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GSM Interaction Based Real Time Climate Change Monitoring Technique

Sarmad Nozad Mahmood
Department of Computer Technical Engineering, Al-Kitab University College, Kirkuk, Iraq
sarmadnmahmood@gmail.com

Abstract

The trend nowadays is towards communication and the way to communicate between the source and destination remotely. This work presents a new technique to communicate among different locations, either automatically or based on notification request. The work methodology was proposed to connect among FOUR different locations and store the data of each individual location periodically. For more applicability, the data chosen to be shared between the four locations are the substantial weather station items identified by (Temperature, Humidity, and Wind speed). Hereby, the tendency is to design robust real time weather station system in order to realize climate conditions at the proposed locations. Finally, the communication module that was chosen to run the system is Arduino microcontroller GSM shield.

Keywords: GSM Arduino Shield, Microcontroller Applications, Wireless Weather Station, Database System, Data Acquisition Module.

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مراقبة التغييرات الحقيقية للطقس باستخدام وحدة منظومات الاتصالات العالمية

سرمد نوزاد محمود

قسم هندسه تقنيات الحاسبات, كلية الكتاب الجامعة, كركوك ,العراق

sarmadnmahmood@gmail.com

الملخص

اصبحت مجالات الاتصالات من المجالات المهمة والمثيرة جدا في الايام الاخيرة خصوصاً عندما يتعلق الامر بمشاركة البيانات ما بين عدد معين من المرسلين والمستقبلين. هذا البحث يناقش ويعرض تقنية جديدة لعملية ربط اربعة اماكن مختلفة مع بعضها البعض ومشاركة البيانات فيما بينها. الحصول على هذه البيانات تتم بشكل ذاتي او اعتماداً على طلب اعلامي. ان منهجية الفكرة المقترحة تبدأ بربط نظام مراقبة المناخ على اربعة مناطق مختلفة وتخزين البيانات الناتجة من كل منطقة بشكل دوري, بالتالي مشاركة ومقارنة هذه البيانات مع بعضها في مركز واحد. جدير بالذكر ان هذه البيانات تم الحصول عليها من متحسسات الطقس الاساسية والتي تتوافق مع متحكمات لوحات الاردوينو. ان متحسسات الطقس المستخدمة في هذا البحث هي متحسس الحرارة, الرطوبة, ومقياس الرياح. تطبيق الفكرة بشكل كامل وعلى اماكن مختلفة يمهد الطريق للحصول احد التقنيات الفريدة من نوعها والخاصة بدراسة ومقارنة بيانات الطقس بشكل دوري وتحت اشراف منظومة زمن حقيقية. اخيراً ممكن الاشارة الى ان الوحدة الرئيسية المستخدمة والتي تحقق هدف البحث الموسوم هي وحدة النظام العالمي للاتصالات المتنقلةGSM والمتوافقة مع متحكمات الاردوينو.

الكلمات الدالة: لوحات متحكمات GSM, تطبيقات المتحكمات, محطات الطقس اللاسلكية, وحدة قاعدة بيانات, وحدة التقاط البيانات.

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1. Introduction

The prediction of the climate conditions started officially since the nineteenth century, and subsequently is improved to measure and record data in reality with respect to a specific location, dominated by atmospheric circumstances. The term Weather Station System is denoted by WSS, considered the nominal strategy that measures the parameters of the climate conditions with respect to the dominations of the atmospheric conditions [1,2]. The atmospheric conditions might be encountered to dominate a specific location either in sea zones or in the land. Hereby, several sensor modules are required to measure and realize the situation of the climate for study and forecast issues. The data chosen to represent weather situation provides opportunities to confirm the usability of a specific location for any kind of project establishment. It has to be mentioned, that weather station systems are mostly fascinated and excited by three weather appreciation elements identified by Temperature, Humidity, and Wind Speed, which they are denoted as T, H, and W respectively. The identified weather items differs from location to another specially in the places that are located under the domination of high grade sun incidents based temperature, coastal areas based humidity, and highlands – mountainous terrain where the speed of the wind is considered substantially plentiful [3]. It is worth mentioning that atmosphere phenomenon effects hardly on the climate in case of very small alternations. That is, it can be concluded that there exists huge problem based far-future weather prediction, while the predication is possible for few days [4, 5].

In this paper, weather station information is transferred through a new communication technique from four different locations based on SIM900 – GSM Module. The GSM module is a wireless communication medium that transfers data over long or short distances between a source and destination without using wires. Generally, such a communication medium is classified inexpensive and suitable to be applicable over wireless communication techniques. In this paper, the realized data is transferred wirelessly based on GSM module over long distances among four locations, by a notification request triggered form a mobile phone. In details, the proposed system was named by Weather Data Accumulation Center, which is denoted by WDAC and constructed of four WSS equipped in four locations. Each WSS module holds the proposed weather sensors in order to report the climate condition of the proposed location depending on a request from the mobile phone. For more clarity, weather data accumulation center WDAC is considered as the monitoring room that controls the four locations remotely [6, 7].

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2. Weather Station System Components

The components that realize the data signal and the information required to construct the proposed unit are specified by:

1. Arduino UNO.
2. DHT11 Sensor.
3. Wind Speed Meter.
4. SIM900 GSM Module.

2.1. Arduino Microcontroller

Arduino microcontroller is an open source electronic board fabricated in several forms identified by Arduino mini, Uno, Mega, Nano …etc. Arduino microcontroller is a friendly board and easily compatible with the hardware and software [4]. The proposed electronic board deals with several sensors as inputs to manage data transfer efficiently. In addition, it deals well with motors, lights, specific kits, and some other actuators. The main controller in Arduino board can be seen equipped on the top named ATMEGA [8], which is considered the sector that holds the programing code in order to dominate the other parts of the board. For more clarity, the proposed microcontroller is shown in Fig. 1 to expose the names of the ports in reality.

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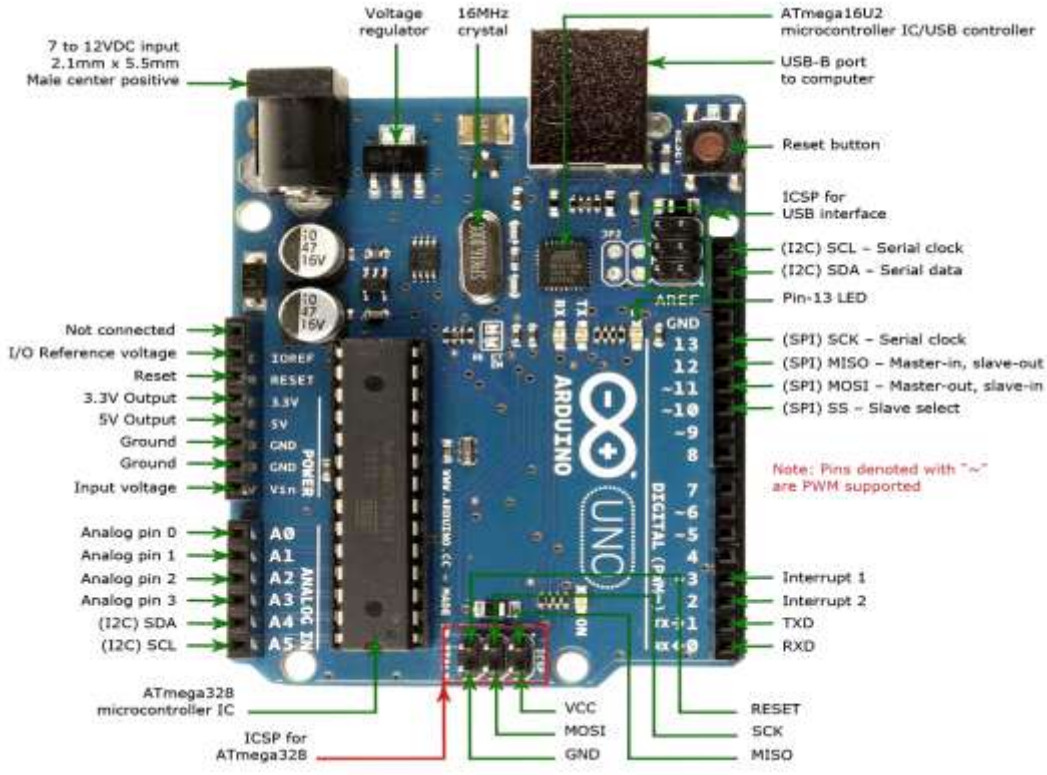

Fig. 1: Arduino UNO Board in Reality

2.2. Temperature – Humidity Sensor (Dht11)

The sensor is dented as DHT11, measures both the temperature and humidity in an individual unique model. The sensor is constructed of three terminals identified by VCC, GND, and Data. It is worth mentioning that Data pin of DHT11 sensor can be connected either to the analog or digital pins of Arduino board. However, signal calibration based analog pins can show higher awkwardness comparing to digital pins. The mining processes of the digital signal in theses sensors ensure great and perfect reliability and stability. Moreover, the sensor supports humidity resistive component and the Negative Temperature Coefficient NTC that can easily deal with the 8 – bit microcontrollers as shown in DHT11 specifications [9] in Table 1. In contrast, high response, perfect quality, energetic ability, and low cost are effectively realized.

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Table 1 : DHT11 Specifications

Parameters	Condition	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25°C		±4%RH	
	0-50°C			±5%RH
Interchangeability	**Fully Interchangeable**			
Measurement Range	0°C	30%RH		90%RH
	25°C	20%RH		90%RH
	50°C	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25°C, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long – Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1°C	1°C	1°C
		8 Bit	8 Bit	8 Bit
Repeatability			±1%RH	
Accuracy		±1 °C		±2 °C
Measurement Range		0°C		50°C
Response Time (Seconds)	1/e (63%)	6 S		30 S

The DHT11 module as shown in Fig. 2 is constructed of three terminals specified by VCC, GND, and Data. The mapping configuration between the terminals and the microcontroller is connected correspondigly such that VCC is attached to 5V of the Arduino, GND to GND, and Data pin is attached to one of the digital pins in Arduino board.

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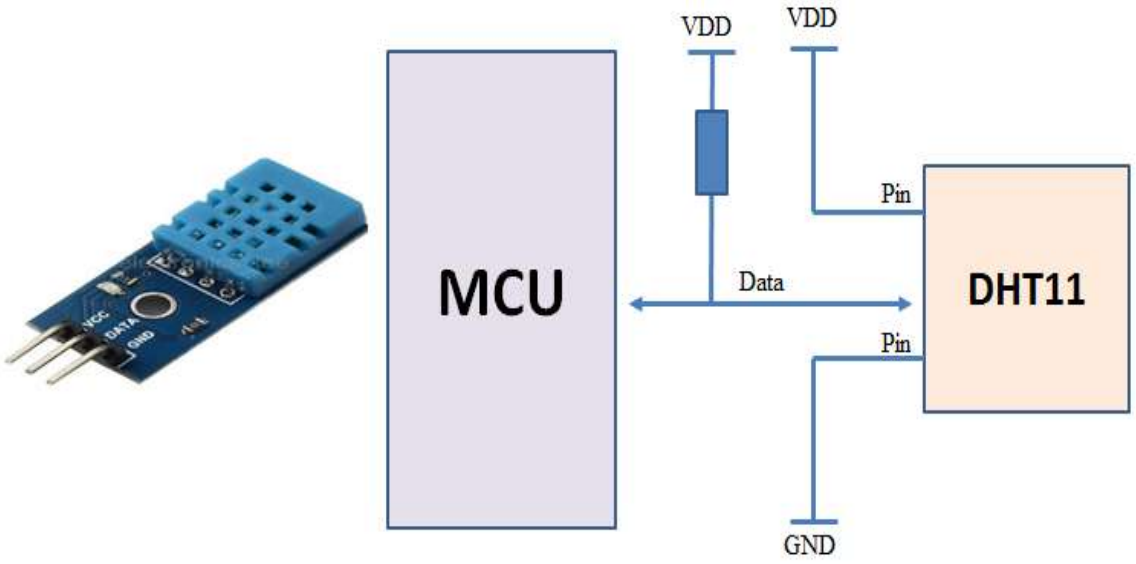

Fig 2: Temperature – Humidity DHT11 Module

2.3. Anemometer – the Wind Speed Module

The anemometer module is employed to measure the strength of the wind blowing up, in order to obtain the minimum and the maximum wind speed with respect to the generated voltage. Wind speed meter measures and provides the microcontroller with the generated signal competently in particular if fastened outdoor. The proposed meter creates the other third ultimate side of weather station attributes in this work. It is employed in order to measure, store, and demonstrate the wind speed in (mph) of a local specific location. Moreover, the Arduino code is proposed to show up the maximum wind speed measured lastly such that if the wind blown up hardly in a precise moment, the max value of the wind that time is stored and shown in the part assigned to measure the peak point of the wind. The peak value of the wind differs from time to time depending on the maximum wind strength, which is proposed to be stored in the database system and shown alongside over the corresponding mobile phone, through an acknowledgment sent to the GSM module; as long as there exists no greater read than the last value is assigned. The working principle of the proposed wind speed sensor depends considerably on the construction of the tidy anemometer shown in Fig. 3.

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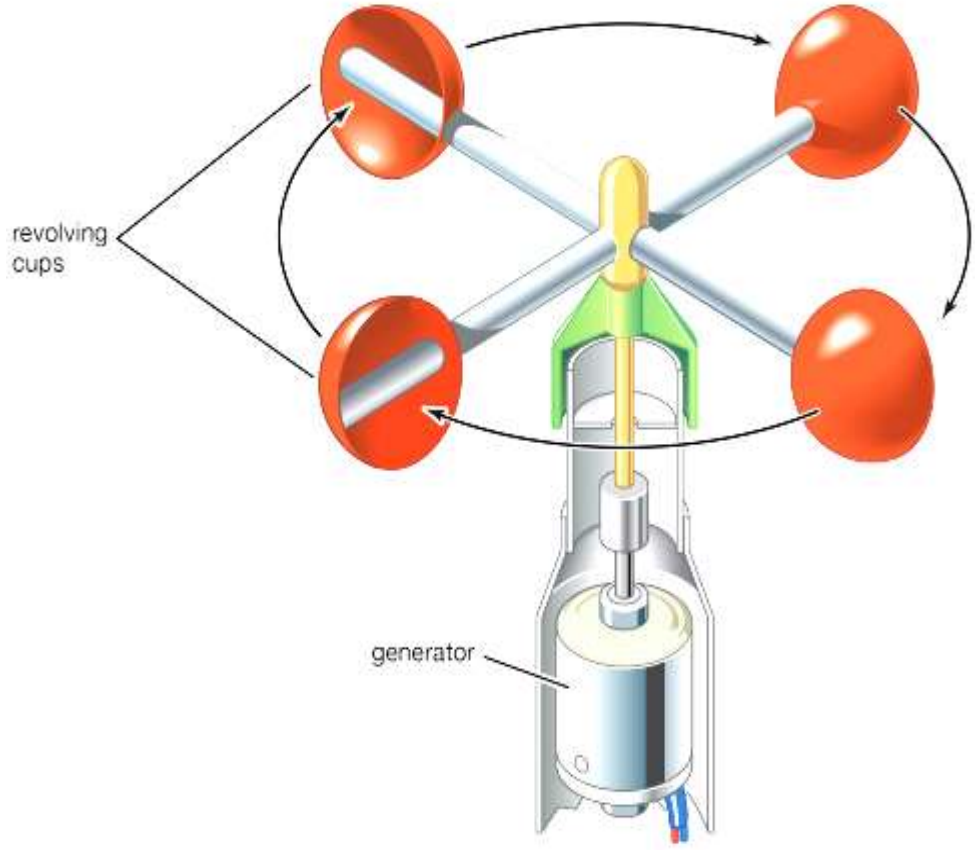

Fig. 3: Anemometer Interior Structure

The interior structure of the device is constructed of a DC motor that works in synchronous with the revolving cups rotation as shown in Fig. 3. The rotation of the revolving cups gives a synchronous moving to the DC motor due to the pole combination between the motor and the Hub which carries the cups. As a reminder about the characteristic of a DC motor, the motion and the energy are reverse proportional, this means that the motor can generate mechanical rotation/motion if it is provided by power, and can work as a voltage generator if the rotor excited by mechanical motion. Hereby, the wind speed sensor attached to the analog pin of employed Arduino board. Finally, the specification of the employed anemometer is clarified as shown in Table 2.

Table 2: The Proposed Anemometer Specifications

Output V	Range m/s	Start Speed m/s	Resolution m/s	Accuracy m/s	Max Speed m/s
0.4 – 2	0.5 – 50	0.2	0.1	1	70

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2.4. Arduino Gsm Shield Module

The three proposed weather station items are ordered and managed in order to be sent via Arduino GSM shield module. The employed GSM in the system is identified by SIM900 Arduino GSM shield module, which is also called Quad – Band GSM/ GPRS unit. The proposed SIM900 GSM module shown in Fig. 4 can work over four frequencies specified by (850 MHz, 900 MHz, 1800 MHz, 1900 MHz) in order to provide (Voice, SMS, Data, Fax) services respectively with inconsiderable power consumption [6]. The standard proposed system uses SMS service; hence, 900 MHz frequency is put in charge. The GSM modem is modeled to be worked normally when provided with 3 – 5 Volt external power, which makes the modem to be interfaced competently with several friendly microcontrollers such as (Raspberry Pi, PIC, and Arduino). In addition, Tx / Rx symbol rate of SIM900 GSM modem is specified between 9600 – 115200 bit / second, which makes SMS or Data acknowledgment broadcasting through the mobile phone more applicable.

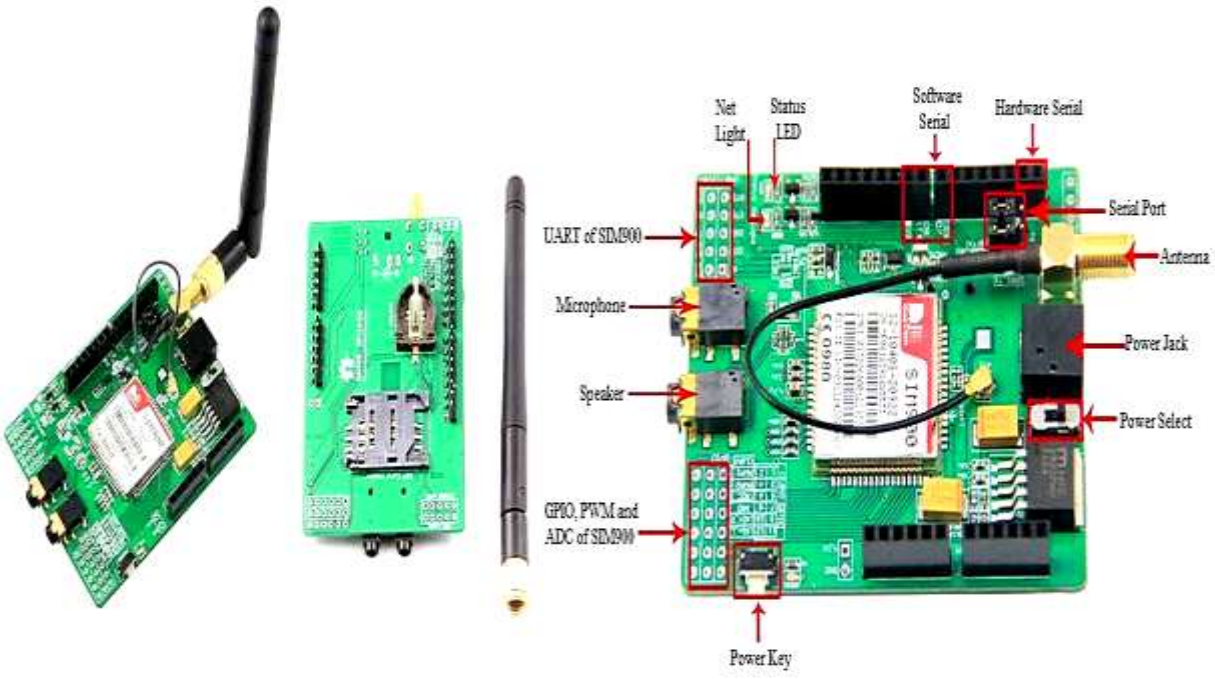

Fig. 4: Arduino GSM Shield Module

3. The Proposed Methodology

The connection scheme in Fig. 5 assembles the sections of WSS, in order to generate the proposed data items. It is worth mentioning that the output terminals of the anemometer consist of three wires identified by positive in red, negative in black, and signal terminal in yellow. As an important point, the proposed anemometer needs external separated power

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(battery) in a range of (9 – 24) Volt, knowing that (18 VDC) source does not demonstrate difficulties. The red terminal is attached to the positive terminal of the battery, the black terminal is common between the Arduino GND and the negative terminal of the battery, finally the signal terminal denoted by the yellow wire is attached to the analog pin A1 of the Arduino. The amount of voltage generated by the rotation of the cups is handed up to the analog pin of the Arduino and hence the wind speed is calculated based on definite formulas represented by Arduino IDE code. For more specificity, the connection schemes in this work are assembled in Fritzing program.

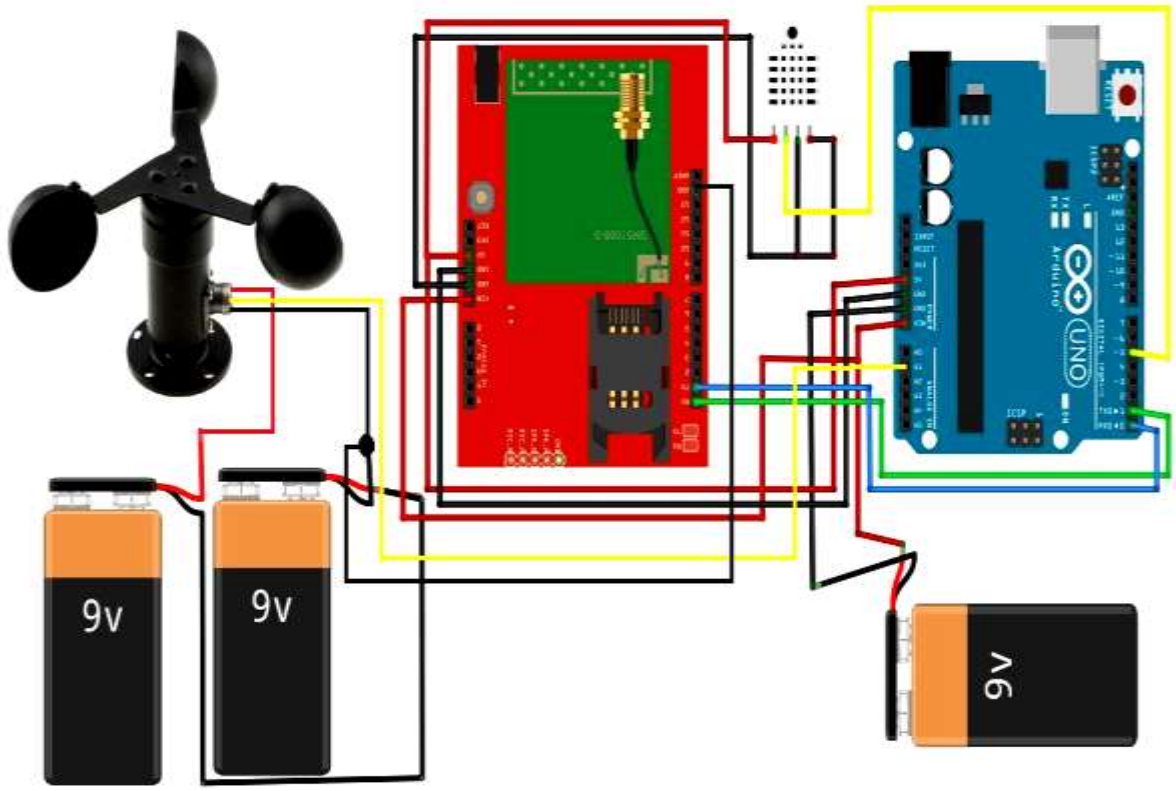

Fig. 5: Weather Station System Combination (WSS)

The next stage discusses, Arduino code formation to control the proposed anemometer model such that, a conversion factor based sensor read is calculated in order to map the analog read of the sensor with voltage range of (0 – 5) volt depending on the following expression [3]:

$$\text{Conversion Factor} = \frac{\text{Max Dig. Read}}{\text{Max Anlg. Read}} = 0.05 \qquad (1)$$

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In addition, it is proposed based on the information in Table 2, that the minimum and the maximum voltage of the module were specified in Arduino code as (0 – 4) Volt, in order to be mapped to minimum and maximum wind speed of (0.2 – 70) mph respectively. For more clarity, it is intended to represent the identified mapping relations as shown in the following set of equations:

$$\text{Mapp [Min Voltage } \rightarrow \text{ Min Speed]} = \text{ Mapp [0 } \rightarrow 0.2] \quad (2)$$

$$\text{Mapp [Max Voltage } \rightarrow \text{ Max Speed]} = \text{ Mapp [4 } \rightarrow 70] \quad (3)$$

The remaining elements of weather monitoring system are realized by the DHT11 sensor that shown in Fig. 5. As mentioned before, the sensor is constructed of three terminals, VCC is attached to the 5V of the Arduino board, Data is attached to D5 of Arduino, and GND to the GND of Arduino. As a proposal based this work, the system identified by WSS can be copied four times in order to be equipped in four different locations to create (*WDAC*).

4. Weather Data Accumulation Center (WDAC)

The term weather data accumulation center WDAC is the center that collects the required data from the sensors with respect to the microcontroller through the proposed network medium as shown in Fig. 6. As mentioned before that each WSS is constructed of the identified sensor models DHT11, Anemometer alongside with Arduino UNO microcontroller and SIM900 GSM module. The components that generate WSS sectors were equipped in four different locations / citiesat Iraq identified by Kirkuk, Erbil, Sulaimanya, and Dohuk, which represented for simplicity as (A, B, C, and D)respectively. The communication medium that gathers information and connects the identified locations with each other as a unique network in order to create the entire WDAC unit is the SIM900 – GSM module. The main methodology starts in this point as a spotlight for this research paper, such that each WSS returns the realized data back in each location remotely to the accumulation center represented by a mobile phone.

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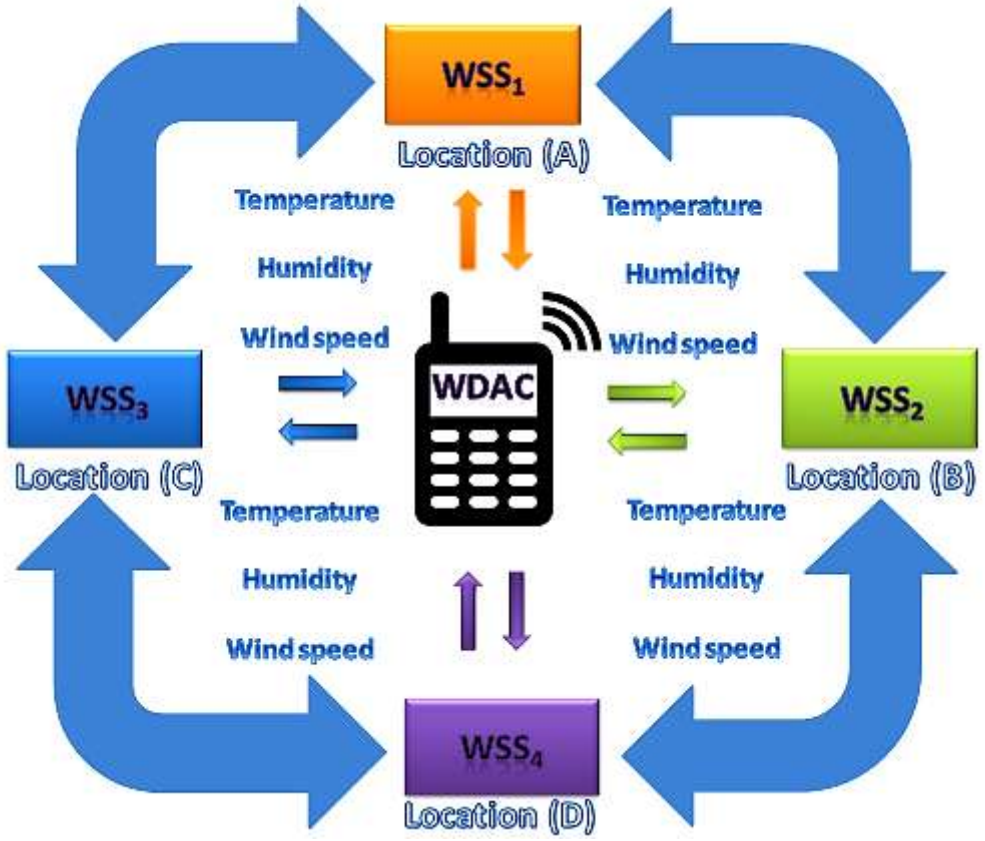

Fig. 6: Data Transportation Medium Based GSM Network

To be more precise, whenever a notification request is sent by the phone to one of the proposed locations, the realized data will be forwarded up to the phone declaring weather situation of the corresponding area. In this paper, the notification request is arranged in Arduino IDE code and linked programmatically with the word "STATUS", so that once "STATUS" is sent by the phone as an SMS, the locations will be excited accordingly.

5. R – Language Simulation Results

The language that is denoted as R, is programming language or software ground area as named recently. The language applies a lot of capabilities and operations over the corresponding data to enhance – manage data entry in order to report the improved data analytically, textually, and beneficially data visualization as graphics [3]. In addition, R – Language graphically supports numerous programs such as C, C++, SQL, FORTRAN, etc [10]. The results in this work depend merely on data visualization feature based R – Language. As a confirmation, it is intended to record the realized results by WSS modules with respect to each location, every one hour form (4 pm – 8 pm).The realized weather station

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elements basedonthe proposed locations are arranged as exposed in Table 3, and visualized by using R – language as Fig. 7.

Table 3: Weather ConditionResults at EachLocation

TIME (pm)	H (%)	T (°C)	W(mph)
Location – A –			
04:00	5	44	7
05:00	11	40	13
06:00	14	38	24
07:00	18	33	12
08:00	21	30	11
Location – B –			
04:00	6	40	7
05:00	15	38	12
06:00	18	35	13
07:00	19	31	20
08:00	24	30	15
Location – C –			
04:00	11	36	10
05:00	14	34	6
06:00	18	30	5
07:00	20	29	7
08:00	22	26	9
Location – D –			
04:00	6	39	7
05:00	12	37	8
06:00	16	36	15
07:00	19	34	20
08:00	21	30	16

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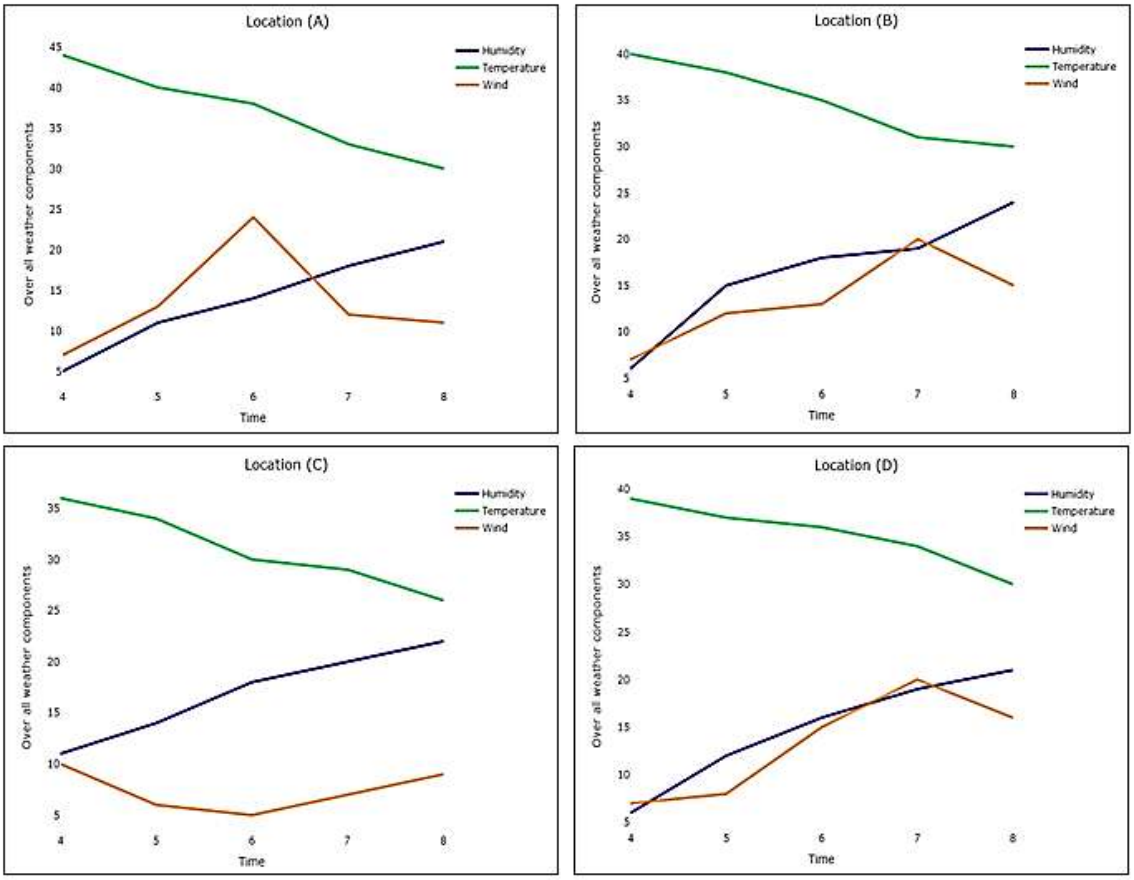

Fig. 7 : Weather Situation at the Four Proposed Locations

6. Programing Code Algorithm

Due to the complexity of the programing code and to excite the direct awareness in the minds, it is intended to show the whole code as a simple flow chart shown in Fig. 8.Initially, the system starts reading the sensors responsible for realizing weather conditions in each individual location. A notification request will be recognized by checking the inbox of the GSM model in *WSS* systems in order to reply the realized weather station data as an SMS from the corresponding location. Finally, the entire loop keeps going over the same scenario as long as the system is ON, otherwise the WDAC system is shut down as stated simply in the flow chart.

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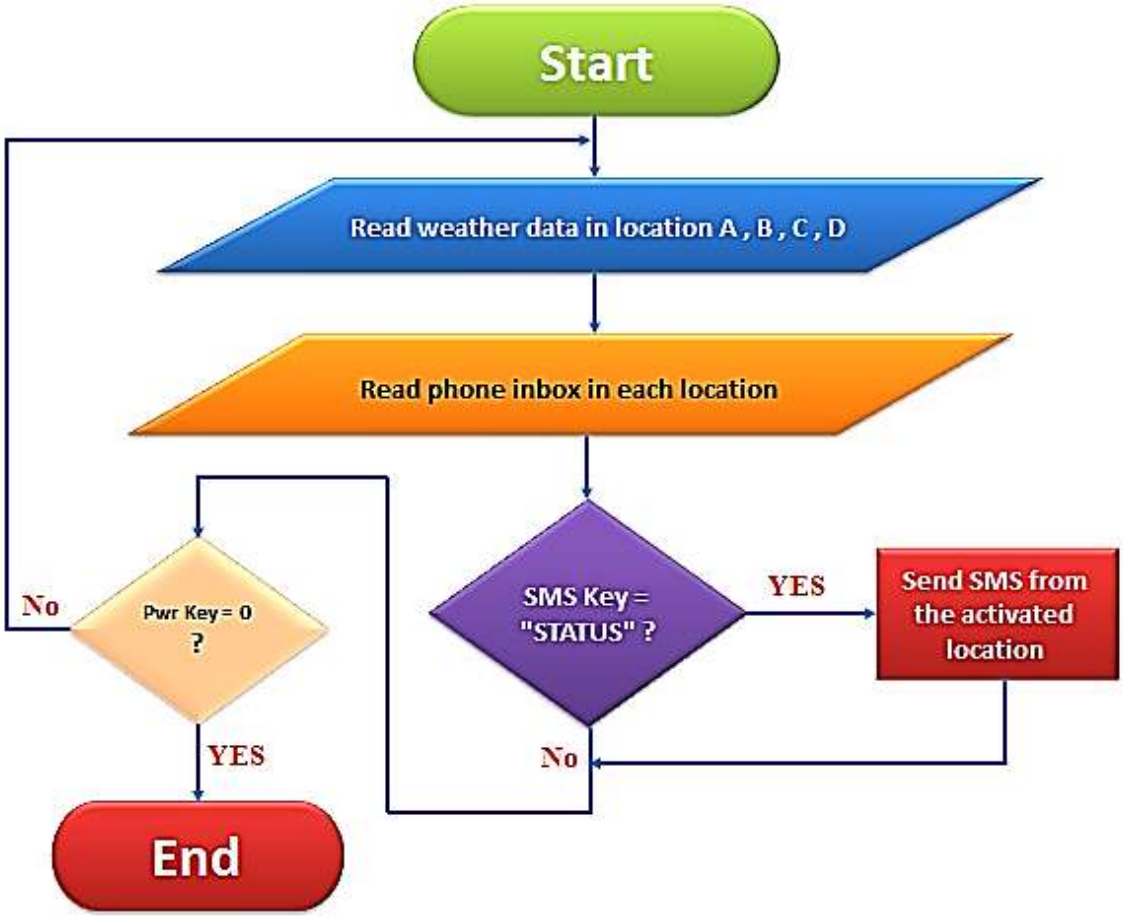

Fig. 8: The Programming Code as Flow Chart

7. Conclusions

In this paper, a distinctive model is invented in a low cost to monitor weather fluctuations based notification request. The system module is designed to cover and combine four locations in order to share their information remotely. For more clarity, it is proposed to present the realized results as follows:

1. The design and implementation costs are inexpensive since the data transfer is considered aperiodic depending on notification request from a mobile phone.
2. The climate conditions at the four proposed places are transferred through the GSM module to the corresponding phone in a short time.
3. The realized weather information in the four locations are stored as a database system with respect to *WDAC* idea.
4. The module is designed to be flexible such that, any phone uses a specific number can be provided by weather station data.

5. It is possible to realize weather data automatically by specifying time delay in the programing code.
6. Finally, the proposed system can be used later as weather forecasting center.

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