Open Access **Baghdad Science Journal** **P-ISSN: 2078-8665**
2021, 18(4) Supplement: 1448-1456 **E-ISSN: 2411-7986**

DOI: https://dx.doi.org/10.21123/bsj.2021.18.4(Suppl.).1448

IoT System on Dynamic Fish Feeder Based on Fish Existence for Agriculture Aquaponic Breeders

***Murizah Kassim*[1,2*]** ***Muhammad Zulhelmi Zulkifli*[2]** ***Norsuzila Ya'acob*[2]**
***Shahrani Shahbudin*[2]**

[1]Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Kompleks Al-Khawarizmi, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
[2]School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA, 40450 UiTM Shah Alam, Selangor, Malaysia.
[*]Corresponding author: murizah@uitm.edu.my
E-mails: zulhelmizulkifli9525@gmail.com , norsuzila@uitm.edu.my , shahranis@uitm.edu.my

Received 18/10/2021, Accepted 14/11/2021, Published 20/12/2021

Abstract:

Maintaining and breeding fish in a pond are a crucial task for a large fish breeder. The main issues for fish breeders are pond management such as the production of food for fishes and to maintain the pond water quality. The dynamic or technological system for breeders has been invented and becomes important to get maximum profit return for aquaponic breeders in maintaining fishes. This research presents a developed prototype of a dynamic fish feeder based on fish existence. The dynamic fish feeder is programmed to feed where sensors detected the fish's existence. A microcontroller board NodeMCU ESP8266 is programmed for the developed hardware. The controller controls the feeding and feedback mechanism based on attached sensors. An ultrasonic sensor is programmed with the controller to detect the level of food and waterproof ultrasonic to detect existing fish. The humidity sensor was used to measure the humidity in the food container to control the food freshness. Two servo motors were used to move the waterproof sensor to attract the fish and to dispense the food to the fish when existed. The result presents four measured levels that are the temperature of the food container, the quality of food based on humidity measured, fish detection counter and level of fish food in the container. Data analytics on all the measured levels was presented on the ThingSpeak platform by using Blynk to get data collections from all sensors. This research is significant for fish breeders that support IR4.0 system connected online and mobile apps which also contribute to today's agriculture.

Keywords: Agriculture, Aquaponic, Fish breeder, Fish Feeder, Humidity, Internet of Things, Ultrasonic.

Introduction:

Today's agriculture for fish breeders is important where many technological concepts and programs have been developed to focus on agriculture such as the design of Internet of things Applications, implications for the IoT in agriculture and communication with energy consumption on IoT-based systems recently[1, 2]. The system of the fish feeder intends to sustain fish at the specific proportion of time that is required by the fish breeders. The framework runs consequently with the nonappearance for the breeders[3]. The fish breeder needs to fill the nourishment in the nourishment holder and the time is set by entering the scheduled time that is expected to sustain or feed the fish. Some fish breeders meet the limitation of aquaponic where most feeders are manually processed. Thus, the automatic fish feeder is an advantage to them, where fish can be fed on schedule time by the system and monitored online. There are some limitations on the existing system where the exact amount of food that your fish needs were unknown, thus the automatic fish feeder can be managed to set the timer and the amount of food. Historically, fish feeders were developed earlier by using springs and actuating wheels. It was to dispense a predetermined amount of fish food from a standard canister into an aquarium at regular periods and in regular amounts determined by the user. The device was helpful. However, some of its limitations included high cost, large scale, poor

flexibility, trouble in movement and IoT communication[4]. The recent technology is an advantage to help the fish breeders in time, a fast and easy task to feed fish in the pond and support today's agriculture was to keep the water clean for the fish[5].

One of the important factors for fish breeders is feeding the fish on a time management controller that acts as the main part of a feeder. Many industrialists in the aqua field and fish owners seem to have trouble with this timely operation[6]. The traditional method of feeding fish either for pond or small lake need more manpower. Workers sometimes face difficulties like feedings at the scheduled time or rain. The problem occurs after feeding this fish, and it is found that the pellet ends at the bottom of the pond as waste faster or leads water to pollute, but the main critical problem is the unfed fish[7]. This matter even grows bigger during the rainy season and will cost a lot of trouble in the industry. Thus, feeding fish based on the existence of fish is important to determine the working of the meal dispense. Some mealtime is changed depending on the fish existence in the pond, when the fish are detected more than the food will dispense more. The system can be managed for the servo motor such as increasing the angle of the servo motor to dispense more food. Added to the functions, a warning siren for the breeders on the food in food container reaches a low level of fish feed that can be developed such as sending a notification to admin's phone. At the same time, monitoring the environment in the agriculture environment is also important in some parts of the country[8]. Some places have constant temperature all year round but there are also some places that the temperature will go from extreme to another. Such cases will carry a huge risk towards the fish. If such cases occur, the fish will probably die. Thus, there is also need to update such a situation via phone.

Aquaponics, also known as the integration of hydroponics with aquaculture, is currently gaining attention as a bio-integrated food production system[9]. Aquaponics is an innovative and viable generation framework for incorporating aquaculture with hydroponic vegetable harvests that can play a basic activity later for natural and financial viability in urban areas zones. However, one of the limitation issues faced by the owner of aquaponics is to feed the fish manually. In the conventional manual nourishing framework, clients face trouble in dealing with the timetable. The proprietor aquaponics consistently pursues a nourishing timetable since they do not have the idea about exactly how frequently to encourage their fish every day. Thus, the breeder must spend most of the time nourishing the fish. Some fish do not get enough nourishment at the perfect time. A programmed fish feeder is a gadget that naturally feeds the fish at the hunger conduct of fish[10]. Some fish feeder is made to help the proprietor of the fish simple to keep the sound of fish particularly to be utilized in the aquaponic framework. By connecting to Wi-Fi, the owner of aquaponics can monitor fish-eating behavior everywhere and anytime[11]. Some communications today utilize the IoT sensor network[12]. Some use the microcontroller called the NodeMCU DEVKIT 1.0 which integrated and easy to prototype development kit[13] and some used Raspberry Pi controller[14]. NodeMCU provides the best platform for IoT application development at the lowest cost. 'C' language is used by using the Arduino IDE platform and it is convenient compared to another microcontroller. This device is implemented with the Internet of Thing system to provide the ability to connect the owner users via the internet. The waterproof ultrasonic sensor is utilized to recognize the recurrence of fish at the water surface to trigger the framework. This sensor is situated at the highest point of water level in the aquarium and turns 180 degrees by servo engine to check the fish. A few warm-water and Coldwater fish species are adjusted to recycle aquaculture frameworks including tilapia, trout, roost, Arctic burn, and bass[15]. In Malaysia, most business aquaponic frameworks depend on tilapia since Malaysia is a warm atmosphere. Tilapia is the second most refined fish and incredibly prominent in aquaponics frameworks. They are difficult to breed, quickly developing and withstand exceptionally in poor water conditions. According to the Department of Statistics Malaysia (DOSM), there are 14.93 million people that are employed till September 2018. The Aquaponics system should be focused more on people with low income as it can save the budget for living expenses. People with low income tend to work harder to overcome their living costs in urban areas causing them to feel fatigued after working. Lastly, huge numbers of the proprietor of aquaponics still use the old method like manual fish feeding by hand. The manual method needs numerous works that require the aquaponic proprietor to cover the numerous employments, for example, cleaning the feeder, topping off the pellet and fix or upkeep activity. Every one of these exercises is required more vitality and time. Some fish breeders have faced trouble in dealing with the whole sustaining timetable.

The objective of this research is to identify the fish feeder input signal on fish existence. When the fish exist then, the food will be dropped to the

fish. The fish then learn and sense the existing system, where fishers will come to the surface of the pond, surround the system to ear the food when they are hungry, and the food does not waste if the fishers are full. This developed research has designed and fabricated a system fish feeder using a NodeMCU microcontroller. This prototype system use NodeMCU as a module to connect the prototype system to the internet using Wi-Fi which was built in.

Materials and Methods:

System Flowchart

Fig. 1 shows the system flowchart and technique to be executed in this undertaking process.

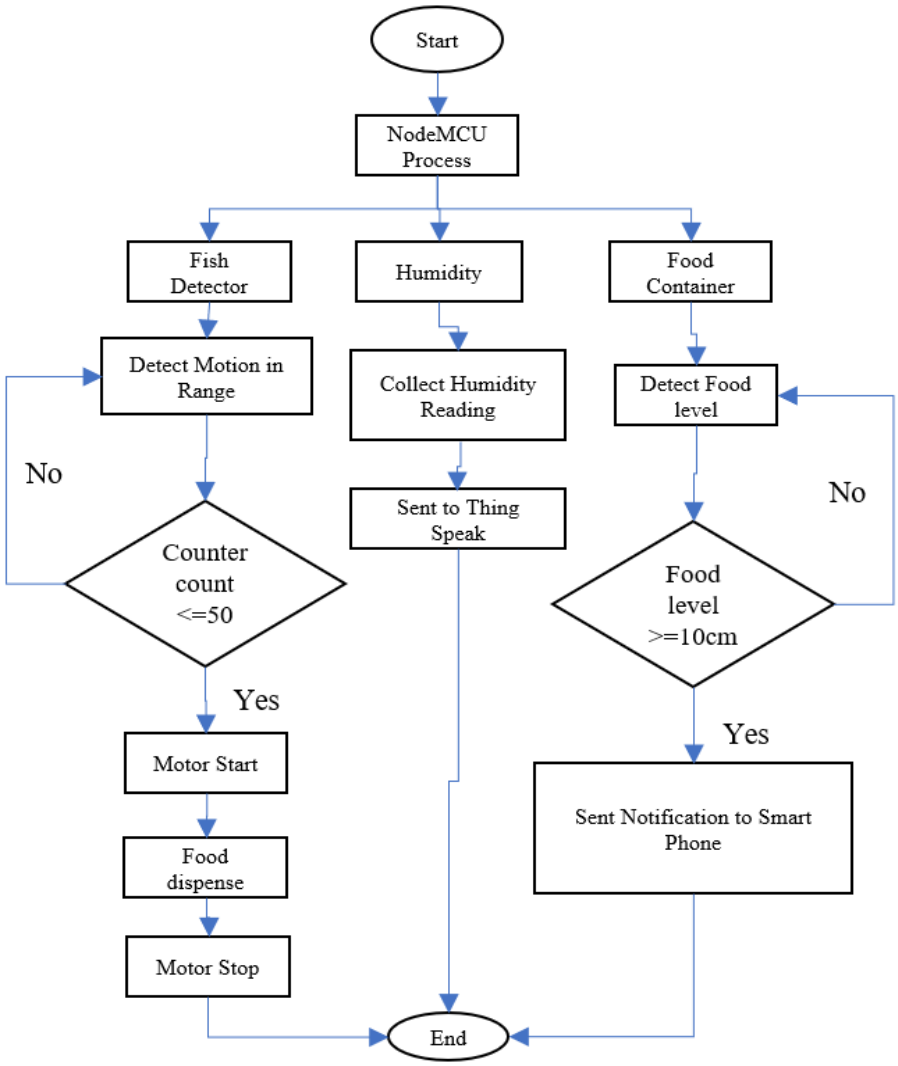

Figure 1. Flowchart of Automatic Fish Feeder

The system detects the motion of fish by using the ultrasonic sensor in a range. The system counts the number of fish and the motor starts for several second to release the food if the counter unit is 20. The food will be dropped from the food container and motor stop. The system is connected to Wi-Fi to send the data to the cloud. There are humidity and the food level can be monitored from the Wi-Fi. The system will identify if the food level is low, then there is a notification will be sent through the phone. The advancements of the designed automatic fish feeder system are comprising of two significant portions which were equipment improvement and programming advancement.

Methods:

System Design Structure

Fig. 2 shows the cycle of the food dispenser when the fish detector counts 10 times. The system will count 10 then the sensor will trigger the controller and send a signal to the servo motor to rotate the shaft 180°[16]. Then, the foods will be dropped from the funnel to the aquarium or pond. It was programmed to wait until 5 seconds and then the servo motor rotates to the original position. The

counter count starts with number one. This prototype system has been testing in an aquarium before it is running at the real pond. Fig. 3 shows the cycle system of humidity in the food container. The humidity sensor has a function to monitor the humidity in the food container to maintain the quality of the fish food. ThingSpeak is used to monitor the changes as it displays the result on the graph and all the data are kept in the cloud so that the administrator can monitor it remotely anytime. The system also is presentable on a website and can download the apps to a mobile phone[17].

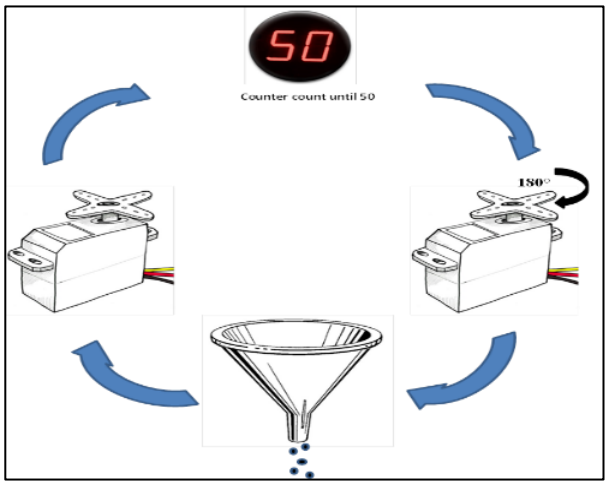

Figure 2. The cycle system of the food dispenser

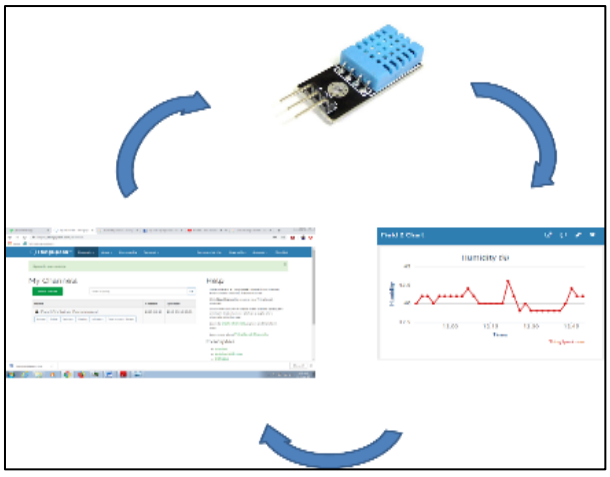

Figure 3. The cycle system of humidity system

Food container:

Fig. 4 shows the system of food container cycles when it is full of food. The system will detect the level of food and when the food container is almost finished, a signal is triggered by the Blynk apps, and a notification is appeared on the screen[18].

The hardware of the System Design:

Equipment is the physical segments that have been combined to assemble and shape the Automatic Fish Feeder System.

Humidity Sensor:

A stickiness sensor is utilized to gauge and report both humidity and temperature of the air content. The proportion of humidity noticeable all around to the most noteworthy measure of humidity at an air temperature is called relative mugginess[19]. Relative mugginess turns into a significant factor for fish feeders to keep up with the nature of the nourishment in the compartment. The compartment of nourishment is presented today by the daily climate, and it is essential to guarantee its firmly shut to keep away from the expanded humidity particularly after coming down. We must continue the nourishment quality for keeping up the fish's wellbeing.

Ultrasonic sensor:

An ultrasonic sensor is a gadget that estimates the separation of an article by engendering sound waves. An ultrasonic sensor likewise utilizes a transducer to send and get ultrasonic heartbeats that handoff back information about an article's vicinity. High-recurrence sound waves reflect from limits to make reverberation designs. So, this sensor can offer data to the client about the degree of nourishment in the compartment[20].

Waterproof ultrasonic sensor:

The measurement distance is accurate at about 0.5cm, the furthest distance that can be measured is 4.5 meters. It is small easy to carry and suitable for a variety of wet measurement environments. This sensor is located at the top of the aquarium or pond to detect the frequency when it surfacing to find foods.

Servo motor

Fig. 5 shows the servo engine is an extremely prevalent minimal effort electric engine whose drive shaft pivots in discrete rakish advances. The engine is utilized to pivot the holder of the compartment to the feeder system. There are numerous kinds of engines anyway the main sort that can participate to hold the holder system is the servo engine. Subsequently, for this venture framework plan, a servo engine is picked.

Figure 4. The cycle system of the food container

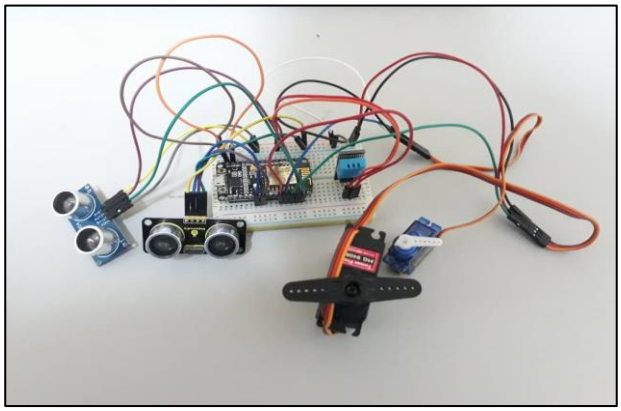

Figure 5. The hardware design of Auto Fish Feeder

Results:

The Prototype System

Fig. 6 shows the front view of the auto fish feeder which was tested in an aquarium. After constructing the 3 different parts separately, the simulation was conducted to simulate the entire circuit design and test its functionality. It was constructed separately to minimize the error before compiling it to form a complete system. Troubleshooting the error easier if there are errors when running simple coding. However, when compiling the three-part of coding in one system, the system response was slow, and it sends inaccurate data especially to the ThingSpeak. The system was not efficient because full of complex coding and the controller cannot be accommodated. To make it efficient, another NodeMCU controller is added to reduce the complexity of the coding. Fig. 7 shows the placing of the sensor in the prototype system. Data are more accurate and running without delay. The whole system was run, and it was observed that as the servo motor rotated, the plate rotated as desired. At the appropriate time, food is released into the aquarium. A funnel placed under the container ensures that food is released to the edge in the aquarium to enhance even distribution. The place of the device is the edge of the aquarium because of the easy-to-get power supply and ease to refill the food when almost finish.

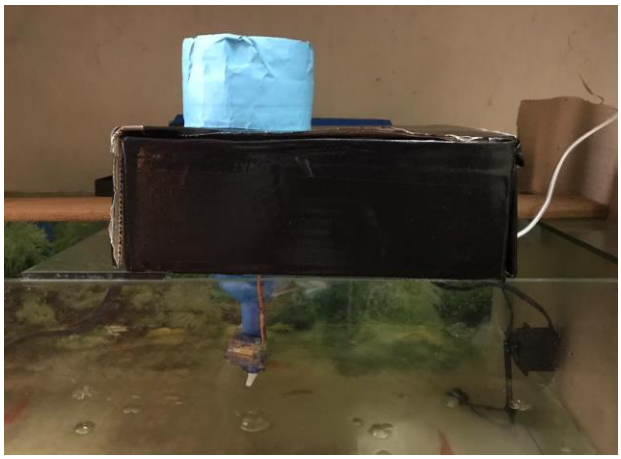

Figure 6. Front View of Auto Fish Feeder

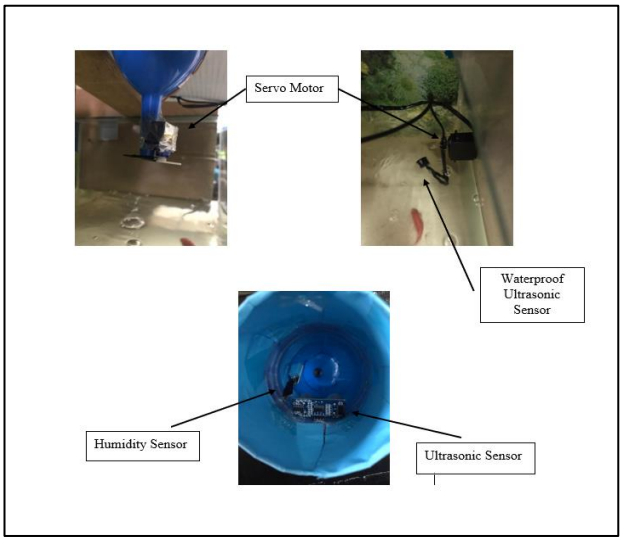

Figure 7. Placing the sensor.

Humidity Analysis:

Fig. 8 and Fig. 9 show the examination of moistness at the nourishment holder. The chart is consistent with room temperature at 29°C it implies the nourishment in dry condition and the nourishment is yet beneficial to encourage the fish. Moistness likewise influences dissipation and sickness improvement in plants and the nature of nourishment, synthetic substances, and pharmaceuticals. The mugginess in the holder is vulnerable due to temperature encompassing.

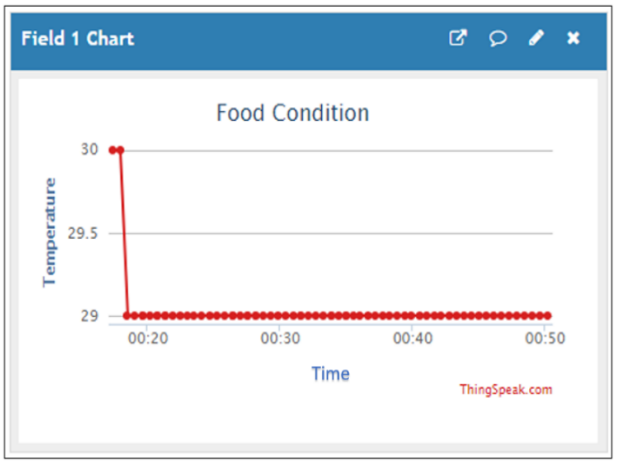

Figure 8. Graph of temperature at the food container

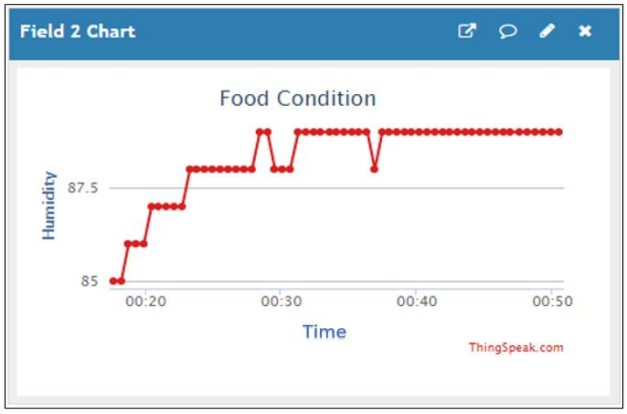

Figure 9. Graph of Humidity at Food Container

Discussions:

Analysis of the Fish Existence and Food Container Level

Fig. 10 shows the analysis of the fish detects counter for the weeks. The system releases the food when the counter count until 10^{21}. The graph shows for the first day is 34 that means the food was release is 3 time per day. This is because the fish is first time exposed to the sensor. The sensor is always moving by the motor to attract fish. For the third day is 84, the food was release 8 times. That shows the fish is knowing where to get the food. Fig. 11 shows the analysis of food levels for the weeks. The food level is detected by using an ultrasonic sensor. So that if the food in the container is full the range between food and sensor is small. If the food is low, the range between food and sensor is big.

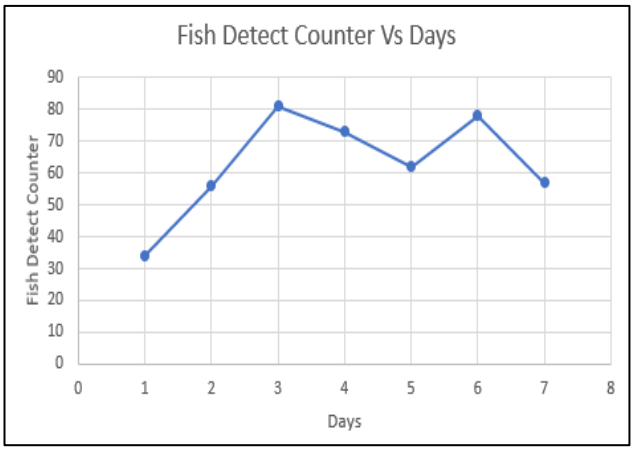

Figure 10. Graph Fish Existence

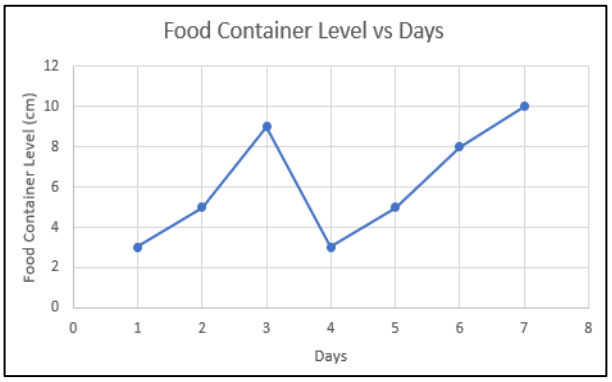

Figure 11. Graph Food Container Level

Fig. 12 shows the mobile application that detected the food level in the container, the distance is programmed to send a notification to the apps when the level of food is more than 11 cm. Fig. 13 shows the notification system for the level of food in the container in the handphone. The ultrasonic sensor detects the distance of the level of food at the container. The owner will be receiving the notification until they refill the food container. The benefit of this notification system, we can monitor the weekly or monthly food intake for the fish by plotting the average timing of food disperse from the container against the duration of food in the container to be emptied. So, if the owner needs to leave the fish for a long period, they can fill the container the period they are not at home.

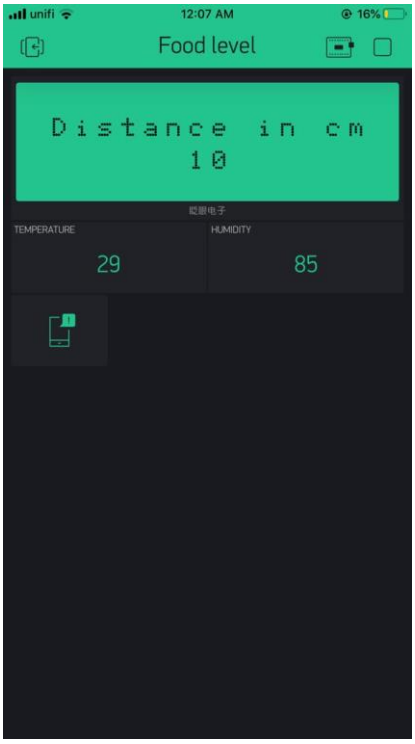

Figure 12. Apps for monitor food level

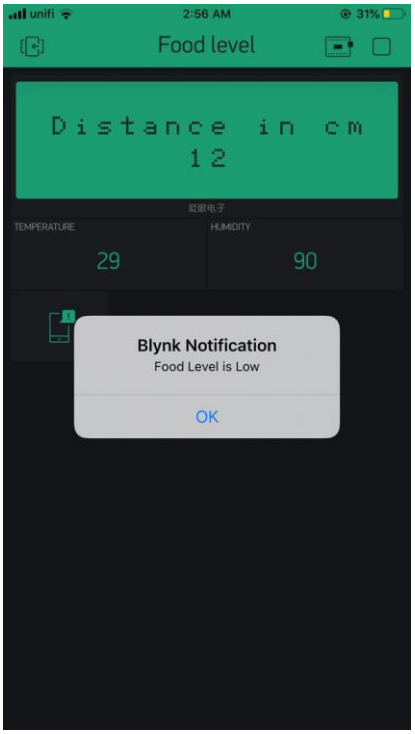

Figure 13. Notification alert

Conclusion:

This research was successful research that developed a prototype of a dynamic fish feeder based on fish existence. The program of the dynamic fish feeder used sensors to detect and feeding the fish by existence help much for fish breeders in time and its maintenance. The result which presents four measured levels consists of the temperature of the food container, the quality of food based on humidity measured, fish detection counter and level of fish food in the container improved the fish breeders' activities and tasks which are concerned as the main issue for the fish breeder. Data analytics on all the measured levels presented on the ThingSpeak platform by using Blynk to get data collections from all sensors helps more for agriculture development. This research is significant for fish breeders that support IR4.0 system connected online and mobile apps which also contribute to today's agriculture.

Acknowledgment:

The authors would like to thank the School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA, Shah Alam, Selangor for the support grants in publishing this research.

Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in Universiti Teknologi MARA.

Authors' contributions:

M. Kassim conceived of the presented idea, development and lead the research. M.K Zulkifli developed and implementation of the research. N. Ya'acob and S. Shahbudin verified the results and writing of the manuscript. M.Kassm encouraged M.K Zulkifli to investigate on the development of the IoT system and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

References:

1. Kaushik N, Bagga T. Internet of things (IOT): Applications, implications & green IOT in agriculture. JGE 2020;10(12):12885-900.
2. Albu-Salih AT, Seno SAH. Optimal UAV deployment for data collection in deadline-based IoT applications. Baghdad Sci. J.. 2018;15(4):484-91.
3. Busaeri N, Hiron N, Andang A, Taufiqurrahman I, editors. Design and Prototyping the Automatic Fish Feeder Machine for Low Energy. ICSECC 2019 - International Conference on Sustainable Engineering and Creative Computing: New Idea, New Innovation, Proceedings; 2019.
4. Ismail NL, Kassim M, Ismail M, Mohamad R. A review of low power wide area technology in licensed and unlicensed spectrum for IoT use cases. BEEI. 2018;7(2):183-90.

5. Othman NA, Damanhuri NS, Syafiq Mazalan MA, Shamsuddin SA, Abbas MH, Chiew Meng BC. Automated water quality monitoring system development via LabVIEW for aquaculture industry (Tilapia) in Malaysia. IJEECS. 2020;20(2):805-12.
6. Kasda, Kosasih DP, Nugraha HD, Rachman M. Low-cost remote control barge boat to feeder fish. JMERD. 2021;44(2):112-21.
7. Zhao Z, Xu Q, Luo L, Qiao G, Wang L, Li J, et al. Effect of bio-floc on water quality and the production performance of bottom and filter feeder carp fed with different protein levels in a pond polyculture system. Aquac. 2021;531.
8. Yasin MNM, Hamzah MMAM, Kassim M, Arbain N. Freshwater ph level control and gui system for prawn breeding. IJATCSE. 2020;9(4):5887-93.
9. Ismail F, Gryzagoridis J, editors. Sustainable development using renewable energy to boost aquaponics food production in needy communities. Proceedings of the Conference on the Industrial and Commercial Use of Energy, ICUE; 2016.
10. Alzubi HS, Al-Nuaimy W, Buckley J, Young I, editors. An intelligent behavior-based fish feeding system. 13th International Multi-Conference on Systems, Signals and Devices, SSD 2016; 2016.
11. Haryanto, Ulum M, Ibadillah AF, Alfita R, Aji K, Rizkyandi R, editors. Smart aquaponic system based Internet of Things (IoT). JPCS; 2019.
12. Abdulzahra SA, Al-Qurabat AKM, Idrees AK. Compression-based data reduction technique for IoT sensor networks. Baghdad Sci. J. 2021;18(1):184-98.
13. Noor MZH, Hussian AK, Saaid MF, Ali MSAM, Zolkapli M, editors. The design and development of automatic fish feeder system using PIC microcontroller. Proceedings - 2012 IEEE Control and System Graduate Research Colloquium, ICSGRC 2012; 2012.
14. Jaafar A, Kassim M, Haroswati CK, Yahya CK, editors. Dynamic home automation security (DyHAS) alert system with laser interfaces on webpages and windows mobile using rasberry PI. 2016 7th IEEE Control and System Graduate Research Colloquium, ICSGRC 2016 - Proceeding; 2017.
15. Li L, Hong J, editors. Identification of fish species based on image processing and statistical analysis research. 2014 IEEE International Conference on Mechatronics and Automation, IEEE ICMA 2014; 2014.
16. Hashim AS, Grămescu B, Cartal AL, Niţu C. Modeling and identification of a high resolution servo, for mobile robotics. U.P.B. Sci. Bull., Series D. 2020;82(2):27-38.
17. Kassim M, Haroswati CK, Yahaya CK, Ismail MN, editors. A prototype of Web Based Temperature Monitoring system. ICETC 2010 - 2010 2nd International Conference on Education Technology and Computer; 2010.
18. Noar NAZM, Kamal MM, editors. The development of smart flood monitoring system using ultrasonic sensor with blynk applications. 2017 IEEE International Conference on Smart Instrumentation, Measurement and Applications, ICSIMA 2017; 2018.
19. Hema LK, Velmurugan S, Sunil DN, Thariq Aziz S, Thirunavkarasu S, editors. IOT based real-time control and monitoring system for food grain procurement and storage. IOP Conf. Ser: Mater. Sci. Eng; 2020.
20. Prafanto A, Budiman E, editors. A Water Level Detection: IoT Platform Based on Wireless Sensor Network. Proceedings - 2nd East Indonesia Conference on Computer and Information Technology: Internet of Things for Industry, EIConCIT 2018; 2018.
21. Toh YH, Ng TM, Liew BK, editors. Automated fish counting using image processing. Proceedings - 2009 International Conference on Computational Intelligence and Software Engineering, CiSE 2009; 2009.

Open Access **Baghdad Science Journal** **P-ISSN: 2078-8665**
2021, 18(4) Supplement: 1448-1456 **E-ISSN: 2411-7986**

نظام إنترنت الأشياء (IoT)على وحدة تغذية الأسماك الديناميكية على أساس وجود الأسماك للزراعة من أجل تربية الأحياء المائية

مرزا قاسم [1,2]* محمد ذوالحلمي ذوالكفل[2] نورسوزيلا يعقوب[2] شهراني شهبودين[2]

[1] معهد تحليلات البيانات الضخمة والذكاء الاصطناعي (IBDAAI) ، كومبلكس الخوارزمي ، جامعة مارا للتكنولوجيا ، 40450 شاه علم ، سيلانجور ، ماليزيا.
[2] كلية الهندسة الكهربائية ، كلية الهندسة ، جامعة مارا للتكنولوجيا ، UiTM 40450 شاه علم ، سيلانجور ، ماليزيا.

الخلاصة:
يعتبر الحفاظ على الأسماك وتربيتها في البركة مهمة حاسمة لمربي الأسماك الكبير .القضايا الرئيسية لمربي الأسماك هي إدارة الأحواض مثل إنتاج الغذاء للأسماك والحفاظ على جودة مياه الأحواض .تم اختراع النظام الديناميكي أو التكنولوجي للمربين وأصبح مهمًا للحصول على أقصى عائد ربح لمربي الاستزراع النباتي والسمكي في الحفاظ على الأسماك .يقدم هذا البحث نموذجًا أوليًا مطورًا لمغذي الأسماك الديناميكي بناءً على وجود الأسماك .تمت برمجة وحدة تغذية الأسماك الديناميكية لتتغذى حيث اكتشفت أجهزة الاستشعار وجود الأسماك .تم برمجة لوحة متحكم NodeMCU ESP8266للأجهزة المطورة .تتحكم وحدة التحكم في آلية التغذية والتغذية المرتدة بناءً على المستشعرات المرفقة . جهاز استشعار بالموجات فوق الصوتية مبرمج مع جهاز التحكم لاكتشاف مستوى الطعام ومقاومة للماء بالموجات فوق الصوتية للكشف عن الأسماك الموجودة .تم استخدام مستشعر الرطوبة لقياس الرطوبة في حاوية الطعام للتحكم في نضارة الطعام .تم استخدام محركين مؤازرين لتحريك مستشعر الماء لجذب الأسماك وتوزيع الطعام على الأسماك عند وجودها .تعرض النتيجة أربعة مستويات تم قياسها وهي درجة حرارة حاوية الطعام ، ونوعية الطعام بناءً على قياس الرطوبة ، وعداد الكشف عن الأسماك ومستوى طعام الأسماك في الحاوية .تم تقديم تحليلات البيانات على جميع المستويات المقاسة على منصة ThingSpeak باستخدام Blynkللحصول على مجموعات البيانات من جميع أجهزة الاستشعار .يعتبر هذا البحث مهمًا لمربي الأسماك الذين يدعمون تطبيقات الأجهزة المتصلة عبر الإنترنت والجوال بنظام IR4.0والتي تساهم أيضًا في الزراعة اليوم.

الكلمات المفتاحية: الزراعة، أكوابونيك ، مربي الأسماك تغذية الأسماك رطوبة، انترنت الأشياء، موجات فوق الصوتية.