ISSN 2278-3091
Volume 8, No.3, May - June 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse29832019.pdf
https://doi.org/10.30534/ijatcse/2019/29832019

Implementation of a Web based Weather Monitoring Station and Data Storage System

Cesar A. Llorente[1], Jefferson O. Ang[2], Kenneth Robert O. Chan Shio[3], John Eric O. Chua[4], Elijah Ivin C. Cu[5]
[1]De La Salle University, Philippines, cesar.llorente@dlsu.edu.ph
[2]De La Salle University, Philippines, jefferson_ong_ang_02@yahoo.com
[3]De La Salle University, Philippines, kenneth_chanshio@yahoo.com
[4]De La Salle University, Philippines, john_eric_chua@yahoo.com
[5]De La Salle University, Philippines, elijahivin@yahoo.com

ABSTRACT

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), being the country's weather bureau, is the one presently monitoring weather conditions. PAGASA has many observation sites and one is the Science Garden which is located in Agham Road, Quezon City. The present system in the Science Garden requires an observer to go to the instrument shelter to take readings and then translate it to weather parameters. Due to the different environmental conditions, readings could be affected as it is taken manually. Safety concerns also pose a threat as observers are required to take readings in the open field. An AWS was made to address such problems as it is automated. Being automated, the weather parameters are sent automatically to the observers PC via SMS. This ensures that during harsh weather conditions, the safety and well-being of the observers are taken care of. Given that technology will drive towards AWS in the future, our system could be considered as an extra node that can be deployed to any part of the country. The hardware and software components of this study include a GSM module, Sensor modules and software such as Apache Web server, MySQL Database and PHP Scripts.

Key words : Automated Weather Station (AWS), Database, GSM, Personal Computer (PC), Short Message Service (SMS), Web server.

1. INTRODUCTION

AWS technology is present in other countries weather bureau, its effect is greatly seen because of its precise and accurate data. Some AWS systems make use of a GSM module than a RF link for the purpose of being used in a remote area because of its wider network coverage. It can also provide wireless applications such as voice services, messaging, data services and image services [1]. But most of the current products presented in the market make use of RF links for it is more affordable than using a GSM module. A major disadvantage of this is that the range between the base and the central station is quite limited. A specific example product would be the WeatherHawk [2].

There are many ways on how to transmit data using an AWS namely: Zigbee, SMS, MMS or GPS. In our system we made used of an SMS. Using SMS, users could view the data by requesting or sending a specified keyword to the system.

The current system done in PAGASA is quite tedious because there is an 8 hour working shift for the observers and for every shift there are 2 observers. The observers go to the field and record the dry and wet bulb readings to determine the temperature and humidity. The other parameters are indoor and also is being checked after they had gotten the temperature and humidity readings. The timing of data gathering using this method would be subjective to the efficiency of the said observers therefore sometimes there are discrepancies in the timing of the data gathered.

This study aims to enhance or improve the current system being used and that is by having an AWS. The technology that would be used provides a more secured method for the observers to observe the data. The timing of the data gathered would not have discrepancies unless there are unforeseen circumstances in the GSM network

2. SYSTEM DESIGN

As shown in Figure 1, the system has three parts: the Base Station, the Central Station and the Users. The Base Station is comprised of the GSM module as well as the sensor modules. The Central Station meanwhile includes a computer/ the GSM receiving module and lastly the users or observers have their own prerogative whether to access the data via SMS or by looking at the data presented thru the internet.

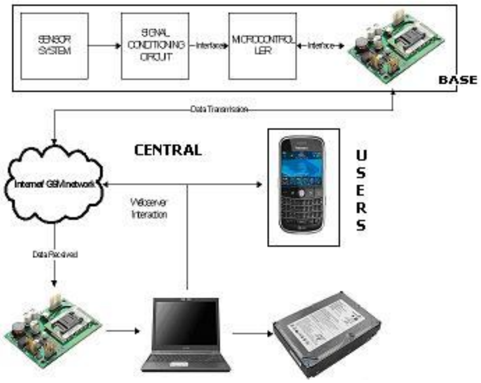

Figure 1: System Block Diagram

The base station is deployed at a remote area whereas the sensor modules would be powered by a constant 5V that is supplied by a regulated supply module. The sensors would gather the analog data and each corresponding ADC data is processed by the microcontroller then it is sent to the GSM module. The GSM module sends the data gathered to either the user or to the central station depending on the timing interval that had been set. The data processing module is programmed using mikroC because it is one of the most commonly used programming languages in PIC micro-controller for it has the simplicity making it efficient and flexible as in [3].

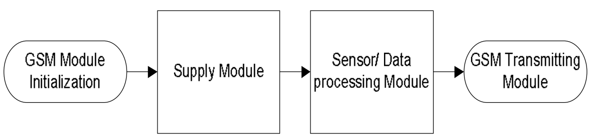

Figure 2: Base Station

The GSM Receiving module, with the use of a SMART BRO USB modem kit, would be the vital part of this system because once the data is sent by the base station the SMART BRO modem kit would receive the data. Once the data had been received it would go thru an SMS gateway program named Ozeki which in turn would send the data to the Apache. Apache with the help of MySQL and PHP scripts would then display the output on the web application that is shown in figure 3. Other features of this central station would include the filtering of which weather station had sent the data so that the user could view the data in an orderly way and also the option of adding or deleting nodes.

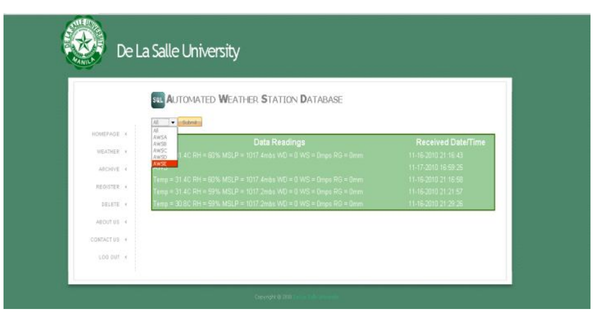

Figure 3: Web Application Screenshot

Users or observers that need to view the data can either text the corresponding keyword 'AWS' to the base station. The microcontroller will now read the message received in the GSM module. The observers could also view it by logging on the site and selecting the proper menu. Observers could also change the timing interval by sending 'AWS (A/B/C)' in which A corresponds to 30 minutes, B to 1 hour and C to 3 hours.

3. RESULTS AND DISCUSSION

In order to determine the accuracy of the sensors, the observation was conducted at the PAGASA Science Garden. The Base Station was deployed in the site currently being used by PAGASA so that parallel readings could be obtained. By doing so, the system can be compared against an accepted standard. In the series of tests made by the researchers, the data acquisition involves the idea of data mining. Data mining has a misconception of just having a collection of data but its main purpose is analyzing and having a deeper knowledge discovery through its database [4]. It also follows the standards of PAGASA which is based from World Meteorological Observation (WMO) [5]. Table I will show the percentage of errors from the readings taken by the Base Station and PAGASA. The researchers considered the allowable standard error of PAGASA in determining the set of erroneous data.

Table 1: Percentage Error of Sensors

Sensors	Error (%)
Temperature (Degree Celsius)	40.9
Relative Humidity (%)	15.9
Mid Sea Level Pressure (mbs)	15.9
Wind Direction (Degree)	56.8
Wind Speed (mps)	10
Amount of Rainfall (mm)	0

By using the surface observation sheet of PAGASA, the researchers were able to compare the results of the system with respect to PAGASA. The table 2 below will show the allowable errors that are within the standards of PAGASA.

Table 2: Allowable Error of Sensors of Sensors

Sensors	Measurement Uncertainty
Temperature (Degree Celsius)	0.2
Relative Humidity (%)	3
Mid Sea Level Pressure (mbs)	0.3
Wind Direction (Degree)	5 0.5 ≤5
Wind Speed (mps)	10%>5 0.1≤ 5
Amount of Rainfall (mm)	2% >5

Discrepancies in data may result from the site in which the sensors were located as well as the time in which the data was taken, especially for the temperature sensor in which changes in decimal points are critical. The direction of the wind also changes significantly as time varies. In order to determine if the discrepancies were the result of the degradation of the analog components and the instability of the sensors itself, the researchers calibrated the sensors at the Instrument Research Development Unit of PAGASA. This was done to ensure that the sensor modules are calibrated well within the standards being followed by PAGASA.

The researchers also tested the data acquisition circuit for one week to determine if any drift are evident. A known reference voltage was used and the temperature was varied over time to detect if the system is affected by it. Figure 4 below will show that there is no drift evident on the data acquisition circuit during the one week testing.

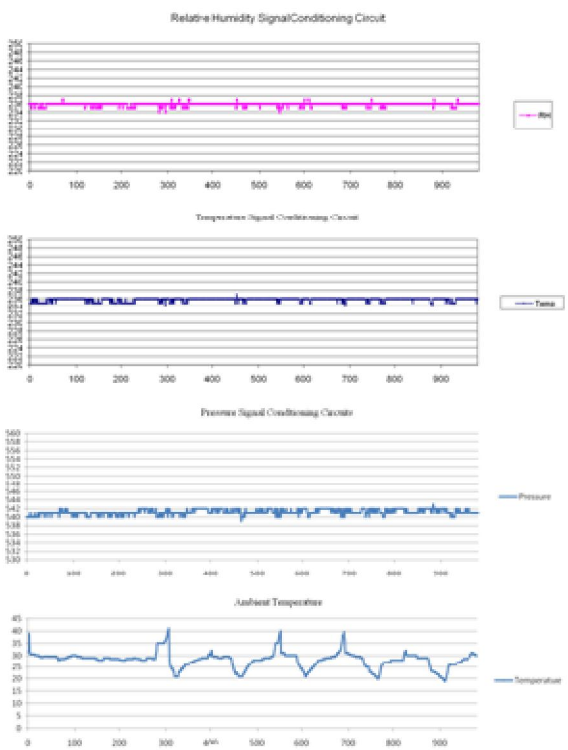

Figure 4: Signal Conditioning Stability Graph

Different weather conditions may require changes in the timing on when data should be taken. As such, the researchers implemented a functionality wherein the timing on sending of data can be reconfigured, given that the message came from an observer. The figure 5 shows the test done to check if the system is able to reconfigure the time.

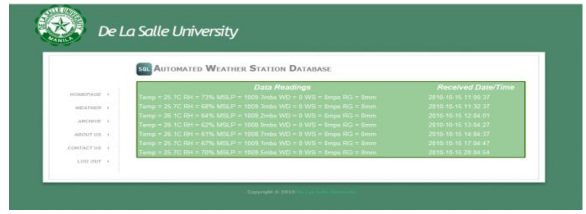

Figure 5: Testing Configuration Keyword

Keywords are texted as shown in Table 3 to check the interval of time. AWS was texted to update the time to every thirty minutes, AWSB to update the time to every hour and AWSC to every three hours.

Table 3: AWS (A/B/C) Keyword Trial A Result.

Trial A	Message Sent by Observer	Data Base Interval Updated.
1	AWSA	Yes
2	AWSB	Yes
3	AWSC	Yes

The researchers also tested if the system would still update if the message came from an unknown number.

As seen from Figure 5 and Table 4, the system was able to reconfigure its time settings. For the security of the system, messages coming from an unknown number cannot affect the configuration of time.

Table 4: AWS (A/B/C) Keyword Trial B Result.

Trial B	Message Sent by Observer	Data Base Interval Updated.
1	AWSA	No
2	AWSB	No
3	AWSC	No

4.CONCLUSION AND RECOMMENDATIONS

The system that was made would be considered a user-friendly and secured system for the observer only needs to log in to the web application to view the data. The system also addressed the security and timing issues that could be considered as factors in the data gathering stage. The system could also be used as a future node in case PAGASA would intend to use an AWS technology. The server's security was also enhanced to prevent hackers from getting and manipulating the data parameters. Overall, the system that was done would make work more efficient as the gathering of data is automated and also safer because observers can be safely secured inside the observation room.

The researchers recommend better sensors for the system because a more sensitive sensor means it is capable of handling even 0.1 to 0.2 changes in temperature. Digital sensors if permitted to use would further improve the accuracy and simplicity of designs. For remote area applications, renewable energy source should be considered for in our system we made used of a rechargeable battery. The researchers also recommend the optimization of the auto-reply functionality for mass usage. The researchers would also recommend that a tie up with a GSM network would be beneficial for cost-constraints and that working hand in hand with a meteorologist would help in terms of calibrating the instruments and analyzing the weather parameters.

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