract

Hybrid subcarrier Multiplexing (SCM) incorporating spectral amplitude coding optical code division multiple access (SAC-OCDMA) technology has been investigated both by simulation and mathematical model. Hybrid SCM/SAC-OCDMA system is combined by two schemes in a way that the resulting hybrid system is robust against the Multi Access Interference (MAI) and much enhanced channel data rate. In this paper, the performance of hybrid SCM/SAC-OCDMA system is improved basing on spectral amplitude coding to suppress such impairments and to improve the overall system performance in the sensitivity at a BER of  $10^{-9}$ . As a result, the proposed system based on Multi Diagonal (MD) code show a better performance compared to the conventional code that employing SAC-OCDMA system. We also evaluate the different design's parameters under the maximum number of subcarrier (18 subcarriers in each optical channel) multiplexed for integrating OCDMA technology onto the existing fiber-wireless infrastructure at 155 M bit/s data rate for different fiber length. Furthermore, the BER  $\leq 10^{-9}$  has been achieved based on the proposed system for 45 km at 4.81 GHz.

**Keywords:** Subcarrier Multiplexing (SCM), SAC-OCDMA, MD code.

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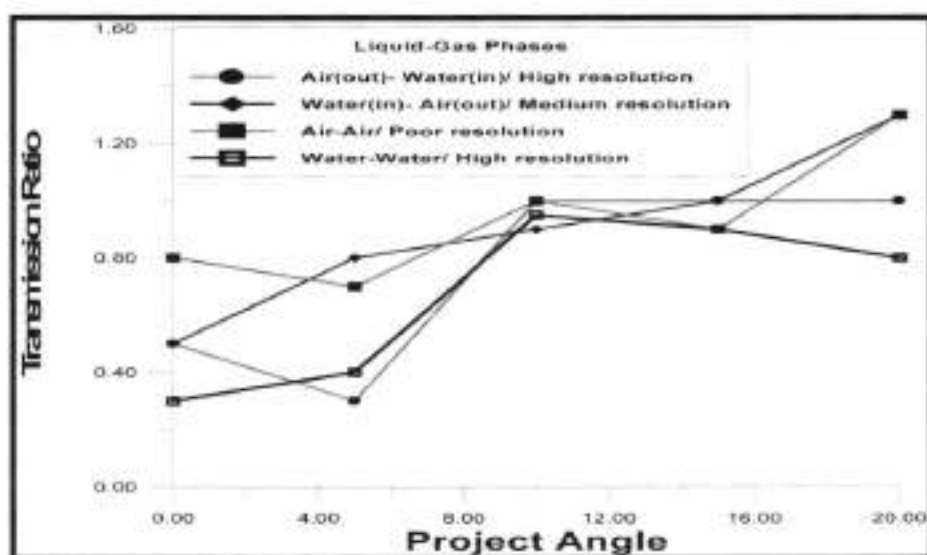


Fig. 22 Transmission ratio against project angle of Liquid-Gas phases

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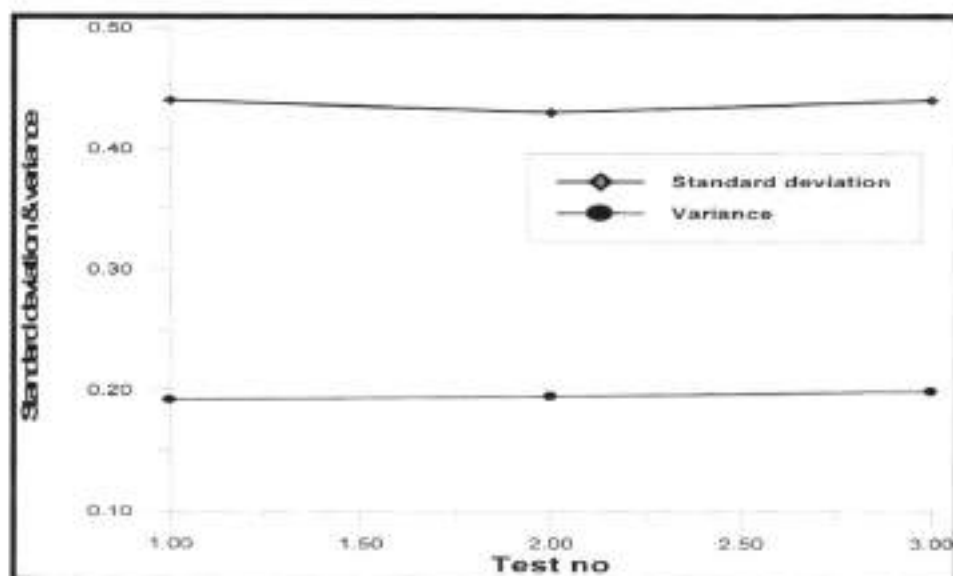


Fig. 20 Standard Deviation & Variance of the solid phase transmission

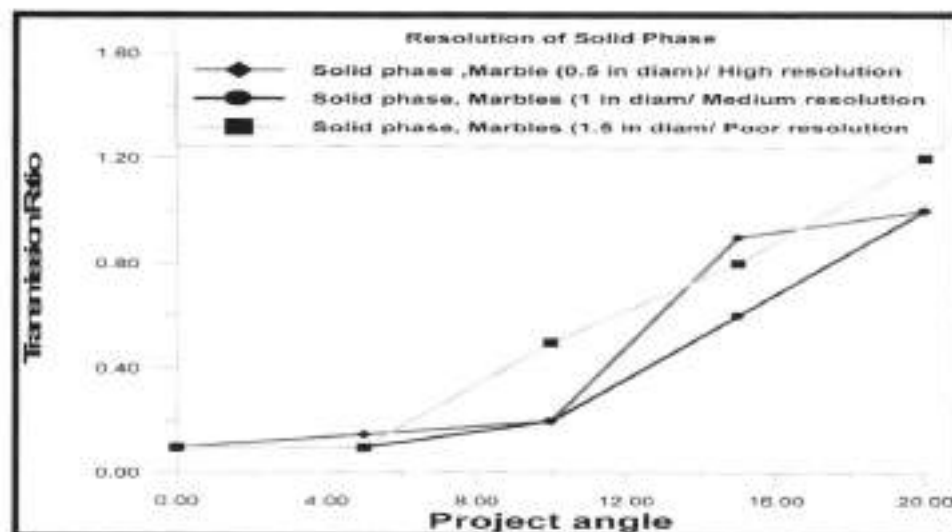


Fig. 21 Transmission ratio against project angle of solid phase

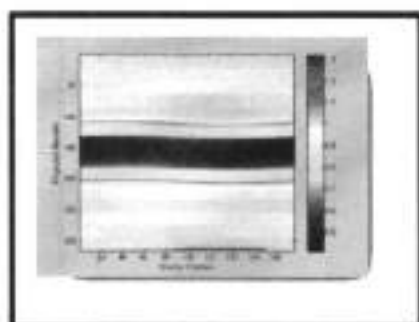


Fig. 14. Image senogram of ( Water-Air) / Table 2

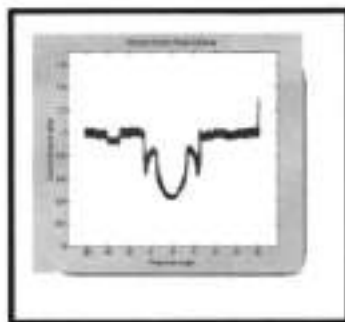


Fig. 15. Transmission of ( Water-Air / Table 2

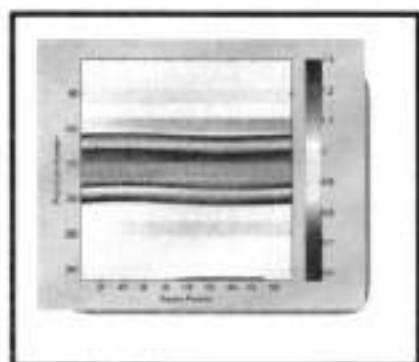


Fig. 16. Image senogram of ( Air-Air) / Table 2

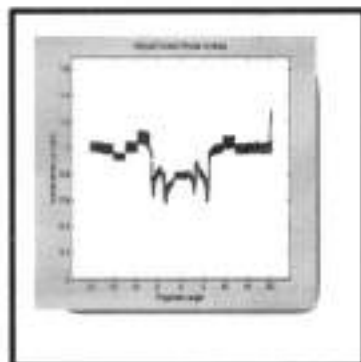
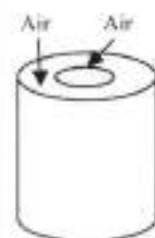


Fig. 17. Transmission of ( Air-Air / Table 2

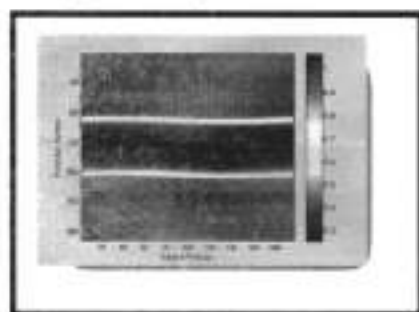


Fig. 18. Image senogram of ( Water-Water) / Table 2

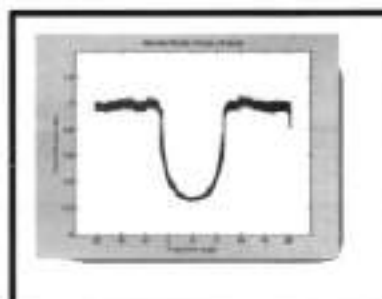
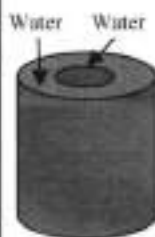


Fig. 19. Transmission of ( Water-Water / Table 2

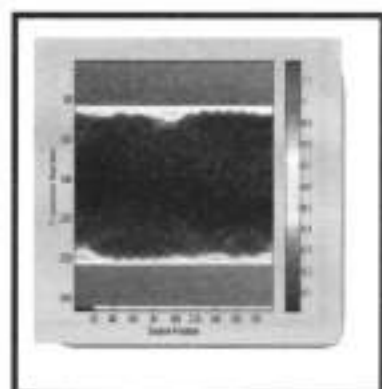


Fig. 10. Image senogram of Test No 3 ( solid phase-glass) dim=1.5in / Table 1



Fig. 11. Transmission of Test No 3 (solid phase-glass) dim=1.5 in/ Table 1/ Variance=0.199173; Standard deviation=0.446286

#### 4.2 Images of exchange phases (Air-Liquid)

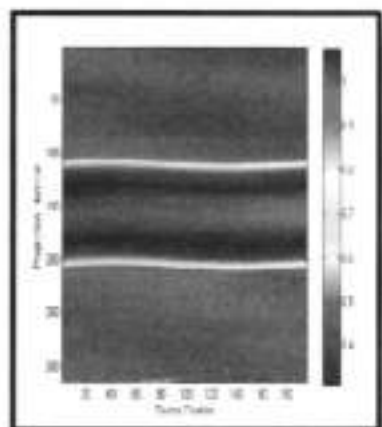


Fig. 12. Image senogram of ( Air-Water) / Table 2

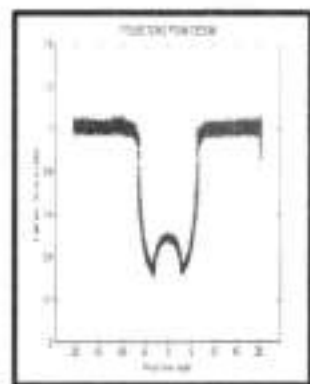


Fig. 13. Transmission of ( Air-Water) / Table 2

## 4.1 Image of solid phase

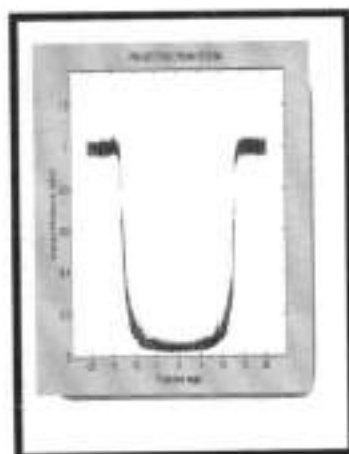
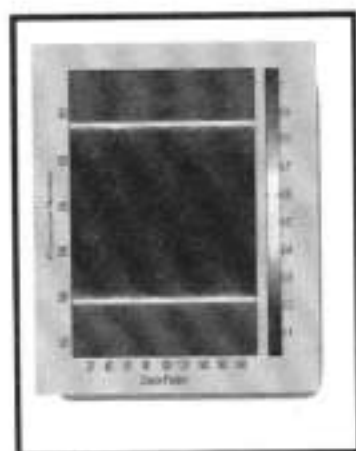


Fig. 6. Image senogram of Test No 1  
( solid phase-glass)  
dim=0.5 in/ Table 1

Fig. 7. Transmission of  
Test No 1 (solid phase-  
glass) dim=0.5 in/ Table 1/  
Variance  
=0.195359; Standard  
deviation=0.4419

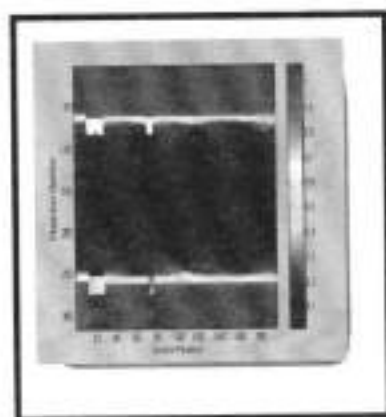


Fig. 8. Image senogram of  
Test No 2 ( solid phase-glass)  
dim=1in / Table 1

Fig. 9. Transmission of Test No  
2 (solid phase-glass) dim=1 in/  
Table 1/ Variance=0.19297;  
Standard deviation=0.439

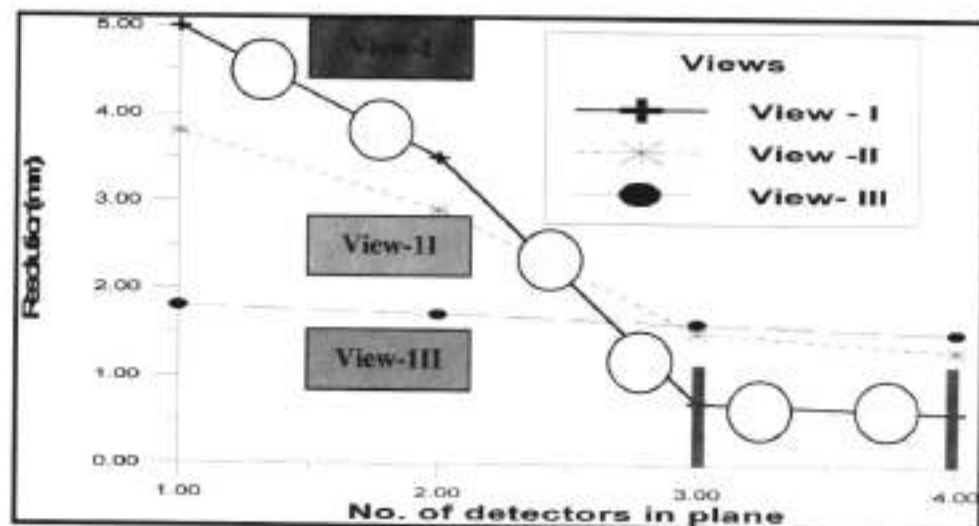


Fig.4 Best resolution (mm) against No of detectors in plane for views I, II, III

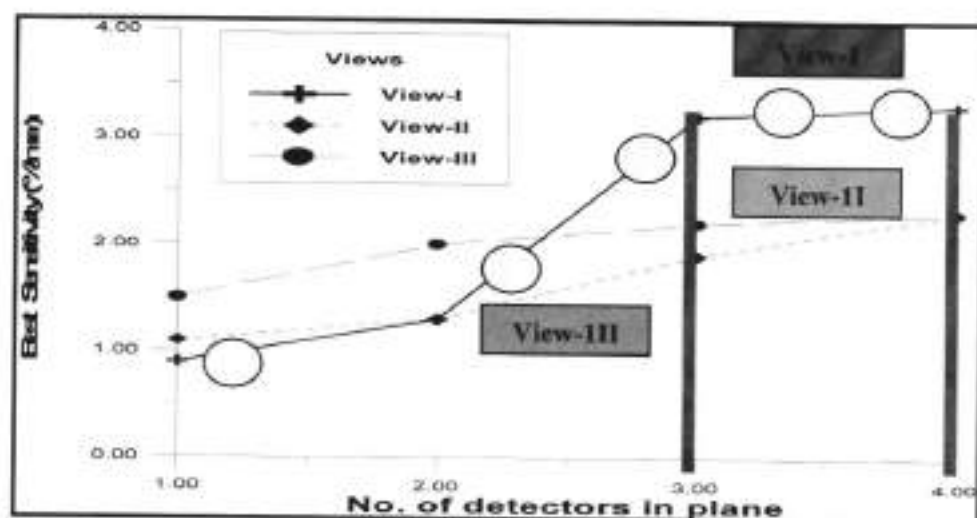


Fig.5 Best sensitivity against No of detectors in plane for views I, II, III

detectors used in the face of this isotope, with the 661 KeV, resolution must not exceed 10% because there are many important factors related to detector specifications like, crystal properties, photomultiplier tube properties, non uniform light collection, light flashes in the crystal, photopeak which affected on photocathode of photo amplifier tubes and photomultiplier tube.

So we can say that the crystal size is the most important factor affecting resolution because it also affects photocathode response, this response increases if phototube area increases in large crystal. These factors are taken into consideration when design detectors reduce resolution and increase sensitivity. Arrangement also gives another best choice, see Figs. (4 and 5) for detectors 3 and 4. Size of fuel marbles inside nuclear core also affect, resolution, when use the lower size, get the best resolution as shown in Figs. (6-11) for solid phase test. The transmission ratio against project angle for solid and other phases, see Figs. (20 and 21).

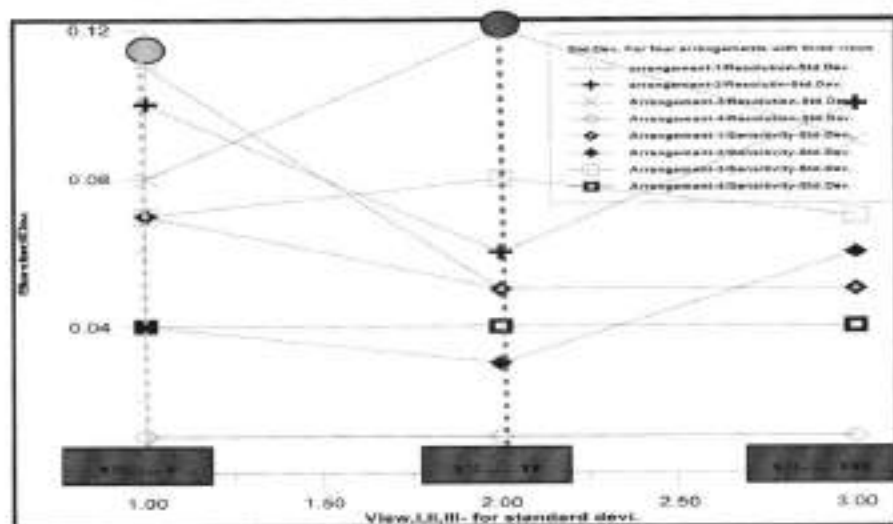


Fig.3 Views I, II, III against standard deviation

deviation indicates the level of noise in the image. If the standard deviation is high and variance is low, this means that the image is noisy. When the standard deviation is small and the error is high, this means that there is a bias in the image. Figs. (6-11) show that the marble size is the most important factors affecting resolution and transmission. Figs. (6 and 7) show the lower resolution and the higher sensitivity because the use of lower marbles size (0.5 in), but when marbles sizes increases (1 and 1.5 in) is used in pot tester, we see unadjusted transmission shapes which leads to no clear image as shown in Figs (8-11), Standard deviation and variance for solid image phase, see Fig. (20). Images of senogram and transmission for (Air-Water) phases as shown in Figs. (12 and 13) have the best resolution; also the Images of (Water-Water) phases have good sonogram and transmission as shown in Figs (18 and 19).

Other phases like (Air-Air) and (Water-Air) show higher resolution and low sensitivity, so the arrangement of these phases must be changed to get a better resolution than shown in Figs. (14-17). The best condition to get high image purity, we must follow the (arrangement 1/view 1), or (arrangement 2/ view 2) or (arrangement 3/ view 2). The best arrangement between detectors and isotope is (arrangement 3/ view 2) which gives us standard deviation equal to (0.12). As we know the higher values of standard deviation, means low resolution with high sensitivity. We can not adjust all detectors on the choice arrangement, but few detectors can be adjusted which are influencing the status of photon account as shown in Figs. (4 and 5).

Size of detector is an important parameter affecting resolution. If it increases resolution, energy increases, when photon energy increases, resolution decreases. We use Cs-137 in our machine, so we must make a comparison between the

#### 4. Results and Discussion

The schematic representation of the two sources (side view) is shown in Fig. (1). There are 15 detectors on each side with 360 angular positions. Photos and the top schematic of the same machine are shown in Fig. (2). We can see that the great value decomposition is as shown in Fig. (3) in (arrangement 3/view-2), but the lower decomposition in arrangement is in (arrangement-4/views-1,2and 3) which is the best arrangement to support detectors about X-axis. Arrangement-4/view-2 is the better than other views for sensitivity. Arrangement-3/view-2 gives us the higher standard deviation for resolution, but arrangement-1/view-1 for sensitivity gives us reasonable values.

From experiment , we see that the best resolution is in view 1 for detectors 3 and 4 as shown in Figure 4, while the best sensitivity is as shown in Figure 5 in view 1 for detectors 3 and 4 also. The schematic representation of fourth generation reactor in this study represents a circular tube of (30cm) diameter consisting of marbles of glass with spherical shape which is represented as a solid phase with diameters of (0.5, 1, and 1.5 in). The gamma ray scanner with a fan beam arrangement of source and detectors are used. Data collected from 197 source positions and 21 projections for each source position.

Approximate photon counts would be received with a 235 mCi of Cs-137 isotope and 50 mCi of Co-60 isotope for the same scanner geometry were chosen as the incident photon counts . The counts data generated for both the energies 661 keV from Cs-137 and 1332 keV from Co-60. The analysis of the images is possible when the senogram values in a given part of the image are analyzed for its standard deviation. Standard

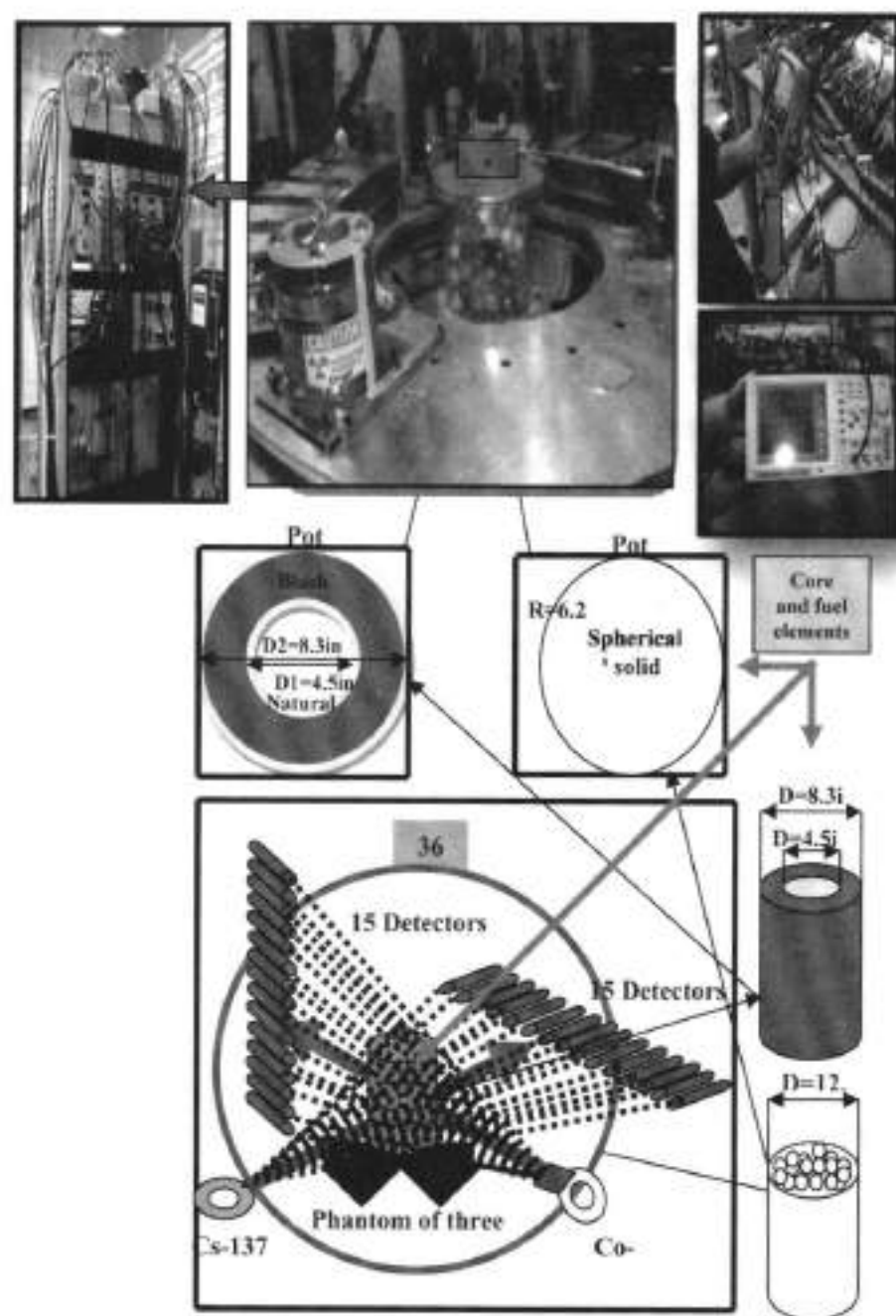


Fig.2 Photo and top schematic representation of system, general views, and pot testers

detectors. Machine of the two source and detectors are fixed on a circular plate which can be moved to different heights along the vertical axis. The maximum diameter of the pot tester which can be tested is equal to (17.9 in). Multiprocessing to get images for all phases are based on the transmission shape and value. The standard deviation and variance for all images are used as an important parameters to measure the quality of multiphase's images.

**Table (1)**  
Testes to image solid phase

Testes	Phase ( Solid)	Attenuat ion Factor ( $\text{cm}^{-1}$ )
Test-1	Spherical glass Dim=(0.5 in)	1.31
Test-2&3	Spherical glass (1 in) & (2 in)	

**Table (2)**  
Testes to image liquid and  
air phases

Testes	Phase ( Black Liquid- Air)	Atte nuati on Fact or ( $\text{cm}^{-1}$ )
Test-1	Air	0
Test-2	Black Liquid	0.08
Testes are changed, like Air- Liquid/ liquid- air/ Air- Air		

### 3. Experimental Work

High thermal reactors consists of core as shown in Figs (1 and 2), fuel element like marbles of glass with spherical shape which is fixed and coolant moves through the channels formed between fuel elements, control rods, and reactor pressure vessel. In pebble bed reactor, the source of heat comes from the fuel which moves in the core under gravity and helium gas as a coolant moves through voids formed between solid marbles and protect the fuel from heat. Marbles with spherical shape are mimicking the pebbles which are flowing under gravity. The marbles of glass is of density ( $34.4 \text{ g/in}^3$ ) flow and circulate permanently. Flow time of pebbles must be adjusted. As a mimic pot testers is used to image the multi phases inside the core of high thermal reactor, a pot tester is manufactured from acrylic material. This pot is formed from two pipes, the inner tube may be empty (air) or filled with water and the outer annular pipe fills with air or water. The attenuation of pot material is lower than any other material. Pot is placed in the center of the machine as shown in Figs (1 and 2) in the route of gamma ray with a  $25^\circ$  between (30) detectors and isotopes. These detectors run through 21 positions and made 189 projections. The source and detector array moves 197 positions and collect data for each position. Pot tester cases are shown in Tables (1 and 2). Machine used with two isotopes should be responsible for imaging large diameter pot testers with high spatial. Pot tester must be exposed to the two array sources to get the scanned status. Each source must be protected inside lead collimator to give the shape of array passing through the pot tester. All detectors are protected by lead and put behind the arc of the shield. Photons generated by these isotopes can be counted by these

influence of resolution. (M. Moszyński et al, 2003) study the effect of different crystals on resolution. Single isotope Cs-137 of 661 keV has been developed by CREL (Kumar S, Duduković MP, 1997). This system has an arrangement angle of  $40^\circ$ . The expectation maximization was used for imaging phases. The second system was fabricated by (Kemoun, et al, 2001) which is lighter and portable. Data processing technique has been fabricated by (Roy S, et al, 2004). The CREL also developed a dual isotopes machine to study the status of two and three phases.

## 2. Materials and Devices

Machine of dual source was designed to determine the image of phases in pot testers. This system used two gamma sources, these sources having different specifications used to emit gamma ray. On the other side of the circle there are (30) Sodium iodine detectors which are used for measuring the transmission of the gamma ray photons across the multiphase of pot testers. Detectors are used to count the un attenuated photons or even the scattered photons of the gamma ray that pass through the multiphase pot tester. Computer and data acquisition system collect the gamma ray counts data. The fifteen detectors are oriented at 21 angular positions each with respect to the source, see Fig.1.

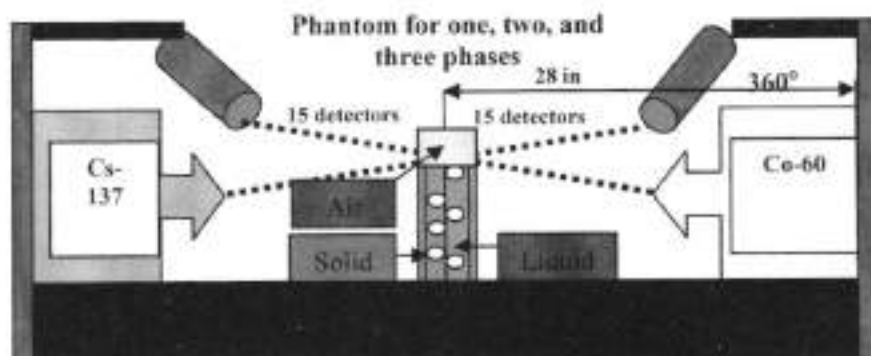


Fig.1 Front schematic representation of sources and phantom through testing process

## قياس الكثافة النيوترونية المؤثره على الاطوار المختلفه باستخدام تقنيّة الابعاد المحتمله

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### المستخلص:

تم في هذا البحث تصميم مآكنه مجهزه بمصدرين لتوليد اشعة كاما مختلفي الشده وهما الكوبلت-٦٠ والسيزيوم-١٣٧. يستخدم هذا النظام للتصوير المقطعي المزدوج لقلب مفاعل تجريبي مرتبط بنظام حاسوبي معقد و متكامل. المآكنه تتكون من ثلاثين كاشفا من نوع (يوديد الصوديوم) موزعه بالتساوي مقابل كل مصدر. الهدف الرئيس من هذا البحث هو للحصول على افضل صورته باعلى درجه من الضوح وباقل درجه من التشويش للاطوار المختلفه العامله في قلب المفاعل وكما نلاحظ من خلال الاشكال (١ و٢) وكذلك من خلال النتائج كما في الاشكال (١٣، ١٢، ٧، ٦). تم تثبيت الكواشف بزوايا ومسافات محدده بالتنسيق مع موقع المصادر المشعه للحصول على الوفرة الفوتونيه اللازمه لاعطاء افضل النتائج. تم اجراء هذا البحث في جامعه ميزوري للعلوم والتكنولوجيا خلال مدة التفرغ العلمى وتحت اشراف رئيس قسم الهندسة الكيمياويه والبيولوجيه والنوويه.

الكلمات المفتاحيه : الكواشف، مصادر اشعة كاما، الترتيب، المشاهد، التضعيف، النظائر.

### 1. Introduction

Our study is matched with the work of the researchers shown in Figs. (1 and 2). Observation of the resolution in the sodium iodine detectors first done by (*John Wiley & Sons, 2000*) and, (*Iredale, 1961*). Excellent resolution done by (*Ohn, et al., 2002*). (*Dorenbos et al, 2004*) verified the

## Measurement of Photon Density Affecting on Different Tested Phases By Spacing Technique

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### Abstract:

In this study we design a machine equipped with two sources generated gamma rays with different intensity, these sources are cobalt-60 and cesium-137. A non-invasive measurement technique is used in this system and applied to the core of an experimental reactor, this system is linked to a complex and integrated computer. Gamma ray machine consists of thirty sodium iodide detectors distributed equally on each side of source. The main objective of this research is to get the best image with the highest sensitivity and the lowest degree of resolution for the working phases inside the core as shown in Figures (1 and 2), also as shown in Figures of results (6,7,12,13). Detectors are installed with different angles and distances in coordination with the radioactive sources location to get the necessary quantity of photons to give the best results. This research was conducted at Missouri University of Science and Technology during the period of full-time sabbatical under supervision of the head of the department of the Chemical, Biological, and Nuclear Engineering.

**Key Words:** Detectors, Gamma sources, Arrangement, Views, Attenuation, Isotopes.

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different Arab women assuming the role of Scheherazad in defending the women of her kingdom from the psychic king Shahrayar.

### Notes

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9. Bhabha, 124
10. Bahareh, 160
11. Qtd. In Twair, 39
12. Fatima Mernissi
13. Mais Yusuf Al-Qutami. Feminist Resistance in Contemporary American Women Writers of Color: Unsettling Images of the Veil and the House in Western Cultures. A Ph. D. Dissertation: Indiana University of Pennsylvania, 2009, p. 56
14. Bahareh H. Lampert. Voices of New American Women: Visions of Home in the Middle Eastern Diasporic Imagination. A Ph. D. Dissertation: University of Wisconsin Madison, 2008,p. 159.
15. Mernissi, 55
16. Bahareh, 160
17. Lisa SuhairMajaj. "Supplies of Grace"
18. Ibid
19. Ibid
20. Abdelrazek, 76

one of the strategies used by Kahf in her poetry collection as a mode of resisting the misrepresentations of Arab-Americans in general, and Arab-American women specifically. The unleashing of the counter-facts here are not pleasing or soothing, but they are the "demons" that haunts the westerners:

the demons she unleashes,  
 the terrors that come from  
 within you and within her  
 And suddenly Scheherazad is nowhere to be found  
 But the stories she unlocked go on and on-  
 (So You Think... ll. 19-23)

By telling her own story and writing her own poetry, the speaker aspires to resist oppressive Arab and American systems and asserts her own independence.

### Conclusion

Arab-Americans suffer from various kinds of misrepresentations that aim, deliberately or not, at distorting the image of the Arabs in the American mainstream. What aggravate the situation are the negative stereotypes of Arabs in the media and in popular culture. Images of Arabs as backwards, religious fanatics, terrorists, oil Sheikhs, and of Arab women as harem or belly dancer and in the best cases as a helpless woman oppressed by the patriarchal society and by religion. These images and stereotypes are more strengthened by the attacks of 9/11 on the Pentagon and the World Trade Center in which waves of hate crimes and Arab profiling were increased and encouraged by certain extremist organizations and TV channels. The aftermath of September 11 attacks also consolidate the conflation of the notion that Arab-Americans and Muslim-Americans in general are potential enemies of the United States. This paved the way for more oppression against them, such as hate crimes, deportations, spying on them, Arab profiling and so many other illegal practices without any evidence of criminal activity.

This study has shown how contemporary Arab-American woman writers have responded to all these challenges with various modes of either resistance or assimilation. Kahf's poetry is characterized by its cultural resistance to any Americanization of the Arab identity in the US. Her collection of poetry *E-Mails from Scheherazad* (2003) features

"But, Officer-"

"Lady-!"

(Lateefa, ll. 101-111)

The Arab-Americans' wedding seems at odds with the usual wedding ceremonies of the U.S, and thus the officer, a symbol of authority, refuses to identify it as such. The differences in the cultural and religious norms seem to pose obstacles in the face of any attempt at full assimilation in the host homeland. What is made clear also in these last lines is the loss of communication between the officer and the lady; she is not able to explain to him that this is a Muslim wedding and that they do not need a priest. This piece of information never finds a way out of the mouth of the speaker either because of the officer's interruptions or because of the difficulty in explaining them. One may wonder here whether the speaker is afraid of telling the officer that this is a Muslim wedding, as she seems so hesitant to articulate it. One may also conclude that the hesitation of the speaker is due to the American stereotypes of the Muslim Arab-Americans which would pose another obstacle.

In her poem "So You Think You Know Scheherazad," Kahf faces the Arab Stereotypes, but instead of shying away from them she reflects them to the dark side of America and plays with the images representing them as a means of resisting them:

Scheherazad invents nothing

Scheherazad awakens

The demons under your bed

They were always there

She locks you in with them.

(So you think... ll. 5-9)

Scheherezad, according to Kahf, is back with no "bedtime stories / That will please and soothe" but she is going to resume her old task again and "Save the virgins" of the modern times from the tyranny of main stream America. The speaker of the poem assumes that the west is not aware of the crucial role that Scheherazad plays in healing Shahrayar, the psychic king. She believes that they misread her role as a woman who entertains and relieves the king by telling him amusing stories. The title of the poem "So You Think You Know Scheherazad" has the sense of confrontation that Kahf emphasizes in highlighting the west's ignorance and misreading of Scheherazad. The re-reading, or re-telling, of history is

roots, the picture of her Arab country gradually fades and recedes from the scene:

(Daddy, you can talk to me  
 All you want about Palestine  
 And I'll be faithful to the end  
 But I don't know it, never  
 Smelled its rainwet streets, don't know  
 Its stoops and backyards and chicken coops  
 and those neighbours standing beside that old Ford  
 in the black & white photograph. My Aunt Cauthar,  
 Daddy, I love her – I think of cougar,  
 Sleek, black-haired, and courageous-  
 but I don't know her, or the abundant rivers  
 of what she really means)  
 I know New Jersey.  
 (Lateefa, ll. 40-52)

These words, printed in italics and placed between parentheses, indicate the private thoughts and feelings of the speaker, who faces the dilemma, like many second, and third-generation Arab-Americans, that she has no actual connection to the Arab world since she never lived there. The only home she really knows is America. However, because of their racial, ethnic, and at times religious differences, immigrants, like this speaker, tend to become marginalized in their new homes. As an Arab-American woman, coming from a different religious and ethnic background, the speaker recognizes the differences between Arab and American cultures that seem poles apart. Nevertheless, the speaker's identification with the American culture and her mistaken assimilation to it is faced with the truth of her difference; she is not American. The end of the poem establishes the disillusionment clearly:

"Officer, if you could just wait for the wedding to-"  
 "What wedding, lady? I see no priest.  
 Where's the priest?"  
 "We don't have- see, we aren't- we're-"  
 "Lady, you people gotta move your cars or they get  
 Tickets, see?"  
 "But Connie's getting-this is a wedding! Just wait one sec  
 Till the ceremony-"  
 "Lady, move these cars or I give them tickets.

for visitors and foreign guests.  
 At school, we pledged allegiance,  
 Trying not to feel like traitors.  
 (ll. 53-57)

The feeling of treason to any side of the hyphen is a kind of an inner struggle within the Arab Americans as they are torn between two different worlds in which they are unable "to choose one over the other".

### III. Assimilation as a Mode of Resistance

The question of assimilation becomes even more drastically important when the immigrants face the rejection and misunderstanding due to the cultural and religious specifications of that specific ethnic group. It is not only a matter of the immigrants' ability and readiness to assimilate, but it is the ability of the host homeland to accept these immigrants as pure Americans. These ethnic people, then, are trapped between an old land which they never know, and a new one which seems to reject them. This specific matter is tackled in the next poem "Lateefa". In this poem the focus falls on the life of Arab-American woman experiences in America and the cross-cultural tensions she experiences.

The speaker of "Lateefa" starts the poem by an announcement of an Arab-American Muslim girl marriage ceremony. An occasion which establishes an atmosphere of a natural, happy, and satisfactory life, and a sense of full assimilation in the new homeland. This scene brings up memories of her childhood seeing her mother in kitchen cooking and asking her to take care of her brother:

... she's holding a baby  
 with her left arm and with her right  
 heaping chicken and Hungarian potato salad  
 onto a paper plate and at the same time calling  
 "Lateefa, help your brother with that soda  
 before he spills it all over himse- Lateefa"  
 (Lateefa, ll. 9-14, italics original)

The components of this scene she still remembers, but she admits that she no longer remembers her Arab homeland, or that she does not really know it, and that the only place she really knows is the United States, and so the focus shifts to her life in America. Though still proud of her Arab

To repeat. It expressed his concerns  
 About our religion and ethnic origin.  
 He had a rifle. We went on home.  
 (ll. 16-22)

The speaker, then, partly blames her parent's "cruel kindness" for her plight, because they brought her to the new world and yet expect her to live as a Syrian without being influenced by the American culture. The children in "The Passing There", feel in their own hearts what W.E.B. Dubois invoked: two souls, two thoughts in one dark body. Their parents with their  
 ...alien expectations,  
 the cruel kindness of parents who,  
 coming from the Syrian sixties,  
 thought they had succeeded  
 in growing little hothouse Syrians.  
 (ll. 25-29)

Indeed, the speaker goes through a dilemma that many second generation immigrants experience. She and her brother live a double life. At home the parents, in an attempt to preserve their original culture, try to rear the children as pure Arabs, feeding them Arabic food, teaching them the Arabic language, and telling them stories of their Arab culture and heritage. Yet, outside their homes, the children live as Americans, go to American schools, befriend American children, and learn American ways of life. These children's parents do not teach their children how to live as hyphenated Arabs, overlooking the fact that a great part of their children's identity, unavoidably, is American. They do not realize that these children spend most of their time at school where they "pledged allegiance / trying not to feel like traitors."(ll. 56-57) These children who grow up to be Arab Americans live between two worlds, trying "to leap the gulch between two worlds, each / with its claim," yet it is "impossible for us to choose one over the other".(ll. 60-62)

The speaker in "The Passing There", and her brother, undergoes the same identity fragmentation and they are set between inclusion and exclusion. They are neither Arabs nor Americans, and they are not able to identify with either. They are taught by their families to:

[sing] the anthems  
 of their remembered landscapes on request

Being a poet, however, Kahf resorts to her imagination to solve all the political crises in her country of origin. Driven by her nostalgia to everything and everyone in Syria, she is able to imagine that they will celebrate her coming back each in its own way, "I am sure that if I went back to Syria/ there would be music/ and all the melodrama of a Hindi movie"(ll.29-31). Simultaneously, the poet is aware that it is only an imaginative world she is talking about. But nonetheless she affirms that "This is my poem and I can do what I want/ with the world in it"(ll.73-74). Kahf, then, seems to be rejecting the two locations of belonging that she has, and chooses instead a third location, though imaginative, to live in temporarily and release herself from the tensions of diaspora.

In the next poem "The Passing there", Kahf discusses the concept of in-betweenness from the point of view of the second generation of immigrants who do not make the choice of leaving their homeland and who get trapped in the third space. The speaker of the poem, Mohja, and her brother, Yaman, at the ages of nine and ten, cross a field of soybeans. The experience of crossing the field alludes to the children's immigrant experience. Even though the field, like the speaker's new homeland, is "golden" and filled with "golden" opportunities, she asserts that she and her brother do not belong there:

It wasn't ours. It was golden.  
I remember raspberry bushes  
Way at the back, and rusted wire,  
Once a fence, a defunct now and trampled under  
By generation of children who belonged  
To this Indiana landscape in the seventies,  
Sixties, forties, tens: Matthews and, Deborahs,  
Toms and Betsys, Wills and Dots. Here we were,  
Yaman and Mohja.

(The Passing There, ll. 1-11)

The description of the experience reveals the difficulty of assimilation on the part of Arab-American as their new home poses obstacles in the way of this assimilation as it has concerns about their religion, culture, tradition, and the colour of their skin:

The man who owned the field was no Robert Frost  
Although he spoke colloquial. "Git  
Off my property," he shouted, "Or I'll-"  
The rest of what he said I do not care

When they arrive in the new country,  
 Voyagers carry it on their shoulders,  
 The dusting of the sky they left behind  
 The woman on the bus in the downy sweater,  
 I could smell it in her clothes  
 It was voyager's dust from China  
 It lay in the foreign stitching of her placket  
 It said: We will meet again in Beijing,  
 In Guangzhou. We will meet again.  
 (Voyager Dust, ll. 1-9)

Although the speaker never speaks to the Chinese woman, she could still "smell it in her clothes" that she carries the dream burden of return and the hope of meeting anywhere in China, being it in Beijing, Guangzhou is not important as far as they meet again. The image of this Chinese woman stimulates Kahf to think about her mother when she first came to the States. She also carries "voyager's dust in her scarves" and also dreams of "meet[ing] again in Damascus/ in Aleppo/ We will meet again" (ll. 23-24).

At stake in *E-mails from Scheherazad* is a sustained examination of the problem of belonging and the way Kahf looks at how both the host community and the country of origin complicate belonging. In "The Cherries", an adult speaker who "left Syria many years ago" begins the poem by seeing the world from a child's perspective. She insists, "Syria is saving some cherries/ in a bowl for me/ at the back of the refrigerator"(ll.) because she is "sure of" the fact that "Syria remembers" her. However, the poet is aware of the political situation that leads her to seek shelter in other lands. She depicts Syria as:

...a poor woman with a cruel master  
 Who wouldn't let her care for me  
 As a child deserves to be cared for  
 He wouldn't let her feed me cherries  
 And dress me in Aleppan wool  
 He wouldn't let her pin little gold trinkets on me  
 To protect me from the evil eye  
 So she had to send her child far away.  
 (Cherries, ll. 83-90)

the most effective device in describing the 'third' space in which the 'self' and the 'other' meet:

Their names and their languages are wildly different  
 And they believe improbable, vile things about each other  
 But see the turn of wrist when a woman from here  
 Or a woman from there kneads dough  
 Although the bread will be twisted  
 Into different shapes for baking,  
 The hands move with a similar knowledge  
 See how a farmer takes up a handful of dirt  
 This one wears overalls and that one wears a sirwal,  
 But the open hand with the dirt in its creases  
 Makes a map both can read.  
 (Kahf 2003: ll. 35-45)

All these different peoples share similarities in the essence of their different cultures and traditions; the 'dough', then, is the same, but they shape it differently. However, all these similarities and differences need a kind of articulation, what Stuart Hall calls 'the diasporic articulation', and the poet wonders about the possible medium of articulation that may bring them all together emphasizing the similarities and subsiding the differences "but who will coax them close enough to know this?"(l. 46) the answer to her question lies in the poet herself and she is aware of that fact "Darling, it is poetry/Darling I am a poet/ It is my fate"(ll. 47-49).

The concept of in-betweenness is presented in the "Voyager Dust". This poem functions as a brief introduction to the whole collection as the "I" speaker, probably Kahf herself, the mother, and the third space are introduced. The poem's title suggests the dream of return of a traveler and the burden of diaspora he carries on his shoulders. The poem starts with a general statement about the immigrant's experience and then focuses on her own experience as the daughter of an Arab immigrant woman. First the "speaker in 'Voyager Dust' says that immigrants, whether Chinese like the Chinese woman she sees on the bus or Arab like her mother, never fully distance themselves from their homes although they are no longer physically there"<sup>22</sup>. The difference in the immigrants' identities emphasizes the sameness of the diasporic experience; all immigrants seem to be shattered between two worlds, the one they left, but still carry within themselves, and the one they emigrated to, although they have not found their way in it yet:

Whole populations of seed sowers and herb knowers  
 Some from Damascus, some from Fayetteville, they meet  
 In my head like the walls of the Red Sea crashing together  
 I roll dizzily toward them  
 Like the bowling ball of a very bad bowler.  
 (Kahf 2003: ll. 23-30)

Through paralleling the people and landscapes of these places that either pick 'khibbeze' or 'poke', wear 'overalls' or a 'sirwal, and knead the same bread though shaping it differently, she describes 'the joint' that is her diasporic experience which both links and separates.

The title of the poem, in a sense, carries the metaphorical weight of the poem as it is based on the pun between the first part of the name of the city, and the poet's fate to carry the burden of finding a common ground for all these people. The poet, however, seems to accept her fate from the very beginning of the poem and she learned to say "Fay'tteville as in fate" and she approaches her new location in "the American way" and "the immigrant way". She seems to be adjusting to both cultures without any explicitly internal conflict, though she carries the roots of her Arab descent with her as she admits that she misses "Abifawq el-Shaggara" and some other cultural things. This kind of nostalgia to the past cultural history is made easier when she hears one of the Wal-Mart clerks saying "Shukran" and she believes again "that's fate".

Her new location then is bound with different people from all races, and she can recognize their difference "around the rims of peoples' eyes":

There is Spain and France left in the names of things  
 There is Wild West and Old South here  
 Sometimes the music of the Ozarks  
 Spills down the mountainside  
 And it is green and brown, and I think I hear it.  
 (Kahf 2003: ll. 18-21)

The conception of people of different races and colours dashing through the mind and memories of the poet and the similarities and differences she could recognize among them testifies to the concept of the poet as a 'joint' in whom two or more cultures meet and hence formulating a new space that belongs to all these cultures and at the same time does not belong to either. This sense of peaceful contradiction that the poet feels within herself leads to the use of paradoxical metaphors as

or when they do not feel well. Even though the younger Skaff is fifty-five years old, married, with a daughter of his own house, deep inside he still feels like a child who needs his mother's warmth to alleviate the pain of exile that eats him up.

However, in the last stanza, he calls his mother "O mae" (mother in Portuguese). Although part of him longs hungrily for his mother and the Arab home that he still remembers, he cannot deny the changes that he has undergone after having spent forty-one years in a new world, with a wife who speaks no Arabic, where he lives a completely different life. The connection to his home now is not the woolen bundle that he has "wasted smaller" but, rather, his daughter who has inherited her grandmother's Arab features; "hair" and "eyes", and who knows how to cook Syrian food, both of which remind him of his mother and his childhood home. He comforts his mother by telling her that:

There's a twelve-year-old Brazilian girl  
 With your hair and eyes, who,  
 Though she's never seen  
 You or your kitchen fire, makes  
 Syrian meat pies proper  
 Baked golden and sealed  
 With your same thumbpress,  
 Precise as an Ottoman coin.  
 (Word from the Younger Skaff, ll. 37-44)

The concept of the *third space* is clearly manifested in "Fayetteville as in Fate". Here in this poem the poet herself is the third space in whom different kinds of people and different races and cultures meet. The first space, that of the poet's origin al homeland, and the second space, that of her immigrant's one, find their own locations within the poet's mind and soul; sometimes they look so different but a deeper thought would set them so similar.

Kahf shows such kind of attitude towards cultural translation in her poems as she weaves English and Arabic words in a hybrid format in poems like "Fayetteville as in Fate". In this poem she contemplates what unites and divides people in Damascus and people in Fayetteville, a small town in Arkansas:

I hear that people pick "poke" here  
 And my family memory stirs with people  
 Who picked the wild herbs, the khibbeze, of other mountains

You wrapped in a woolen bundle  
 Were everything I and my brother  
 Had from home. They had to last  
 A lifetime. I was fourteen  
 The night we left, and  
 It was dinnertime.

(Word from the Younger Skaff, ll. 1-11)

Yet, before satisfying his hunger for his mother's food and his thirst for his home's warmth, he had to leave and "disappear" from the "one piece of earth I knew." The sense of taken-for-granted family cohesion now dissipates. The word "disappear" adds to the suddenness and quickness of his departure for which he has not prepared. He manages to take from his home only the money his father gave him and the woolen bundle with his mother's mincemeat pies. Since he brought only these things from home, the younger Skaff knew that they "had to last/ a lifetime."

The sense of loss the speaker of the poem is undergoing underlines the ongoing confusion of spatial location or social belonging that foreshadows his future life as an immigrant living in, and suffering from, an in-betweenness that would (re)shape his identity. The speaker describes powerfully the agonizing feelings he goes through as a war refugee. He explains that, even though he hardly contacted his mother, he never forgot about her or about his home. He has always hungered for the sustenance of his home and his mother. After forty-one years in Brazil, his hunger for his home:

... still lurches  
 Inside me, like the sea voyage  
 From Beirut to Brazil.  
 Sometimes I think  
 I could eat the house out,  
 Hearth, oven, gate, and all.  
 (ll. 17-22)

He addresses his mother using the endearing Arabic word "*Yumma*" to show his deep love for her and for his motherland, emphasizing that he has not cut off his relationship to them despite the distance that separates him from them. Indeed, children use "*Yumma*" not only when they want cuddling, but also when they call their mothers to save them from danger

## II. The Growth of the Third Space

Mohja Kahf's poems engage this "in-between" space Bhabha describes through rhetorical strategies such as first-person narration, ethical appeals, and signifying. The *third space* is an in-between space in which people of two or more cultures live. They have created this space on the bases of what they have kept from the old world and what they have gained from the new one. That is; they reject certain cultural principles from their homeland, basically the ones that do not suit their new world and they have taken from the new one what suits them most. However, this is a relative process, for the choice is not random and in most cases it is not theirs to make, rather it is the result of many cultural factors in the new environment they live in. The mother speaker in Kahf's poem is aware of that and this is why she blames herself for displacing them. She knows that "They [are] far away/ For passage back" and she knows that one day the "Word stop[s]" and she would no longer be able to hear from them. The tone of the poem also suggests this ending. It starts sad and slow with general presentation of the circumstances that forced the mother to send off her sons far away to "survive" and then culminates when she realizes that the "Word stopped" and that they have grown old and got married and will never come back again.

In the second poem, the same story is narrated from the point of view of the son, the one who immigrated. The poem is entitled "Word from the Younger Skaff" and it emphasizes the attachment of the first immigrants to their homeland. Abdulrazek believes that the poem is "elaborating on the themes of the exile-home relationship, introducing a more positive and constructive view of home rather than a nostalgic one"<sup>20</sup>. This poem carefully describes the painful experience of a war refugee or an exile living in the border zones, neither completely in his new or old homeland and feeling at home in neither. Lavie and Swedenburg claim that "Borders are zones of loss, alienation, pain, death.... Living in the border is frequently to experience the feeling of being trapped in an impossible in-between"<sup>21</sup>. The speaker asserts that circumstances forced him to leave his home "at dinnertime," a time when the whole family usually gathers and shares their stories:

I was still hungry  
 When I left home, mother,  
 To disappear from the one piece  
 Of earth I knew. The Ottoman liras  
 Father gave us and the mincemeat pies

their new world have wasted the bundle and the liras; the only things they have brought from their motherland. In a sense, they have lost all kinds of homeland roots attaching them to their family as symbolized by the mother. The poem, from another perspective, is more concerned with the people who stayed home, not those who have immigrated. In other words, the immigrants' story is told from the point of view of the mother, the one who stayed home and the internal conflict that she suffers from. The poem, it seems, is a kind of justification for immigration; as the mother is giving reasons for, what she believes her own decision, of sending them abroad. In a way she is convincing herself that what she did is the right thing for her sons, and to assure this she repeats the word "survive" about seven times in the poem, and in one of them she "swear[s]/ to keep them with us" for " they [are] only boys/ Fourteen and fifteen is too young to suffer war/ And maybe die"(ll. 33-35).

The mother speaker then wonders about the very essence of survival "but what is it to survive/ Like grafts cut off a tree/ a child without a bundle"(ll. 36-37). These sons, the mother thinks, have been displaced from their own homeland and they have been implanted into a totally different one without the means to survive there. This is clearly shown in the poem when she says " had no more wares/ Nor skills to make a living". But the question is not merely about certain skills to make a living as it is about surviving in a totally different space other than their own homeland and the attachment, whether cultural, familial, to the homeland which they seem to have lost gradually by being away. Thus the mother's burden is the homeland's burden which fails to provide its people with security and protection they need to survive. This loss of security and protection is manifested in the absence of the father figure from the familial scene, and it is again a consequence of the war " The end of war/ brought cholera that took their father"(ll. 24-25), this metaphorical representation of the father figure as a representative of the cultural security is one of the markers of eastern familial life. The absence of the father figure, then, denotes an absence in the continuity of the cultural and familial attachments of the immigrants to their homeland, it also connotes that even if they return, they would not find the security they need as the father is absent. Hence, these immigrants lose contacts to both cultures, the original and the new. Here one may refer to Homi Bhabha's concept of the third space as discussed in his book, *The Location of Culture*.

survival and a way of living; for the main role of Scheherazad here is to narrate stories of Arab-American women, if for no aim at all, but to bear witness to the oppressions practiced on them by main stream America. This "bearing witness" is in fact one of the strategies used by Kahf in her poetry as a technique of resistance in exposing the stories of these women and the difficulties they encounter in their everyday life.

Kahf, in a way or another, is documenting the story of the first immigrants, who were obliged to escape the oppressions of the Ottoman Empire at that time which used to conscript the young boys and send them to fatal wars. The poem starts then from the very beginning; people make a kind of information network telling of the movements of the Turks and their search for the young boys in the different areas in the Arab world. By the time the "Word came", the mother starts wrapping a "bundle" for her sons and the father supporting them with some "liras" to escape conscription into the unknown. The bundle of wool and the liras in the poem are not to be taken literally as the poet repeats them all over the poem. Of course any deserter would need a bundle of wool to keep him warm and some money to survive, but even surviving is ambiguous here. Is it only living, or keeping up with the family, or by maintaining the way of life of their original culture, or all of these together? Hence, the bundle is a materialistic entity, but charged with culture, tradition, familial closeness and solidarity, and all the abstract things that a man needs for his "survival". This is why the mother reminds them before leaving:

...."Survive"

I whispered in their ears the night they left, "Survive  
And come back to us." We wanted life for our boys  
So desperately we didn't think to ask how far away  
The ship was bound. "Come home to share the bundle  
Of mother, father, kin, house, bread, and wool,"  
(The Skaff Mother Tells the Story, ll. 12-17)

The poem, then, if not the whole book, is about survival, or means of survival in life and in a totally different way of life and culture. Is surviving the Turks' conscription the main concern of the mother as well as the sons? Or is it finding the way of life in the new world in which they settle? and the kind of tools or equipment they have for such kind of survival for the mother believes that " Their lives' small bundle/ must have wasted smaller." And they have "Sold off the liras". The sons in

migratory subjects, but works to unsettle dominant structures through acts of reinterpretation and resistance"<sup>14</sup>. Taking on the role of poet-seer, Kahf seeks to forge new forms of inclusion out of the vestiges of war-torn and intolerant cultures. In her poem "Fayetteville as in Fate" she poses the question of "who will coax" two hostile cultures "close enough" toward reconciliation and communication (p.7), she suggests "that it is up to language-workers to close the distances between us. In a sense, this might be the purpose for Kahf's revival of the figure of Scheherazad, whose skill is to "use dialogue to disarm"<sup>15</sup>. In *The Thousand and one Nights*, Scheherazad is a hero because she "commands words, not armies, to transform her situation and liberate the kingdom"<sup>16</sup>. In *E-mails*, Kahf expands Scheherazad's project to a larger scale by positing that the "fate" of the poet is to be an agent of redemption for a global community sick with prejudice and violence.

Lisa Suheir Majaj sees that *E-mails from Scheherazad* conjures up an image of Scheherazad, "bent over a computer keyboard, veil flung behind, manicured nails clacking as she types missives to American readers, is quintessential Kahf"<sup>17</sup>. And notices that "Kahf makes clear Arab and Muslim women are part and parcel of the contemporary landscape, living American lives in the heart of the U.S. amid the motley miscellany of the land"<sup>18</sup>. Indeed, Scheherazad, in Majaj's view, is an exemplar not only of oriental women but "of storytellers everywhere"<sup>19</sup>. She is in Majaj's words "Kahf herself" taking on different speakers each represent a fragment of the life of an Arab-American women.

At the very beginning of *Kahf's E-mails from Scheherazad* the story of the first wave of Arab-American immigration begins. The first poem is entitled "The Skaff Mother Tells the Story". The narrator of the poem is a mother as a symbol of the Arab tradition and culture and also to give a kind of simplicity to the story as she is not so well-educated and speaks more passionately about her sons. In doing so, the story is told in a manner analogous to the stream of consciousness in fiction in which the ideas flow unconsciously through the mind of the speaker. This technique adds a kind of credibility to the story and charges it emotionally as the reader may sympathize with the mother narrator. The technique of telling stories is also one of the main "surviving" techniques used by the Native Americans to keep their traditions and culture specific to the way of life that these Indians find suitable for them. The effectiveness of the technique, however, is not in writing these stories, but in narrating them orally from generation to generation. So narrating becomes a kind of

so much as an American poet or just as a poet"<sup>11</sup>. As a result of such a standpoint, E-mails from Scheherazad reflects a wide range of critical discussions that are certainly informed by Kahf's interest in how Muslims function in the U.S. mainstream, but the issues she works with reflect the multiple varied concerns that shape the diasporic experience of Arab immigrants in America.

E-Mails from Scheherazad offers the most articulated example of the challenges facing Arab-American women and the resistance they practice. It is composed mostly of short poems, each with its respective speaker. The poems are narratives of women, assuming the role of Scheherazad in taking the lead of telling their stories touching upon sensitive issues facing these women in contemporary America. These stories, however, are not to be told without the help of the Scheherazad character and the sense of sacrifice that is usually attached to her in saving her peers from the psychic king. "The vizier's daughter, Scheherazad, volunteers to marry the despotic king, Shahrayar, and to save the kingdom's women from the cycle of his violence"<sup>12</sup>.

Following the example of Scheherazad, the speakers of the poems analyzed here use their art to correct Americas' biased view of Arab women. In doing so, they assume that Shahrayar is the main stream American community which forms certain stereotypes of Arab-American in general and Arab women in particular, distorting their image as backward, oppressed, harem, belly dancers, and so on. These women play the role of Scheherazad in her courage to face the tyrannical king who oppressed them. "Depicted as feminists, these Arab-American Scheherazads not only seek to alter the frozen American misconceptions of the Arab woman as the exotic sex object or the oppressed victim. They also critique the view that a woman's expressions of desires and the pursuit of her interests contradict the interests of man and challenge the patriarchic eastern society"<sup>13</sup>. The different speakers in E-Mails from Scheherazad also focus on the challenges that an Arab woman confronts in her decision to leave her original homeland, her hyphenated identity, the bias and discrimination she encounters and continues to encounter in her adopted homeland, and her attempts to build a new future. These speakers also announce their strategies of resistance, which include their introduction of a new and more encompassing concept of difference, their notion of hybridity, and more crucially, their own poetry.

E-mails from Scheherazad is a text that admits the reality and potency of multiple intersecting exclusionary forces in the lives of

focuses on the position of African Americans, his concept of double-consciousness can be applied to the Arab-American and other minority groups in the United States. Nathalie Handal's critical works, for example, invoke this double-consciousness on the part of Arab-American's experiences, particularly as they are manifested in creative works. Such writers suffer from what might be described as a "split vision of identity"<sup>5</sup> in which he is torn between two different sides of his identity; the Oriental and the Occidental, each of which is trying to find a form of expression in his writing. Arab-American feminists also have found it impossible to disengage themselves "from the larger context of a hegemonic U.S. discourse that interprets all things related to Arabs as oppressive or 'backwards'"<sup>6</sup>.

Bhabha's discussion of national minorities and global migrants coincides with Du Bois' argument about the "quasi-colonized" and also the double-consciousness with which they negotiate their positions in the west<sup>7</sup>. The quasi colonized move between cultures and, in that space between cultural boundaries, articulate hybrid identities that belong wholly neither to one culture nor the other<sup>8</sup>.

This urgent task is complicated by a history of Arab-American erasure and assimilation in the United States that relates to what Bhabha defines as "mimicry" in the colonized subject. In the context of colonialism, "mimicry is the desire for a reformed, recognizable Other, as a subject of difference that is almost the same, but not quite. Which is to say, that the discourse of mimicry is constructed around an ambivalence; in order to be effective, mimicry must continually produce its slippage, its excess, its difference"<sup>9</sup>. Mimicry, as engaged in the Arab-American literary works, confronts the stereotypes, such as 'all Arabs are Muslims, all Muslims are terrorists', that are applied generally to Arab-Americans and ignoring the American side of their identities.

### **I. The Revival of Scheherazade**

Setting off her mission as a representative of Arab and Muslim-American women in the U.S., Mohja Kahf's first book of poetry, *E-mails from Schehrazad* (2003), "is intensely focused on how Arab women work to make America a home without losing those markers of identity that they hold sacred, or at least important"<sup>10</sup>. But Muslim identity in the diaspora is not the only subject that Kahf explores in order to imagine a more hospitable place for first and second generation immigrants. In fact, Kahf has herself insisted, "I don't want to be identified as a Muslim poet

ومتطرفون وسذج. في حين ينظر الى المرأة على أنها مضطهدة، خاتعة، خاضعة لسيطرة الرجل وذلك من خلال إفحام مفهوم بابا (البعد الثالث). وأخيراً ختمنا هذا البحث بأهم ما توصلنا اليه من نتائج.

الكلمات المفتاحية : المقاومة، الدليل، التهميش والبعد الثالث

## Introduction

Arab-Americans in general and Arab-American women in particular have continuously resisted any type of marginalization and the formation of negative stereotypes. Thus, Arab-American literature is situated in a broader context altogether, as just one part of the cultural work that minority communities use as a mode of resistance.<sup>1</sup> Arab-American writers have established their own space within mainstream American community generally defined as white and to a certain extent hegemonic in its systematic formation of stereotypes as binary tools to divide community to "Us" and "Them". This space, referred to by Homi Bhabha as the "Third Space", has enabled Arab-Americans to create their own narratives and rewrite their own history by which they have challenged the hegemonic image of them in Western discourses and have struggled to reinvent themselves in the American consciousness.

Articulating both sides of their heritage, Arab and American, becomes difficult when "Arabness" carries such negative connotations as harem girl, religious fanatic, terrorist, in mainstream American discourse, particularly after such traumatic events as September 11, 2001. Barbara Nimri Aziz asserts that " Arab-Americans have been 'colonized' to an extent: 'encouraged to forget [their] beautiful difference, [they] imbibe so many of the biases and distortions [of Arabs] around [them]"<sup>2</sup>. Aziz's comment relates to W.E.B. Du Bois' concept of the "quasi-colonial" state of American minority groups (i.e., those who are not white). According to Du Bois, the problems of minorities in western locales, specifically large cities like New York, are similar to the discriminatory treatment of colonized peoples elsewhere in the world<sup>3</sup>.

In addition to these obstacles of recognition and self-identification, the pressure some Arab-Americans feel to assimilate into mainstream American culture and to ignore or cover up their "Arabness" has created a tension between these two aspects of their identities. Du Bois' concept of a double-consciousness speaks to this tension: " this sense of always looking at oneself through the eyes of others... one ever feels his twoness,-an American, a Negro; two souls, two thoughts, two unreconciled strivings; two warring ideals in one dark body"<sup>4</sup>. Though Du Bois

## Testimonies of Resistance and Assimilation: A Postcolonial Study in Mohja Kahf's E-mails from Scheherazad

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### Abstract

This study examines resistance and assimilation as postcolonial modes in Arab-American women's poetry after the 9/11, 2001. Here the intention is to clarify the modes of resistance and assimilation as two important aspects in Mohja Kahf's volume of poetry, E-Mails from Scheherazad (2003); and the forces that formulate and shape these modes, and the extent to which these modes reflect the complexities and difficulties that Arab-Americans face in their daily life in America. Kahf's poetry functions as a testimony that resists and challenges the stereotypes of Arabs and Muslims as terrorist, ignorant, fundamentalist, naïve and others, and the woman as an oppressed, belly-dancer harem; so submissive, passive, and subordinate to the dominant role of man; by engaging Bhabha's concept of the Third Space.

Key Words: resistance, testimony, marginalization and third space

أدلة المقاومة والاستيعاب: دراسة تحليلية لمرحلة ما بعد الاستعمار  
في ديوان الشاعرة مهجة كهف (رسائل إلكترونية من شهرزاد)

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### المستخلص

المقاومة واستيعاب الآخر اسلوبين من أساليب مرحلة ما بعد الاستعمار تمخض في شعر الأمريكيات العرب بعد أحداث أيلول ٢٠٠١، دراسة تتناول هذين المفهومين. ان الهدف من هذه الدراسة أيضا هو توضيح اسلوب المقاومة واستيعاب الآخر كونهما مهمان في ديوان الشاعرة مهجة كهف (رسائل إلكترونية من شهرزاد ٢٠٠٣). يمكن اعتبار شعر مهجة على أنه دليل على تحدي ومقاومة النمط المأخوذ على المسلمين والعرب على أنهم أناس أرهابيون وجهلة

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1. This translation is late in that it came after the first two translations. This entails that these translators benefited from identifying the shortcomings of the other translations. Moreover, they seem to have also benefited from the developments of translation theory, especially in finding new strategies of translation. This explains their introduction of *couplet* which the study has shown to be a suitable method in the euphemisms it is used for.
2. their religious, cultural, and linguistic backgrounds (Muslims with Arabic as mother tongue) seem to have helped them in understanding the intended meaning of the euphemisms at hand, and consequently in choosing the proper translation method, thus avoiding the inconveniences in this respect.

Finally, the study has shown that at times all translators failed to grasp the intended meaning of the euphemism at hand, as with *فاعتزلوا* when they resorted to the less probable interpretation of not to share wives the same bed during menstruation. They, moreover, failed to deal with the meaning nuances of *نسريح*, thus rendering it in a way that declined to capture all pragmatic aspects of this euphemism.

#### 4. Conclusion

The present study has revealed that there are twelve euphemistic expressions in Surat Al-Baqarah, used in nine verses. One euphemism جناح is used in other verses with the same meaning, and the same translational strategy is used for rendering it into English; so it was discussed only once, namely at its first occurrence. It has also been shown that euphemisms constitute a thorny area in that the proper understanding of such expressions require a careful analysis through consulting reliable exegeses. In fact, Arab Muslims and in spite of their cultural and linguistic backgrounds which help them in a better understanding of such expressions have come to understand them through consulting exegeses, let alone non-Arab Muslims who are the main target of translating the Glorious Qur'an.

As for translation, it has been concluded that no one method is always suitable for rendering them into English. In sum, three methods have been used; paraphrase, literal translation, and couplet. Pickthall used *paraphrase* and *literal translation* equally, six times each. Arberry used *literal translation* method in seven instances, and *paraphrase* in five. Hilali & Khan used *literal translation* two times, *paraphrase* six times, and *couplet* four times. The total shows that *paraphrase* is the commonest method among the three translations. The study has also shown that *literal translation* is the least reliable method in the majority of instances. This leads us to conclude that Hilali & Khan's translation is the most adequate one, since they opted least for literal translation. This can be attributed to the following reasons:

And forget not kindness among yourselves. Allah is Seer of what ye do.

### Arberry

There is no fault in you, if you divorce women while as yet you have not touched them nor appointed any marriage-portion for them; yet make provision for them, the affluent man according to his means, and according to his means the needy man, honourably – an obligation on the good-doers.

### Hilali & Khan

There is no sin on you, if you divorce women while yet you have not touched (had sexual relation with) them, nor appointed unto them their *Mahr* (bridal money given by the husband to his wife at the time of marriage). But bestow on them ( a suitable gift), the rich according to his means, and the poor according to his means, a gift of reasonable amount is a duty on the doers of good.

SL Euphemism	SL Texts	Method of Translation
تَمَسُّوهُنَّ	1.touched 2.touched 3.touched (had sexual relation)	1.literal 2.literal 3.couplet

This euphemism refers to the consummation of marriage through indicating the necessary beginning for such consummation (synecdoche). The first two translations opted for literal translation which does not guarantee communicating the intended meaning of the expression. To get rid of such obscurities, the third translation preferred couplet whereby the SL image is preserved, and at the same time conveying the exact meaning intended here.

SL Euphemism	TL Texts	Method of Translation
تسريح	1.release 2.release 3.release	1.paraphrase 2.paraphrase 3.paraphrase

This euphemism is used to avoid the socially-embarrassing, and unpleasant associations of the, theme of divorce. Although it is acceptable in Islamic regulations, Muslims are advised to make it the last resort as it causes much harm to the familial unity, and consequently to that of the community at large. The word تسريح, moreover, carries the nuances of rest for both sides, husband and wife, from an unpleasant situation. The three translations opt for paraphrase strategy for rendering this euphemism, which seems to be the most suitable one. However, the three translations seem to decline in choosing the appropriate equivalent needed here. The word *release* is usually used in the field of law to indicate freeing a prisoner, and this undermines the woman's status in the marital relationship. Moreover, the word *release* attaches the trait of freedom, and consequently rest, to women only, whereas it is meant here to be attached to both parties, men and women. Accordingly, *separate* would be a better choice as it satisfies the meaning nuances mentioned.

### 3.2.9 Ayah (236)

لَا جُنَاحَ عَلَيْكُمْ إِنْ طَلَقْتُمْ النِّسَاءَ مَا لَمْ تَمْسُوهُنَّ أَوْ لَفَرِحْتُمْ عَنْهُنَّ فَرِيضَةً وَمَتَّعُوهُنَّ عَلَى الْمَوْسِعِ قَدْرَةَ وَعَلَى الْمَقْتَرِ قَدْرَةَ مَتَاعًا بِالْمَعْرُوفِ حَقًّا عَلَى الْمُحْسِنِينَ.

#### Pickthall

If ye divorce them before ye have touched them and ye have appointed unto them a portion, then (pay the) half of that which ye appointed, unless they (the women) agree to forgo it, or he agreeth to forgo it in whose hand is the marriage tie. To forgo is nearer to piety.

الطلاق مرتان فإبساك بمغروف أو تسريح بإحسان ولا يحل لكم أن تأخذوا مما آتيتموهن شيئا إلا أن يخافا ألا يقيما حدود الله فإن خفتما ألا يقيما حدود الله فلا جناح عليهما فيما اقتدتا به تلك حدود الله فلا تعتدوها ومن يتعد حدود الله فأولئك هم الظالمون.

#### Pickthall

Divorce must be pronounced twice and then (a woman) must be retained in honour or released in kindness. And it is not lawful for you that ye take from women aught of that which ye have given them; except (in the case) when both fear that they may not be able to keep within the limits (imposed by) Allah. And if ye fear that they may not be able to keep the limits of Allah, in that case it is no sin for either of them if the woman ransom herself. These are the limits (imposed by) Allah. Transgress them not. For whoso transgresseth Allah's limits: such are wrong-doers.

#### Arberry

Divorce must be pronounced twice and then (a woman) must be retained in honor or released in kindness. And it is not lawful for you that ye take from women aught of that which ye have given them; except (in the case) when both fear that they may not be able to keep within the limits (imposed by) Allah. And if ye fear that they may not be able to keep the limits of Allah, in that case it is no sin for either of them if the woman ransom herself. These are the limits (imposed by) Allah. Transgress them not. For whoso transgresseth Allah's limits: such are wrongdoers.

#### Hilali & Khan

The divorce is twice, after that, either you retain her on reasonable terms or release her with kindness. And it is not lawful for you (men) to take back (from your wives) any of your *Mahr* (bridal money given by the husband to his wife at the time of marriage) which you have given them, except when both parties fear that they would be unable to keep the limits ordained by Allah (e.g. to deal with each other on a fair basis). Then if you fear that they would not be able to keep the limits ordained by Allah, then there is no sin on either of them if she gives back (the *Mahr* or a part of it) for her *Al-Khul'* (divorce). These are the limits ordained by Allah, so do not transgress them. And whoever transgresses the limits ordained by Allah, then such are the *Zalimun* (wrong-doers, etc.).

**Arberry**

Your women are a tillage for you; so come unto your tillage as you wish, and forward for your souls; and fear God, and know that you shall meet Him. Give thou good tidings to the believers.

**Hilali & Khan**

Your wives are a tilth for you, so go to your tilth (have sexual relations with your wives in any manner as long as it is in the vagina and not in the anus), when or how you will, and send (good deeds, or ask Allah to bestow upon you pious offspring) before you for your own selves. And fear Allah, and know that you are to meet Him (in the Hereafter), and give good tidings to the believers (O Muhammad ).

SL Euphemism	TL Texts	Method of Translation
فأتوا حرثكم أي شتمكم	1.go to your tilth as ye will 2.come unto your tillage 3.go to your tilth (have sexual relations with your wives in any manner as long as it is in the vagina and not in the anus)	1.literal 2.literal 3.couplet

This euphemism is one of the most eloquent expressions in the Glorious Qur'an, as it says much, as explained by Hilali & Khan, in one short expression.

Pickthall and Arberry go to literal translation which is not a very suitable strategy for rendering this expression, for it tells much implicit information understood by Muslims through a long time of acquaintance and heavy reliance on interpretation. Realizing the shortcoming of literal translation, Hilali & Khan go to couplet which briefly explains the intended meaning of the expression.

**3.2.8 Ayah (229)**

These three euphemistic expressions have the same referent, namely sexual intercourse. Concerning *فَاعْتَرِلُوا* it seems that the three translators went for the weaker explanation of not sharing women the same bed. Ibn Katheer (1996) gives a lengthy discussion concerning this expression indicating that Muslims first understood the expression in its literal meaning, an interpretation that degrades the status of women and their humanity which is against the Islamic teaching. However, and after citing many trustworthy exegeses he comes to the conclusion that it indicates an order not to have sex with women during menstruation, an indication which is not reflected in the three translations mentioned above. In other words, the three translations have erroneously rendered this euphemistic expression. The second expression *لَا تَقْرُبُوهُنَّ* also indicates an order to stop having sexual intercourse and it is repeated with exactly the same meaning because of the significance of the matter under discussion. Pickthall and Hilali & Khan rightly opt for paraphrase strategy to give the exact intended meaning. Arberry, however, goes for literal translation which seems to supplement his misinterpretation of the first euphemism. As for the third euphemism *أَوْهْنُ* which is an apparent permission for men to have sexual intercourse with their wives, the three translators opt for paraphrase as a strategy for rendering it, a choice which seems to be very suitable.

### 3.2.7 Ayah (223)

بِسَايَتِكُمْ حَرْثٌ لَكُمْ فَآتُوا حَرْثَكُمْ إِلَىٰ سَبِيحٍ وَقَدِّمُوا لِأَنفُسِكُمْ وَاتَّقُوا اللَّهَ وَاعْلَمُوا أَنَّكُمْ مَدْفُوعٌ وَبَشِّرِ الْمُؤْمِنِينَ

#### Pickthall

Your women are a tilth for you (to cultivate) so go to your tilth as ye will, and send (good deeds) before you for your souls, and fear Allah, and know that ye will (one day) meet Him. Give glad tidings to believers, (O Muhammad).

them till they are cleansed. And when they have purified themselves, then go in unto them as Allah hath enjoined upon you. Truly Allah loveth those who turn unto Him, and loveth those who have a care for cleanness.

#### Arberry

They will question thee concerning the monthly course. Say: 'It is hurt; so go apart from women during the monthly course, and do not approach them till they are clean. When they have cleansed themselves, then come unto them as God has commanded you.' Truly, God loves those who repent, and He loves those who cleanse themselves.

#### Hilali & Khan

They ask you concerning menstruation. Say: that is an *Adha* (a harmful thing for a husband to have a sexual intercourse with his wife while she is having her menses), therefore keep away from women during menses and go not unto them till they have purified (from menses and have taken a bath). And when they have purified themselves, then go in unto them as Allah has ordained for you (go in unto them in any manner as long as it is in their vagina). Truly, Allah loves those who turn unto Him in repentance and loves those who purify themselves (by taking a bath and cleaning and washing thoroughly their private parts, bodies, for their prayers, etc.).

SL Euphemisms	TL Texts	Method of Translation
فَاعْتَرِلُوا	1. let women alone 2. go apart from women 3. keep away from women	1. literal 2. literal 3. literal
لَا تَقْرَبُوهُنَّ	1. go not in unto them 2. do not approach them 3. go not unto them	1. paraphrase 2. literal 3. paraphrase
أَوْهِنَ	1. go in unto them 2. come unto them 3. go in unto them	1. paraphrase 2. paraphrase 3. paraphrase

This euphemism is mentioned twice due to its significance in the Ayah under discussion, once as an order to do and a second time as an order of not to do. In the analysis, too, it is mentioned twice as it needs some discussion due to the translators' differing interpretations. It indicates sexual intercourse through the part-to-whole relationship as any intercourse presupposes an introduction, be it made through words or gestures hinting at the process intended. The three translations rendered this euphemism through paraphrase, thus sacrificing the SL linguistic form for the sake of communicating the intended meaning (dysphemism). However, Arberry chooses a less direct expression through choosing the word *lie* whose secondary meaning, not the primary, captures the intended meaning in this context.

As for the second occurrence *لَا تَبَاشِرُوهُنَّ*, it seems to have been understood by Pickthall as an order not to initiate anything related to sex, thus he chooses to use the word *touch* which mostly indicates the act of touching. Arberry and Hilali & Khan, on the other hand, seem to have interpreted it in the same sense they did with the first occurrence. Ibn Katheer (1996) isolates a long discussion for these two words, and after citing many trustworthy interpreters, come to side with Arberry and Hillai & Khan. Accordingly, the last two translations show a more accurate rendition of this euphemistic expression. However, paraphrase here has proved to be the most suitable translation strategy.

### 3.2.6 Ayah (222)

وَسَأَلْتَهُنَّ عَنِ الْمَحِيضِ قُلْ هُوَ أذى فَأَعْتَرَلُوا النِّسَاءَ فِي الْمَحِيضِ وَتَلَقَّرْتَهُنَّ حَتَّى يَنْظُرْنَ فَإِذَا تَنْظُرْنَ فَاتَوَهُنَّ مِنْ حَيْثُ أَمَرَكُمُ اللَّهُ إِنَّ اللَّهَ يُحِبُّ التَّوَّابِينَ وَيُحِبُّ الْمُتَطَهِّرِينَ.

#### Pickthall

They question thee (O Muhammad) concerning menstruation. Say: It is an illness, so let women alone at such times and go not in unto

Fast unto the night, and do not lie with them while you cleave to the mosques. Those are God's bounds; keep well within them. So God makes clear His signs to men; haply they will be godfearing,

Hilali & Khan

It is made lawful for you to have sexual relations with your wives on the night of *As-Saum* (the fasts). They are *Libas* [i.e. body cover, or screen, or *Sakan*, (i.e. you enjoy the pleasure of living with her - as in Verse 7:189) *Tafsir At-Tabari*], for you and you are the same for them. Allah knows that you used to deceive yourselves, so He turned to you (accepted your repentance) and forgave you. So now have sexual relations with them and seek that which Allah has ordained for you (offspring), and eat and drink until the white thread (light) of dawn appears to you distinct from the black thread (darkness of night), then complete your *Saum* (fast) till the nightfall. And do not have sexual relations with them (your wives) while you are in *I'tikaf* (i.e. confining oneself in a mosque for prayers and invocations leaving the worldly activities) in the mosques. These are the limits (set) by Allah, so approach them not. Thus does Allah make clear His *Ayat* (proofs, evidences, lessons, signs, revelations, verses, laws, legal and illegal things, Allah's set limits, orders, etc.) to mankind that they may become *Al-Muttaqun* (the pious - see V.2:2).

SL Euphemisms	TL Texts	Method of Translation
بأشروهن	1.hold intercourse 2.lie 3.have sexual relations	1.paraphrase 2.paraphrase 3.paraphrase
لا تأشروهن	1.touch them not 2.do not lie 3.Do not have sexual relations	1.paraphrase 2.paraphrase 3.paraphrase

This expression is used to indicate deviation from the right path, as explained by Ibn Manzūr (1990, Vol.2 : 430). The word **جَنَاح** is then used to refer to **إثم** (sin). The three translators opt for paraphrase as a method for rendering it "... a procedure where ST meaning is explained in the TL" (see Newmark, 1988b:91). However, Pickthall and Hilali and Khan give a better rendition through using "sin" which carries a religious overtone rather than "fault", resorted to by Arberry, which is used for general purposes. This expression is repeated in many ayahs in this surah, and is translated the same. Therefore, it is analyzed only once to avoid repetition.

### 3.2.5 Ayah (187)

أَجَلٌ لَكُمْ لَيْلَةَ الصَّيَامِ الرَّفْتُ إِلَى نَسَائِكُمْ هُنَّ لِبَاسٌ لَكُمْ وَأَنْتُمْ لِبَاسٌ لَهُنَّ عَلِمَ اللَّهُ أَنَّكُمْ كُنْتُمْ تَخْتَلِفُونَ أَلْسِنَتَكُمْ فَعَابَ عَلَيْكُمْ وَعَفَا عَنْكُمْ فَالآنَ بَاشِرُوهُمْ وَأَنْتُمْ لَكُمْ مَا كَتَبَ اللَّهُ لَكُمْ وَكُلُوا وَاشْرَبُوا حَتَّى يَتَبَيَّنَ لَكُمُ الْخَيْطُ الْأَبْيَضُ مِنَ الْخَيْطِ الْأَسْوَدِ مِنَ الْفَجْرِ ثُمَّ أَتُوا الصَّيَامَ إِلَى اللَّيْلِ وَلَا تُبَاشِرُوهُمْ وَأَنْتُمْ عَاكِفُونَ فِي الْمَسَاجِدِ تِلْكَ حُدُودُ اللَّهِ فَلَا تَقْرُبُوهَا كَذَلِكَ يُبَيِّنُ اللَّهُ آيَاتِهِ لِلنَّاسِ لَعَلَّهُمْ يَتَّقُونَ. (الآية ١٨٧)

#### Pickthall

It is made lawful for you to go in unto your wives on the night of the fast. They are raiment for you and ye are raiment for them. Allah is Aware that ye were deceiving yourselves in this respect and He hath turned in mercy toward you and relieved you. So hold intercourse with them and seek that which Allah hath ordained for you, and eat and drink until the white thread becometh distinct to you from the black thread of the dawn. Then strictly observe the fast till nightfall and touch them not, but be at your devotions in the mosques. These are the limits imposed by Allah, so approach them not. Thus Allah expoundeth His revelation to mankind that they may ward off (evil).

#### Arberry

Permitted to you, upon the night of the Fast, is to go in to your wives; – they are a vestment for you, and you are a vestment for them. God knows that you have been betraying yourselves, and has turned to you and pardoned you. So now lie with them, and seek what God has prescribed for you. And eat and drink, until the white thread shows clearly to you from the black thread at the dawn; then complete the

suitable strategy as it captures the SL linguistic trait without causing damage to the intended meaning. In other words, the English *touch* and the Arabic *تمسنا* perform the same function in their languages respectively as far as this text is concerned.

### 3.2.4 Ayah (158)

إِنَّ الصَّفَا وَالْمَرْوَةَ مِن شَعَائِرِ اللَّهِ فَمَنْ حَجَّ الْبَيْتَ أَوْ اعْتَمَرَ فَلَا جُنَاحَ عَلَيْهِ أَن يَطَّوَّفَ بِهِمَا وَمَن تَطَوَّعَ خَيْرًا فَإِنَّ اللَّهَ شَاكِرٌ عَلِيمٌ.

#### Pickthall

Lo! (the mountains) As-Safa and Al-Marwah are among the indications of Allah. It is therefore no sin for him who is on pilgrimage to the House (of God) or visiteth it, to go around them (as the pagan custom is). And he who doeth good of his own accord, (for him) lo! Allah is Responsive, Aware.

#### Arberry

Safa and Marwa are among the waymarks of God; so whosoever makes the Pilgrimage to the House, or the Visitation, it is no fault in him to circumambulate them; and whoso volunteers good, God is All-grateful, All-knowing.

#### Hilali & Khan

Verily! As-Safa and Al-Marwah (two mountains in Makkah) are of the Symbols of Allah. So it is not a sin on him who perform *Hajj* or *'Umrah* (pilgrimage) of the House (the Ka'bah at Makkah) to perform the going (*Tawaf*) between them (As-Safa and Al-Marwah). And whoever does good voluntarily, then verily, Allah is All-Recogniser, All-Knower.

SL Euphemism	TL Texts	Method of Translation
جناح	1. sin 2. fault 3. sin	1. paraphrase 2. paraphrase 3. paraphrase

## 3.2.3 Ayah (80)

وَقَالُوا لَنْ نَمَسَّنَا النَّارُ إِلَّا أَيَّامًا مَعْدُودَةً قُلْ أَلَيْسَ الَّذِي بَعَثَ اللَّهُ فِيكُمْ رَسُولًا لَمَّا مَعَدُّوا لَهُمْ فَلَنْ يَخْلِفَ اللَّهُ عَهْدَهُ أَمْ تَقُولُونَ عَلَى اللَّهِ مَا لَا تَعْلَمُونَ.

Pickthall

And they say: The Fire (of punishment) will not touch us save for a certain number of days. Say: Have ye received a covenant from Allah - truly Allah will not break His covenant - or tell ye concerning Allah that which ye know not ?

Arberry

And they say, 'The Fire shall not touch us save a number of days.' Say: 'Have you taken with God a covenant? God will not fail in His covenant; or say you things against God of which you know nothing?

Hilali & Khan

And they (Jews) say, "The Fire (i.e. Hell-fire on the Day of Resurrection) shall not touch us but for a few numbered days." Say (O Muhammad Peace be upon him to them): "Have you taken a covenant from Allah, so that Allah will not break His Covenant? Or is it that you say of Allah what you know not?"

SL Euphemism	TL Texts	Method of Translation
نَمَسْنَا	1.touch us 2.touch us 3.touch us	1.literal 2.literal 3.literal

This euphemism is achieved through the application of part-to-whole relationship (rhetorically a synecdoche). In other words, burning indicates the involvement of body in fire, the beginning of which is through touching which causes the least pain. All translators have successfully rendered this euphemism through literal translation which is the most

**Hilali & Khan**

in their hearts is a disease (of doubt and hypocrisy), and Allah has increased their disease. A painful torment is theirs because they used to tell lies.

SL Euphemism	TL Texts	Method of Translation
مَرَضٌ	1.a disease 2.a sickness 3.a disease (of doubt and hypocrisy)	1.literal 2.literal 3.couplet

The expression مَرَضٌ is a general term used to describe any abnormal condition in a body organ or in behavior. It is thus a hypernym used to cover a wide variety of hyponyms. It is euphemistic in the sense that the general, rather than the specific, is used. Rhetorically it is a synecdoche used in whole-to-part relation. Pickthall and Arberry prefer literal translation so that TL readers are informed just like SL readers. However, SL readers are further informed about the exact meaning of the word through exegesis, as Muslims are constantly advised to depend on the explanation of Qur'anic Ayahs for a better understanding, an opportunity not usually available to TL readers. Proceeding from this stand, Hilali & Khan resort to couplet method adding the exact meaning intended, namely doubt (see Ibn Katheer, 1996). The translators also varied in choosing the equivalent of مَرَضٌ between *sickness* "more specific" and *disease* "more general". One can conclude that *sickness* is more suitable as the SL euphemism contextually hints at something more specific.

The Qur'anic euphemistic expression **ختم** is usually used in its literal sense in the field of manufacturing in which a product is sealed either to authenticate the name of the producer or to prevent adding a similar substance to the quantity already kept in. It is used here to indicate that disbelievers' hearts and ears (organs of feeling and hearing) are closed so that the right (Allah's revelation) cannot find its way to them. It is euphemistic in the sense that otherwise, more direct words that can be used in this context (lard-hearted and deaf) would be more face-threatening. Pickthall and Arberry opt for literal translation "...the conveyance of denotative meaning of phrases and sentences in a text from one language to another" (Farghal and Shunnaq, 1999:13) leaving the reader to infer what the right is as it is done with Arabic speakers. Hilali & Khan, on the other hand, use couplet ( a translation method that combines two procedures to deal with a single problem "literal translation + explanation") (see Newmark, 1988b:91) to directly tell the reader what these senses are closed to. All translation methods have successfully rendered this euphemism, with Hilali & Khan combining their translation with an explanatory note, telling the reader directly about the intended meaning of the text at hand.

### 3.2.2 Ayah (10)

في قلوبهم مرضٌ فزادهم اللهُ مرضاً ولهم عذابٌ أليمٌ بما كانوا يكذبون.

#### Pickthall

In their hearts is a disease, and Allah increaseth their disease. A painful doom is theirs because they lie.

#### Arberry

In their hearts is a sickness, and God has increased their sickness, and there awaits them a painful chastisement for that they have cried lies.

3. The translators of these works are of different religious, linguistic, and cultural backgrounds; aspects of direct impact on interpretation and translation.

The citation and analysis of translation is made on chronological consideration. Every Ayah in Surat Al-Baqarah that contains a euphemism is written in full for the purpose of contextualization which is of great importance in the process of analysis. Then the euphemisms targeted are tabulated together with their translations for easy reference. Every Ayah, together with its three translations, is given a separate subsection.

### 3.2 Analysis

#### 3.2.1 Ayah (7)

خَتَمَ اللَّهُ عَلَىٰ قُلُوبِهِمْ وَعَلَىٰ سَمْعِهِمْ وَعَلَىٰ أَبْصَارِهِمْ غِشَاوَةٌ وَلَهُمْ عَذَابٌ عَظِيمٌ.

##### Pickthall

Allah hath sealed their hearing and their hearts, and on their eyes there is a covering. Theirs will be an awful doom.

##### Arberry

God has set a seal on their hearts and on their hearing, and on their eyes is a covering, and there awaits them a mighty chastisement.

##### Hilali & Khan

Allah has set a seal on their hearts and on their hearing (i.e. they are closed from accepting Allah's Guidance), and on their eyes there is a covering. Theirs will be a great torment.

SL Euphemism	TL Texts	Method of Translation
خَتَمَ اللَّهُ عَلَىٰ قُلُوبِهِمْ وَعَلَىٰ سَمْعِهِمْ	1. hath sealed their hearing and their hearts ... 2. has set a seal on their hearts and on their hearing.... 3. has set a seal on their hearts and on their hearing (i.e. they are closed from accepting Allah's Guidance)...	1. literal 2. literal 3. couplet

placing such phenomena within a framework of culture to be able to produce a natural translation. She, moreover, sees that the focus of translation of such phenomena should be on what the original message indicates in its culture.

Al-Hamad and Salman (2013) carried out an analytical study of 23 Qur'anic euphemisms randomly chosen. According to them, translating Qur'anic euphemisms poses certain problems due to linguistic and cultural diversity. They pointed at some inadequately translated euphemisms and attempted to suggest some alternative translations based on functional criteria.

### **3. Euphemisms in Surat Al-Baqarah: Methodology and Analysis**

This section first sets down the methodology to be followed in the analysis of the euphemistic expressions in Surat Al-Baqarah, and then it moves to the analysis itself.

#### **3.1 Corpus and Methodology**

The theoretical data in this paper is collected from the vast literature available on the topic. As for the analysis, three translations have been chosen for the purpose of this study; these are: Pickthall's *The Meaning of the Glorious Quran* (1930), Arberry's *The Koran Interpreted* (1955), and Hilali and Khan's *Translating the Meanings of the Noble Koran* (1417 H, corresponding to 1996). These three translations are chosen for the following reasons:

1. These translations, for the researcher's knowledge, are widely consulted.
2. They cover a wide range of time as they are made in relatively remote times (1930, 1955, and 1996 respectively) which indicates that new findings in translation theory are supposedly utilized.

Qur'anic style which is an essential component of understanding the Qur'an.

Al-Qadi (2009) carried out a sociolinguistic comparison of euphemisms in various varieties in English and Modern Standard Arabic. Although this study is not directly related to Qur'anic euphemisms, its conclusions give important insights of euphemisms in English and Arabic in general. The main conclusions of this study are:

1. English and Arabic employ three main rhetorical devices to realize euphemism, namely: metonymy, synecdoche, and circumlocution. Farghal (1995:2) adds "remodeling" as a fourth category.
2. There are quantitative as well as qualitative differences between English and Arabic in as far as euphemisms are concerned. English euphemisms are quantitatively greater than Arabic. Qualitatively, Arabic displays a higher degree of politeness in euphemisms, and this is ascribed to the fact that English is overt while Arabic is covert.

Abdel Haleem (2011) investigated euphemism in the Qur'an with focus on marital relation manifested in Surat Al-Baqarah, Ayas 222-3. His investigation is motivated by the observation that the way women's status addressed in the Glorious Qur'an is misinterpreted. He observed that misinterpretation is due to decontextualizing a euphemistic expression linguistically and culturally, and failure to regard the Qur'anic style properly.

Related to this argument, Dagut (1975:32) sees that the translatability of a SL metaphor, of which euphemism is part, depends on (1) the particular cultural experience and semantic associations exploited by it, and (2) the extent to which these can, or cannot, be reproduced non-anomalously into the TL, depending on the degree of overlap in each particular case. Bassnett (1991) elaborates on that by maintaining that the translation of cultural phenomena must take into consideration

## 2.2 Taboo

Euphemism and Taboo are entwined, for were it not for taboo, euphemisms would not have appeared. Ayers (1988:222) says that taboo is "...the restriction enforced by psychological motivation and social customs.". Adeyanju (2008:167) sees that taboo expressions are avoided "... for the purpose of face saving of the potential readers, since taboos are believed by some to violate fundamental human rights".

Wardhaugh (1986:230) taboo in the following way: Taboo is one way in which a society expresses its disapproval of certain kinds of behaviour believed to be harmful to its members, either for supernatural reasons or because such behaviour is held to violate a moral code.

Ullmann (1962:204-209) suggests three categories of taboos. These are: 1. Taboo of Fear, such as *هذاك المرض* to avoid the direct mentioning of *cancer*, 2. Taboo of Delicacy, such as *معينة* instead of the socially embarrassing *خادمة*, and 3. Taboo of Propriety, *العلاقة الحميمة* to indicate sexual intercourse.

## 2.3 Review of Related Literature

The topic of euphemism in general has been intensively investigated and a large amount of search is available. However, the study of euphemisms in the Glorious Qur'an suffers paucity. According to the available literature, investigating euphemism has been made during the last ten years or so.

Mohammed (2007) detected the errors committed in the English translations of four Qur'anic euphemisms, tried by Pickthall and Zaidan. Due to their significance in the Glorious Qur'an, he calls for an accurate rendition of euphemistic expressions through preserving the image as well as the meaning of the euphemism. Accordingly, he concludes that a translation that sacrifices either aspect does not reflect the

of the Glorious Quran. Moreover, he is a famous historian who consults trustworthy exegeses.

In brief, this paper attempts to answer the following questions:

1. What are the Euphemisms in Surat Al-Baqarah?
2. What strategies are used in translating these euphemisms?
3. To what extent have these translators succeeded in rendering euphemisms into English?

### 2.1 Euphemism: Definition and Types

Hudson (2000: 261) defines euphemism as "the extension of ordinary words and phrases to express unpleasant or embarrassing ideas. The indirectness of form is felt to diminish the unpleasantness of the meaning. The words so extended are called euphemism , and some examples are ... pre-owned , and pass away".

Allan and Burridge (1991:14) outlines thirteen devices used to realize euphemism; metaphor, idiom, circumlocution, acronym and abbreviation, general for specific, hyperbole, litotes, technical jargon, denial, euphemistic dysphemism, metonymy, synecdoche, and associative engineering.

Rawson (1998:492) classifies euphemisms into positive and negative. Positive euphemisms tend to express solidarity with the addressee or the referent, such as *ساعي* instead of *فراش*. Negative euphemisms are used to avoid the loss of face, such as *فقر* to replace *دخل محدود*.

Rawson (Ibid:493) also distinguishes between conscious and unconscious euphemisms. Conscious euphemisms are those with readily available, less polite, alternatives, such as *جنابك* instead of *انت* . Unconscious euphemisms are those conventionally developed that it is very hard to consider as a euphemism, such as the Qur'anic euphemism *العائط* .

use of euphemism, but they are differences in degree rather than differences in kind". This entails that rendering euphemisms from one language into another poses serious problems which translators have to deal with and provide remedial suggestions.

It is highly noticeable that religious texts in general, and the Glorious Qur'an in particular, abound in euphemistic use as such texts are intended to regulate people's life in different life walks. Any misinterpretation of such expressions leads to serious consequences of giving a distorted image of the intended meaning. The matter becomes even more serious when it comes to translation, where, in addition to misinterpretation, conflict between form and meaning obtains. In this respect, Shaker (2007:142) says " The translator's options get extremely limited in authoritative texts, e.g.: religious texts which, generally, maintain an emotive style of address".

The present paper attempts to carry out an assessment of three translations of euphemistic expressions in Surat Al-Baqarah, the longest surah in the Glorious Qur'an which carries teachings to Muslims in sensitive topics which necessitate the use of euphemisms. This surah has been chosen for the purpose of this study because, according to the available literature, no study has been devoted to specify its euphemisms and the way they are dealt with in translation. Some of this surah's euphemisms are handled in scattered studies, and rendered by translators other than those chosen in this study. The translations chosen are those of Pickthall (1930), Arberry (1955), and Hilali & Khan (1996). This choice is based on the fact that these are among the most well-known translations. For the purpose of interpretation, Ibn Katheer (1996) is adopted, as he is one of the most famous interpreters

## لطانف التعبير والترجمة: دراسة في ثلاث ترجمات للتعبير اللطيفة في سورة البقرة

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### المستخلص

يهدف هذا البحث الى دراسة لطانف التعبير في القرآن الكريم من خلال سورة البقرة وترجمتها الى اللغة الانكليزية. وقد تم لهذا الغرض اختيار ثلاث ترجمات على اساس كثرة تداولها وعلى اساس الخلفية اللغوية والثقافية للمترجمين. اظهرت الدراسة ان عدد التعبيرات اللطيفة في سورة البقرة هو اثنا عشر تعبيراً موزعاً على تسع آيات، تتعلق بمواضيع شديدة الحساسية مثل العلاقة الزوجية وترويع الكافرين من نتائج عدم الانصياع للحق والمسائل المتعلقة بالاباحة والمنع. اما بخصوص الترجمة فقد اظهرت الدراسة ان المترجمين استخدموا ثلاث طرائق للترجمة وهي: الترجمة التفسيرية والترجمة الحرفية والترجمة الثنائية وهي التي تزوج بين طريقتين، وكانت الترجمة التفسيرية هي الاكثر استخداماً. كما اظهرت الدراسة تبايناً في نجاح المترجمين في نقل لطف التعبير الى الانكليزية. كما اظهرت فشل المترجمين في تفسير بعض التعبيرات الملطفة بشكل صحيح مما اثر سلباً على نقلها للانكليزية.

الكلمات المفتاحية: القرآن الكريم، سورة البقرة، لطف التعبير، الترجمة التفسيرية، الترجمة الحرفية، الترجمة الثنائية.

### 1.Introduction

Euphemisms constitute an integral part of every language to talk about aspects which would otherwise be face threatening. Burchfield (1985:29) maintains that " a language without euphemisms would be a defective instrument of communication". However, as every language is set in a particular culture, it follows that every language forms euphemisms in a way that does not always coincide with another language. In this regard, Allan and Burridge (1991:8) write " Sure, there are cultural differences with respect to the

## **Euphemism in Translation: An Assessment of Three Translations of Euphemistic Expressions in Surat Al-Baqarah.**

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### **Abstract**

The present paper attempts to evaluate three translations of euphemistic expressions in Surat Al-Baqarah in the Glorious Qur'an. The choice of the three translations is based on the criteria of popularity, as well as linguistic and religious backgrounds. Euphemisms in this Surah deal with touchy topics related to marital relationship, disbelief and deviation from the right path. The study has found that there are twelve euphemistic expressions in nine Ayahs.

As for translation, the study has concluded that translators differ in rendering the euphemisms into English. Three translation strategies are generally used, paraphrase, literal translation, and couplet, with paraphrase being the most frequent one. Not all translations have been equally successful in rendering the euphemistic expressions in this Surah; rather accuracy of rendition is placed on different levels. At times all the translations failed to capture the appropriate interpretation of a euphemism and have therefore come up with erroneous rendition. In one instance all the translators failed to give an equivalent that can capture all the meaning nuances of the Qur'anic euphemism.

**Key words:** Glorious Qur'an, Surat Al-Baqarah, euphemism, paraphrase, literal translation, couplet.

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**AL - MA'MOON COLLEGE  
JOURNAL**

A Refereed Scientific  
Journal of  
Al-Ma'moon University  
College

Number 27/ 2016

Baghdad/ Iraq

ISSN: 1992-4453