Thesis for the Degree of Master of Engineering

A Study on Data Monitoring of Multiple Sensors and Internet Service

by

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Pukyong National University

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A Study on Data Monitoring of Multiple Sensors and Internet Service
복수개의 센서 자료 모니터링과 인터넷 서비스 데이터에 대한 연구

Advisor: Prof. Kim Jong Nam

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A thesis

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요약

센서기술은 일상 생활 속 다양한 곳에서 사용되고 있다. DHT11 센서는 온도와 습도를 측정하고 HC-SR04 는 물체와 거리를 감지하며 Water Level 센서는 액체 수위를 측정한다. 그리고 MQ-5 센서는 화재 경보 시스템 구축에 사용된다. 본 연구에서는 여러가지 센서들을 이용하여 실험 환경의 상황을 실시간으로 모니터링 하는 방법을 구현한다. TeraTerm, Xampp 와 같은 소프트웨어와 아두이노를 통하여 연결된 센서들로부터 데이터를 수집하여 복수의 감지 요소들을 접속할 수 있는 시스템을 개발하고자 한다. 이전 연구들에서는 적은 수의 센서들만 사용되었다. 하지만 본 연구에서 제안하는 시스템에서는 이상 상황이 발생하였을 때 온도, 습도, 거리, 수위, 연기가 나는 정도 및 경보를 측정하는 센서들이 사용되고 이 정보들이 기록된다. 개발된 프레임워크(framework)는 이더넷 쉴드(ethernet-shield)와 같은 외부 물리적 모듈 없이 테라텀(Tera term)을 이용하여 phpmyadmine 웹 서버에 자동으로 저장되며, 구축된 프레임워크에는 센서들 각각에 대한 데이터베이스가 생성된다.

A Study on Multiple Sensors Data Monitoring and Internet Service Data

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Abstract

There are several sensors that are used to perform different activities in daily life whereby the DHT11 sensor is used to measure temperature and humidity. HC-SR04 sensor detects object and distance, Water Level sensors are able to measure the level of substances that can flow and MQ-5 sensors are used to build fire alarming systems. In this study, several sensors are used to monitor real-time situation of an experimental environment. The aim of this study is to develop a framework where able to interface multiple sensing elements that can collect data from the sensors connected through Arduino, software such as TeraTerm and Xampp. In previous studies, the use of sensors was minimal.

The proposed system has an ability to record temperature, humidity, distance, water level, smoke level and alarms when an abnormal situation appears. The developed framework will automatically save data into phpmyadmine web server using Tera term without any external physical module such as ethernet-shield. Furthermore, the built framework creates a database for each of the sensors. This study involves the use of multiple sensors to monitor physical properties as we represent different sensors and their use in normal life.

I. Introduction

The present world is going through technological revolution and changes rapidly. We are depending on data and data driven devices for better and efficient output. It is very difficult for human to reach the best decision instantly as human are most of the time error prone. For instance, we can consider farming and cultivation. Because of intrinsic complexity and variability imposed by type, climate, soil, etc., looking after a living object (be it a plant, a fish or an animal) has been until now and for the past millennia probably characterized by successful practices passed down from father to son. Such a view is supported by statistics like those published by the EU, showing for example that 93.7 percent of all farms are run by only family workers [1] well established and stable business models, best known by the locals and refined over centuries of family trial and error.

A computing concept where physical objects used in daily life connected to the internet can help reducing the trial-and-error process. Physical objects embedded with software, sensors, actuators and smart objects converge with the internet to accumulate and share data which are the solutions to most of the daily problems in the real world. To develop this kind of device is not easy. Challenges in developing data driven device is a constant companion. These challenges could be categorized into two groups, as shown in Figure 1.

1.1.Systematic Challenges

Systematic challenges are those that result from institutional shortcomings, and obvious due to insufficient practices, norms, laws, and regulations.

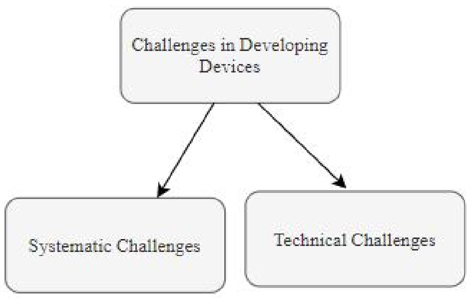

Figure 1. Challenges in developing devices

1.1.1. Data collection and analysis

It is necessary to first identify barriers to consistent data collection. Inadequate collection of data is one of the main challenges to identify and understand the vulnerabilities of IoT sector. Complicated forms can lead to nonresponse or respondents filling in answers at random simply to complete the survey. Lack of understanding of context in data collection can result in complete failure to overcome desired solution. Sometimes before quantifying anything, it is to be learned more about the context of a respondent group. This may require qualitative research to answer key questions that can then be used for quantitative research; without it, we are risking missing truth altogether.

As data collection can be expensive, collaborating with like-minded nonprofits to conduct mutually beneficial research is a good way to collect good data at half the cost. Hiring and training a local data collection team will be cheaper and often more effective at obtaining data than bringing in non-locals to do the work. Appropriate sampling of data may rise noise in system which often leads to undesirable outcomes. To generalize findings, it is essential to have an appropriate sample that reflects the data. Not only that, in order to the findings be relevant, it is must have statistical power.

Data collection often fails as harmful interference goes unreported when users assume that equipment is malfunctioning instead of experiencing harmful interference, or because users do not know that such interference should be reported. Even for users that want to monitor interference, it can be difficult to do because devices are not designed to enable such monitoring. At a broader scale, some operators might not be able to detect interference because they outsource expertise about network functions to vendors [2]. According to [3], the challenges of analyzing Big Data are distinguished by their high dimensionality and big sample size. These two characteristics present three distinct challenges: (i) High dimensionality results in noise buildup, false correlations, and accidental homogeneity. (ii) The combination of high dimensionality and big sample size causes difficulties such as high computing cost and algorithmic instability; (iii) huge samples in Big Data are generally collected from numerous sources at different time periods using diverse technologies. This causes problems with heterogeneity, experimental variances, and statistical biases, necessitating the development of more adaptable and flexible methods.

1.1.2. Data Shearing

During the last few years, survey funders from throughout the world have issued call for broad and open data sharing to extend scientific findings and encourage new science. Indeed, many disciplines have found that data sharing, especially when enabled through formal data archiving, results in greater numbers of publications based on the data (Pienta, Alter, & Lyle, 2010; Piwowar, Day, & Fridsam, 2007). But data sharing is not yet firmly established in all disciplines and countries Authors [4] Several research participants were concerned that their data would fall into the wrong hands and cause them damage. This is acceptable given that data sharing is still uncommon and confidence in certain procedures is developing slowly. The informed consent pledge can alleviate some of this apprehension by assuring investigators that they would go to great lengths to preserve individual identities. Furthermore, rather than totally open access, the majority of the writers advocated for some form of limited access to the final data.

Despite the availability of technologies for data collection and processing, there is limited data exchange between communication system operators and the authorities keeps operators from having information they need to mitigate risks and prevents collaborative efforts to prevent vulnerabilities. Even if there were adequate reporting tools, some operators are reticent to share data because it could include sensitive or proprietary information and data that might be utilized to determine culpability. Additionally, following the disclosure of the Public Safety Agency's vast monitoring system in 2013., operators hesitate to share data with the government due to concerns the government would exploit their vulnerabilities [2].

1.1.3. Research and Testing

Currently, Experts are still unable to obtain the data required to undertake testing. This is in part because data is not being shared with them, but also because academic researchers are increasingly limited by what they can demonstrate in paper and analysis simulations, as a result of inadequate access to real-life networks with which they can experiment. Closed-form solutions are becoming less viable because of increased system complexity, discussed below, not to mention the high cost of proper testing equipment, typically beyond the budget of academic researchers to obtain on their own.

Even when research can be conducted, it can be of limited effect, as it often occurs after networks are already commissioned, designed, and deployed. When the risk of disclosing confidential information is small but not negligible, data repositories often require data use agreements with additional safeguards. Prospective data users must submit data security plans and agree not to publish tables or statistics that might disclose confidential information. The data are transferred to the user in a secure way after agreements have been approved and signed [4]. The most sensitive data are available to prospective users only through controlled on-site access at an approved data center. Although access restrictions are applied to protect confidential data, metadata describing sensitive data are normally available online to allow researchers to discover the data. Subjects are seldom endangered by documentation, and the ICPSR online catalog [5] provides research descriptions and variable information describing limited data. Copyrighted instruments, such as batteries of questions, are sometimes included in paperwork, and care must be taken to safeguard such rights.

1.2. Technological Challenges

Technological challenges are those that result from the design and distribution of wireless systems.

1.2.1. System and Design

Equipment commoditization creates misaligned incentives for system developers because it prioritizes qualities like high-speed, low cost, and speed to market over security and resiliency. Even when vulnerabilities in wireless systems are known, they are not given adequate attention. Such is the case for PIM (passive intermodulation) has become a technique that may be used to launch far more complex cyberattacks [6] and 4G LTE specifications, which offer a software stack directly connected to the vulnerable open wireless input. Despite that, those specifications might be used for 5G networks being developed today.

Equipment with vulnerabilities could be used, for example, to cause jamming by changing channels within radios to achieve massive pileup pollution within a network. However, the equipment is popular for 5G deployments because of its low cost. Over the long term, a lack of equipment diversity has its own risks. The ubiquity of technology from a foreign source could allow an intelligence service to gain leverage, not through a back door, but because it helped build the network, and thereby knows the network better than anybody else does. Equipment diversity risks increase as the number of trusted suppliers decreases due to competition.

Many explain that standards setting is incomplete in terms of system design, system complexity, and distribution network concerns. System complexity is one reason existing standards are insufficient. Standards setting organizations often develop standards and conduct testing for a particular use, but do not account for the beginning of optional features that are not tested or do not have standards and may have vulnerabilities of their own. Standards are also often developed after innovations are already on the market. Additionally, a government may be falling short on influencing standards setting bodies, hamstrung by its deference to industry and its cadence of technology neutrality.

Motivation

Recording and saving time series data require large memory discs to preserve the data for future use. Previous studies substantiate that it is possible to connect Arduino UNO and Ethernet shield to record and save data using 6 to 7 sensors. This study is highly motivated by the limited number of sensors to be connected on the Arduino Uno. From such a limitation we suggest a robust system that uses 1 Arduino MEGA2560 micro-controller and 15 sensors to record temperature, distance, humidity, gas leakage, water level indicator, etc.

II. Related Works

Sensors are used in the field of electrical and electronics engineering to design and develop new products. invent a machine Sensors and other numerical algorithms are commonly used for these systems. During the invention and creation of automation Sensors are usually linked to Arduino super, breadboards, computers, Rasberry Pis, and other similar devices. There are several interfaces, some of which are internet-based and others are not.

2. Web-based data logging system

Yasyfi et al., in [8] study developed and objectified a web-based data logging system that sought to record contact and sensor data in IoT devices so that log data in IoT could be monitored. Devices from this data logging system is built with an arduino uno r3 and an Ethernet shield board, as well as a temperature sensor DHT 11 in IoT devices, also able to monitored real time data with date and time stump. The above system could record contact between an Arduino computer and an NTP server over the internet. Aside from that, this system could record important system parameters such as IP source address, IP destination address, I address in each node, device time, and room temperature data. The parameters that had been registered would be saved to the archive and then displayed in web results.

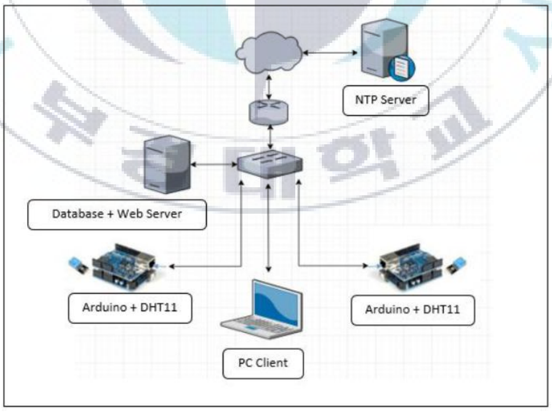

Figure 2 Web based data logging system

The authors developed and described a system that could record communication between Arduino device and NTP server using internet network. Apart from the study by the scholars above.

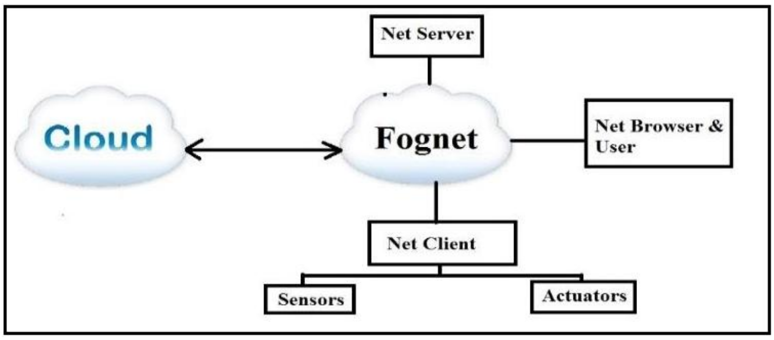

Figure 3. Wireless Sensor Network Configuration.

2.1. Lab View and Data Logger

Wardoyo et al., [9], proposed to create an alternative system to the data logger and interface a microcontroller and Labview software as data logger. Ejodamen et al., in [10] the system able to determine whether the weather Hot, Normal, or Cold based on the exact temperature and relative humidity within a 20-meter radius. They also show how to recycle plastic foam for use as an insulator and lining for electrical components. When plastic foam, a waste substance, is recycled poorly, it significantly adds to the Global Warming Potentials (GWP). used Arduino UNO to develop a weather monitoring system based on temperature and humidity variables obtained from a DHT11 sensor.

2.2.Weather Monitoring

Arko et al., in [11], The quality and sustainability of human life are directly related to environmental sustainability. This topic has recently come up in a number of global forums. However, most people ignore it because there are no credible widely accessible sources of knowledge to help create strong environmental consciousness. In reality, almost all human behaviors have an impact on the condition of their surroundings to some extent. Unfortunately, installing such environmental surveillance systems is also relatively expensive and only a few specialist firms have such specialized systems. This work is a modest step toward resolving this global problem by assisting in the collection of accurate atmospheric environmental parameters. The solution is an Internet of Things (IoT) module that can be conveniently installed in the desired geographic region. The data are graphed to help consumers track patterns both locally and remotely. Since the calculation values are kept in the cloud, the graphs can also be downloaded through the internet, allowing people to easily obtain current atmospheric environmental statistics. Indoor and outdoor deployments, both static and mobile, are possible. The framework has been checked in the vicinity of Tangerang. The use of this IoT module will increase environmental quality understanding, as well as biodiversity and human life quality. showed a low cost environment monitoring system to collect temperature and humidity data.

2.3. Student Record Management System (SRMS)

Er. Saurabh et al., in [12], The Student Record Management System (SRMS) provides an easy to-use platform for managing student information. It may be used by educational institutions or colleges to easily keep track of student data. In colleges and universities, the development and management of error-free, excellent data concerning a student's research career is from the greatest priority. The student information system maintains all types of student information, academic records, college information, fee information, grades, batch information, attendance information, and other resource information. It records all of a student's information from the beginning to the conclusion of the course, and can be used for all monitoring purposes, such as recording enrollment, success in the thesis, completed semesters, years, coming semester year curriculum data, fee details, project or some other task details, all of this will be accessible through a secure, online portal installed in the college's Student Record Management System.

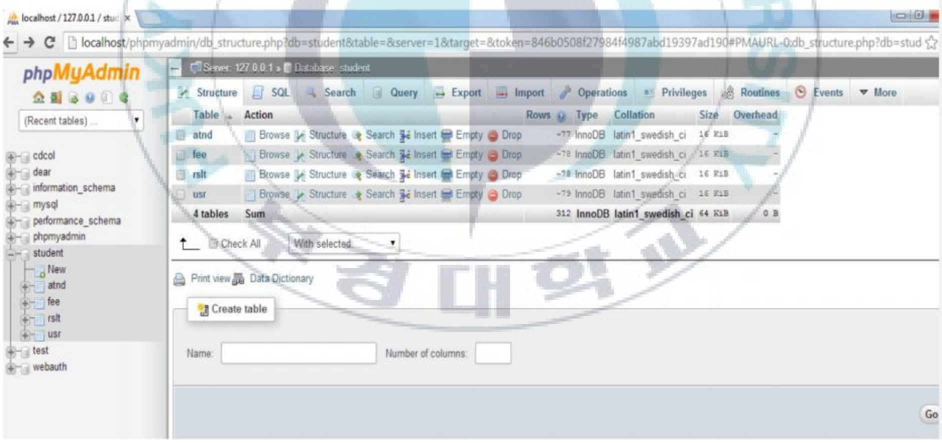

Figure 4. Tables in student database

This framework can operate on a network. Students receive the information they need immediately. This method is only applicable to universities and schools. The details contained in the server can be searched at any time, so there can be no waste of resources in colleges and universities if this technology utilized.

III. The Proposed Methods and Experimental Results

3. Architectural Design

This chapter discus about components, design and implementation. To the system connected fifteenth sensors through Arduino-Mega2560, ten sensors connected to the digital pin of micro-controller and more five sensors by analog pin of AT-Mega2560. Read the sensors output on Arduino IDE and configure the Tera Term with micro-controller port for displaying and saving data on Spreadsheets. Export the data sheet to the PhPMyAdming by PHP programming. Enable the server access from different computer.

Hardware part

3.1.Arduino Mega AT2560:

It's an ATmega2560-based 8-bit microcontroller. It features 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, an USB port, a power connector, an ICSP header, and a reset switch. It comes with everything you'll need to get started with the microcontroller; simply plug it into a computer with a USB connection or power it with an AC-to-DC converter or battery. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila. [13]

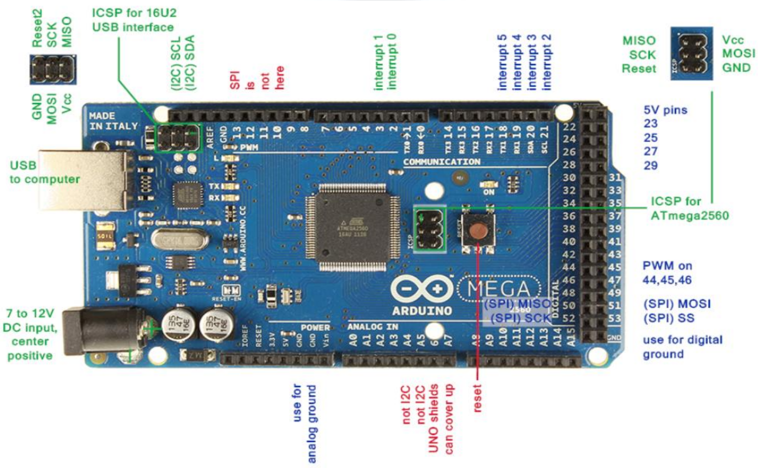

Figure 5. Arduino Mega AT2560

	Arduino Uno	Arduino Mega 2560	Arduino Micro
Price Points	$19.99-$23.00	$36.61 - $39.00	$19.80 - $24.38
Dimension	2.7 in x 2.1 in	4 in x 2.1 in	0.7 in x 1.9 in
Processor	Atmega328P	ATmega2560	ATmega32U4
Clock Speed	16MHz	16MHz	16MHz
Flash Memory (kB)	32	256	32
EEPROM (kB)	1	4	1
SRAM (kB)	2	8	2.5
Voltage Level	5V	5V	5V
Digital I/O Pins	14	54	20
Digital I/O with PWM Pins	6	15	7
Analog Pins	6	16	12
USB Connectivity	Standard A/B USB	Standard A/B USB	Micro-USB
Shield Compatibility	Yes	Yes	No
Ethernet/Wi-Fi/Bluetooth	No (a Shield/module can enable it)	No (a Shield/module can enable it)	No

Figure 6. Arduino Uno Mega 2560 and Micro comparison

Annotations are color coded. Green have the same function and position as the Arduino UNO R3. Red are differences, where the functionality has moved on Mega2560 compared to UNO. In general, this means that the UNO put several functions on one pin and these have moved to separate pins on the Mega. Blue is for differences due to added functionality (extra pins).

I find it convenient to use the GND pins near to the analog input pins as analog grounds, and to use the GND on the end block for digital grounds, when linking to external circuitry. Update: correct SCL to SCK, correct colors, call out second ICSP header. [14]

3.2. Technical specification of Arduino mega AT2560

As Arduino Mega is based on ATmega2560 Microcontroller, the technical specifications of Arduino Mega are mostly related to the ATmega2560 MCU. But none the less, brief overview about some important technical specifications of Arduino Mega 2560. [15] The Arduino comparison table below shows a side-by-side comparison of the Uno, Mega 2560, and Micro.

MCU	ATmega2560
Architecture	AVR
Operating Voltage	5V
Input Voltage	6V – 20V (limit) 7V – 12V (recommended)
Clock Speed	16 MHz
Flash Memory	256 KB (8 KB of this used by bootloader)
SRAM	8 KB
EEPROM	4 KB
Digital IO Pins	54 (of which 15 can produce PWM)
Analog Input Pins	16

Figure 7. Technical Specifications

3.3.DHT11 Sensors:

The DHT11 is a relative humidity detector. Relative humidity is based on the amount of water vapor in the air divided by the saturation point of water vapor in the air. Water vapor begins to condense and collect on surfaces at the breaking point, creating dew. The saturation point varies with the temperature of the air. Arctic air may retain less water vapor before being saturated, but warm air can store more water vapor before becoming saturated.. [16] The formula to calculate relative humidity is:

$$RH = (\frac{\rho_w}{\rho_s})\ x\ 100\%$$

$RH :\ Relative\ Humidity$
$\rho_w :\ Density\ of\ water\ vapor$
$\rho_s :\ Density\ of\ water\ vapor\ at\ saturation$

Showed figure implement 4 DHT11 sensors. All red wires connected to the power source and black wires indicate the ground, all other connection with digital pin 2,3,4,5 for data output.

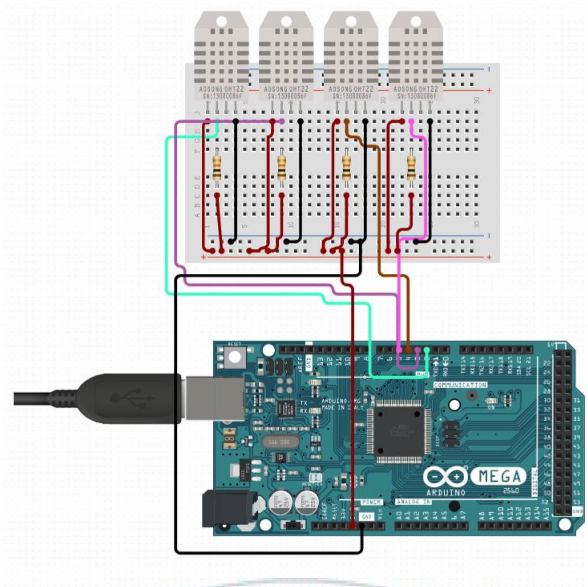

Figure 8. DHT11 Sensors Connection

3.4. Ultrasonic Sensors:

HC-SR04 sensor range of detect is 2cm to 400cm. The transmitter sends out brief bursts that are bounced by the object and managed to pick up by the receiver. The time difference between ultrasonic signal transmission and reception is determined. The distance between the source and target may be easily estimated using the speed of sound and the 'Speed = Distance/Time' equation [17].

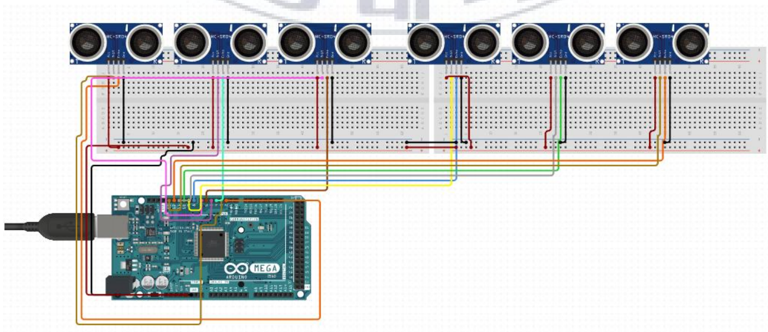

Figure 9. HC-SR04 Ultrasonic Sensors connection

Here we connect 6 ultrasonic sensors. Each sensor connected to the Vcc and Gnd, then connected triger and echo pin continually to digital pin 2,3,4,5,6,7,8,9,10,11,12.

3.5.Water Level Sensor:

Vcc pin supplies power for the Sensors and GND is ground connection. S pin is connected to Analog Pin A0 and A10 for data output.

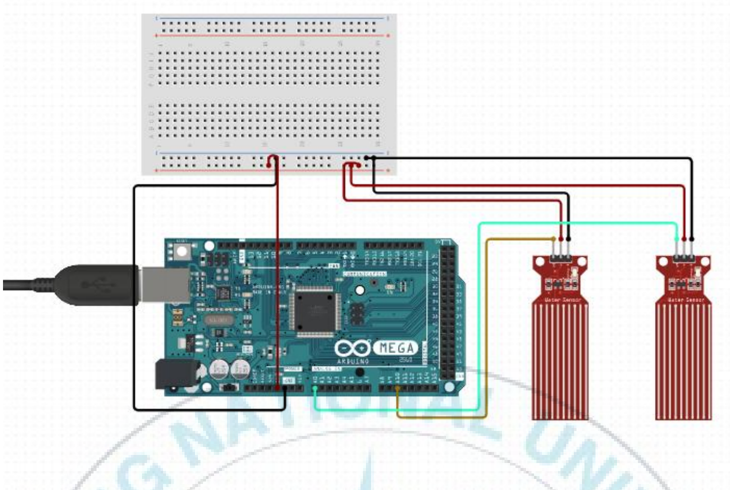

Figure 10. Water Level Sensor

3.6.Gas Sensor:

It has 4 pin, possible to read analog and digital output. Here we use analog pin. Vcc ic connect to 5V, GND to GND and analog pin to A10.

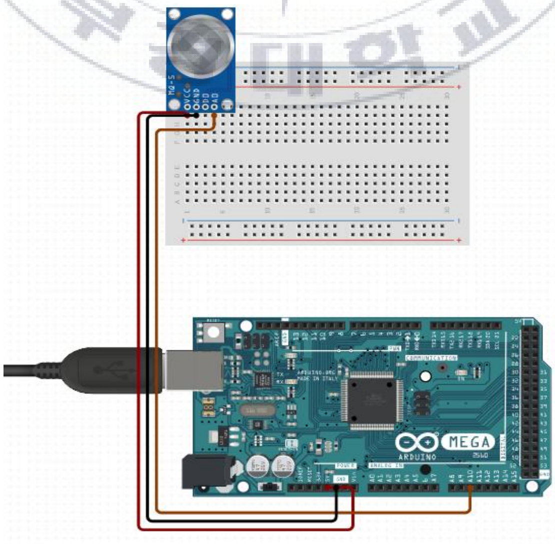

Figure 11. Gas Sensor (MQ5)

3.7.Touch Sensor:

The touch sensor's SIGNAL pin is connected to an Arduino's input pin. By reading the state of Arduino's pin (configured as an input pin), we can detect whether the touch sensor is touched or not. Connect VCC pin to 5V, GND to GND and out pin to digital pin 2 on Arduino mega.

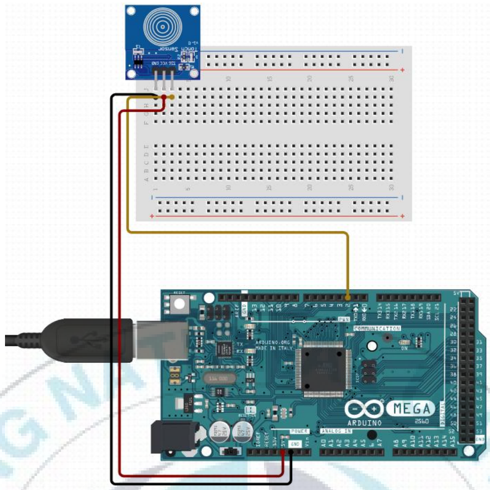

Figure 12. Touch Sensor

3.8.Moisture Sensor:

It has 3 pins, Power pin connected to the 5V Arduino, GND to GND and Signal pin added to the Analog pin A0. It's length of detection 38mm and working voltage is 2V-5V.

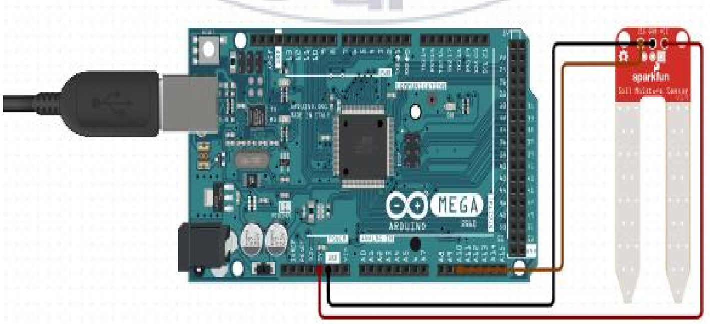

Figure 13. Moisture Sensor

3.9.Arduino IDE:

Integrated Development Environment (IDE), we use Arduino IDE for writing code and upload program to the Arduino Mega AT2560. It's and cross platform for windows, macOS, Linux). Programming language support C and C++.

3.10. Xampp

The most widely used PHP development environment is XAMPP. XAMPP is a fully free and simple to install Apache installation that includes MariaDB, PHP, and Perl. The XAMPP open source software has been designed to be extremely simple to install and use. [18].

Apache: Is open source web server Apache is the most widely used server worldwide for delivery of web content. The server application is made available as a free software by the Apache Software Foundation.

MySQL/MariaDB: In MySQL, XAMPP contains world most popular data management system. In combination with the web server Apache and the scripting language PHP, MySQL offers data storage for web services. Current XAMPP versions have replaced MySQL with MariaDB (a community-developed fork of the MySQL project, made by the original developers).

PHP: The server-side programming language PHP enables users to create dynamic websites or applications. PHP can be installed on all platforms and supports a number of diverse database systems.

Perl: The scripting language Perl is used in system administration, web development, and network programming. Like PHP, Perl also enables users to program dynamic web applications. Alongside these core components, this free-to-use Apache distribution contains some other useful tools, which vary depending on operating system. These tools include the mail server Mercury, the database administration tool phpMyAdmin, the web analytics software solutions Webalizer, OpenSSL, and Apache Tomcat, and the FTP servers FileZilla or ProFTPd.

```
<html>
 <head>
  <title>PHP-Test</title>
 </head>
 <body>
  <?php echo '<p>Hello World</p>'; ?>
 </body>
</html>
```

Figure 14. PhP Programming

3.11. Phpmyadmin:

Can use the Admin button of database module to open phpMyAdmin. Here, manage the databases of web projects that are testing on XAMPP. Alternatively, reach the administration section of MySQL database via localhost/phpmyadmin/ [19]

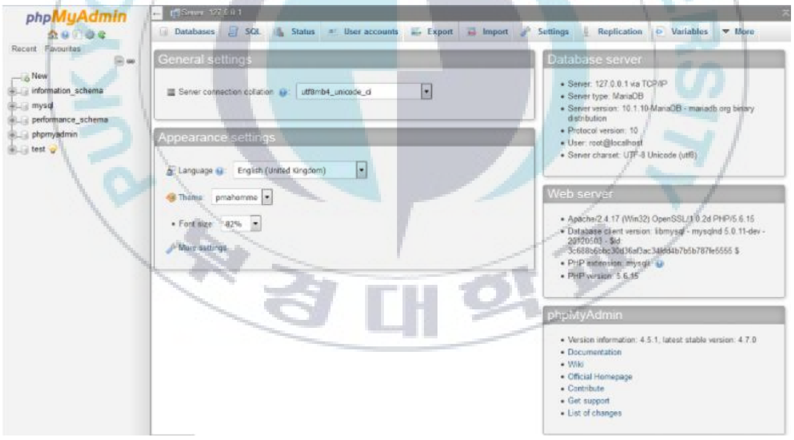

Figure 15. Web-Server

3.12. Tera Term:

Tera Term is a well-known Windows terminal application. It's been around for a while, it's open source, and it's easy to use. [20]

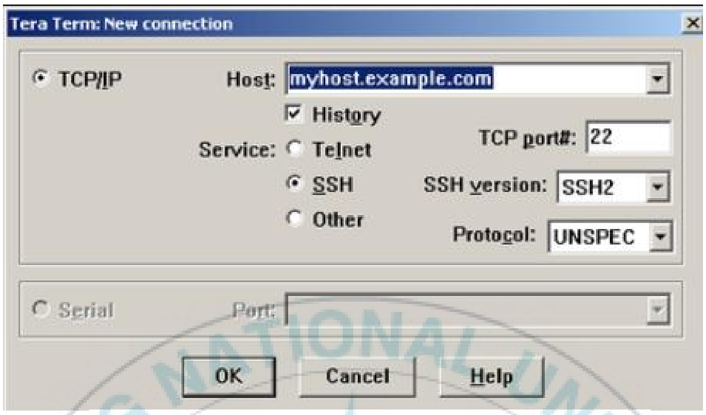

Figure 16. Tera Term Connection Terminal

3.13. Python:

Working on any program frequently necessitates exporting data from the Python application to a data storage such as a database or a flat-file. This data can be accessed by other backend assistance programs. To connect to the database engine, we apply the sqlalchemy package. Sqlalchemy works with a variety of databases, including SQLServer, Oracle, MySQL, and PostgreSQL. When the script is launched, data from the csv file is read and sent to the database server.

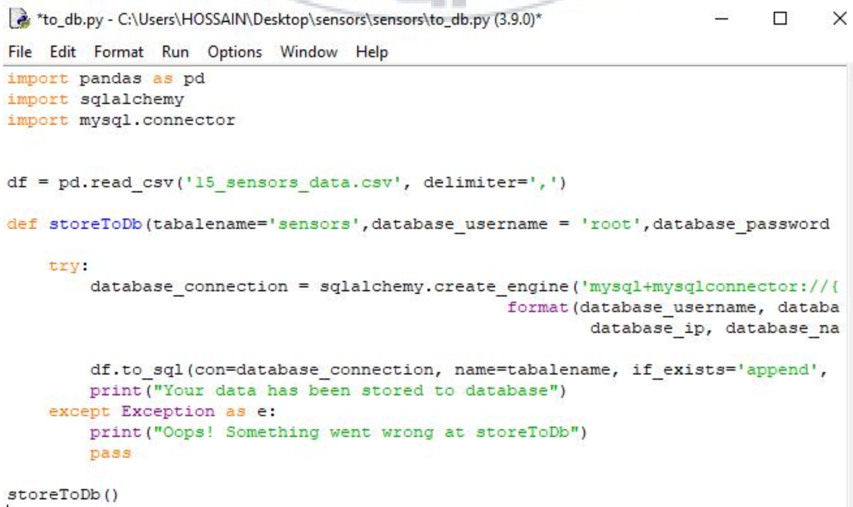

Figure 17. Python script connect to csv file and database server

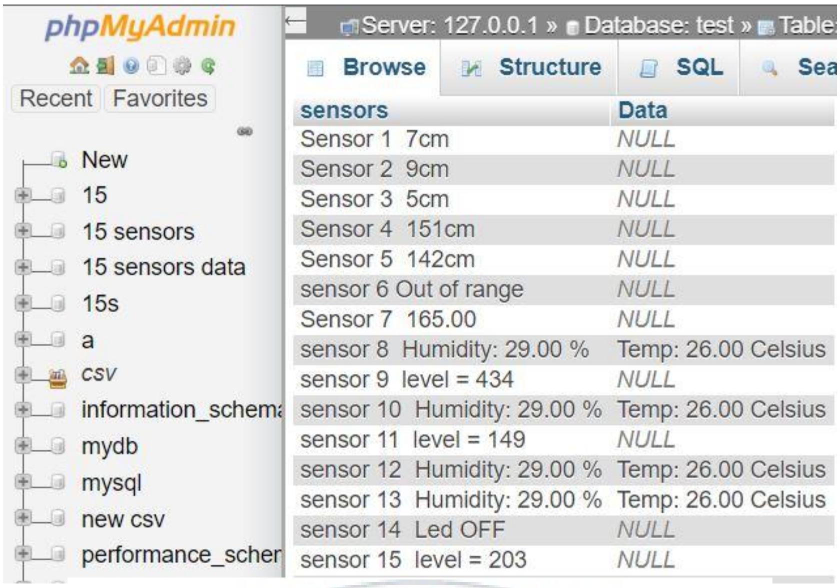

Figure 18. csv file results show on the database server

4. Proposed Method:

In this work we propose a system that uses 15 sensors to monitor our laboratory environment. The proposed algorithm will be used to record any amount of water leaking through the roof. moreover, it will be used to record the room temperature and humidity for providing information to every lab member. There is a touch sensor which is connected for the purpose of security in our laboratory. We connect 15 sensors voltage source and ground with Arduino using breadboard and sensors output we connect with our micro-controller as shown at (figure). For web server we create a table in database then connect our csv file with database by php program. We installed Xampp for interface localhost webserver and Tera Term for reading data from Arduino serial monitor. We open Xampp command prompt and launch “Apache” and “MySQL” to access the web server while PHP linked for transferring the data to the web server. We created a table on our database for reading data from 15 sensors saved in the excel spreadsheet file. Thereafter, we upload Arduino sketch on microcontroller to launch Tera Term and connect with micro-controller by designating serial ports.

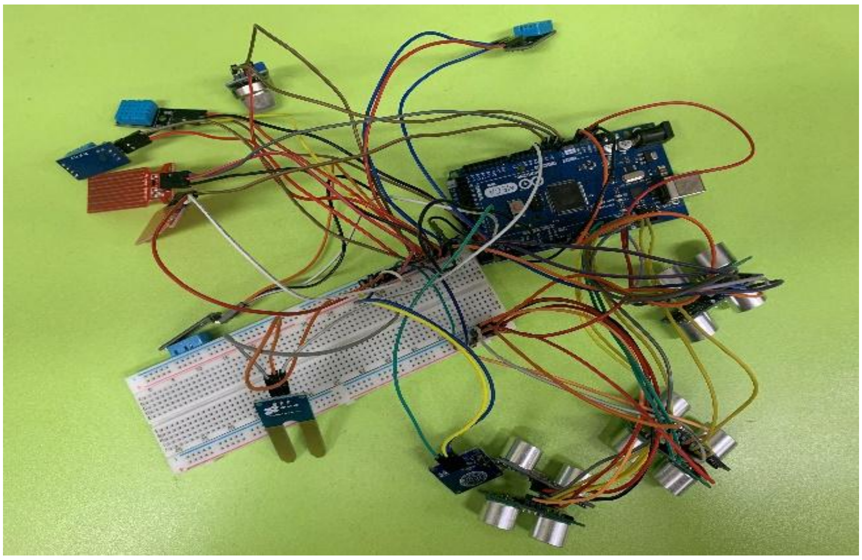

Figure 19. Prototype Project

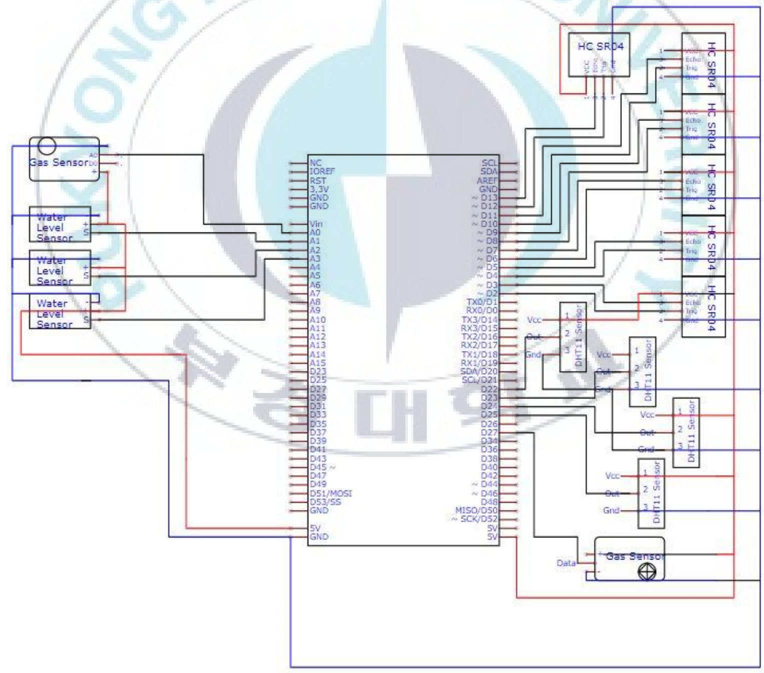

Figure 20. Circuit Diagram

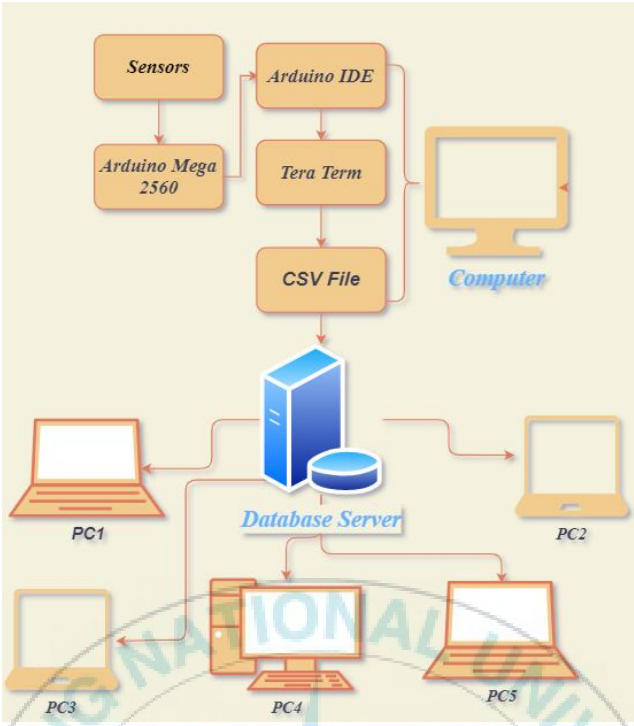

Figure 21. Proposed Method Flowchart

4.1. Experiment results and discussion

We conducted our experiments on a computer operating through windows 10 and installed with Arduino IDE, Tera Term and Xampp for controlling the web server. This experiment has two parts which are hardware and software. The software part involves using Xampp, tera term, and php whereby, Xampp was used to control the web server, tera term is used to read the output data and create spreadsheet to be connected to the server. PhP was used to connect the spreadsheet and the database for data storage. As shown in Fig, the result shows that our system was able to collect the information obtained from 15 sensors. Additionally, the system was able to give an alarm and a LED could turn ON of OFF. Therefore, the connected sensors can provide good assistance and monitoring of our laboratory utensils when installed properly.

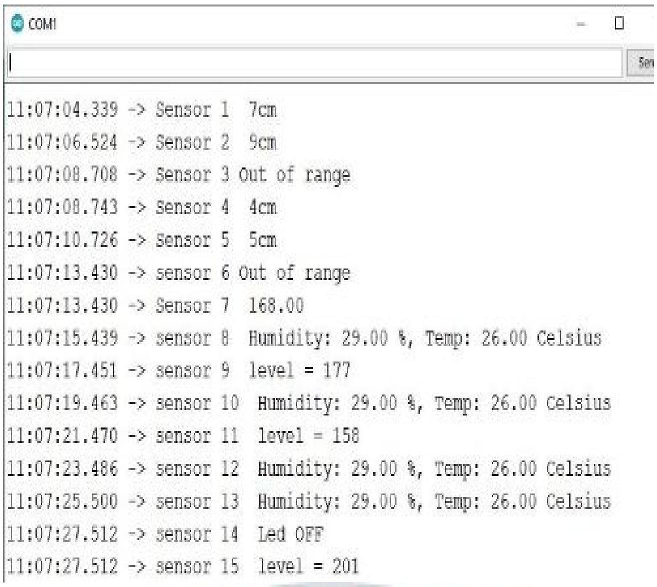

Figure 22. Sensors Output Results on Arduino IDE

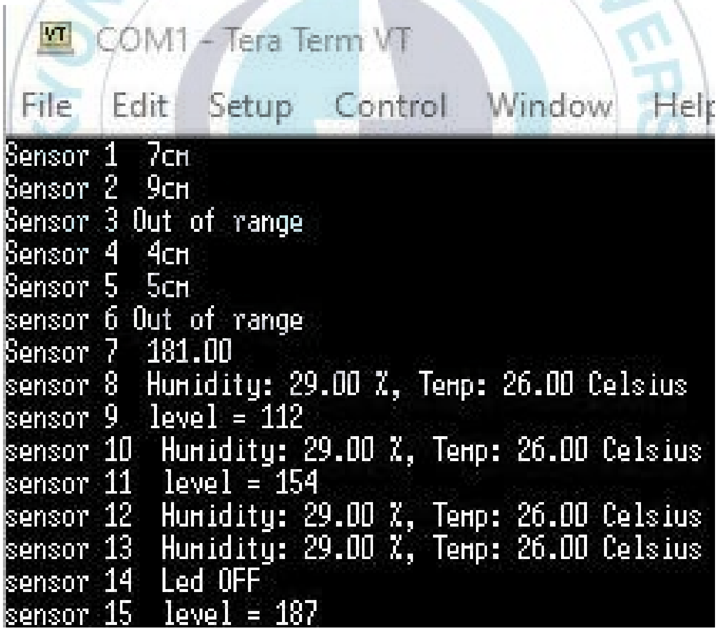

Figure 23. Sensors Results Displaying on Tera Term Terminal

A	B	C
Sensor 1 7cm		
Sensor 2 9cm		
Sensor 3 4cm		
Sensor 4 4cm		
Sensor 5 5cm		
sensor 6 Out of range		
Sensor 7 185.00		
sensor 8 Humidity: 29.00 %	Temp: 26.00 Celsius	
sensor 9 level = 92		
sensor 10 Humidity: 29.00 %	Temp: 26.00 Celsius	
sensor 11 level = 148		
sensor 12 Humidity: 29.00 %	Temp: 26.00 Celsius	
sensor 13 Humidity: 29.00 %	Temp: 26.00 Celsius	
sensor 14 Led OFF		
sensor 15 level = 193		

Figure 24. Data Converted to Spreadsheets

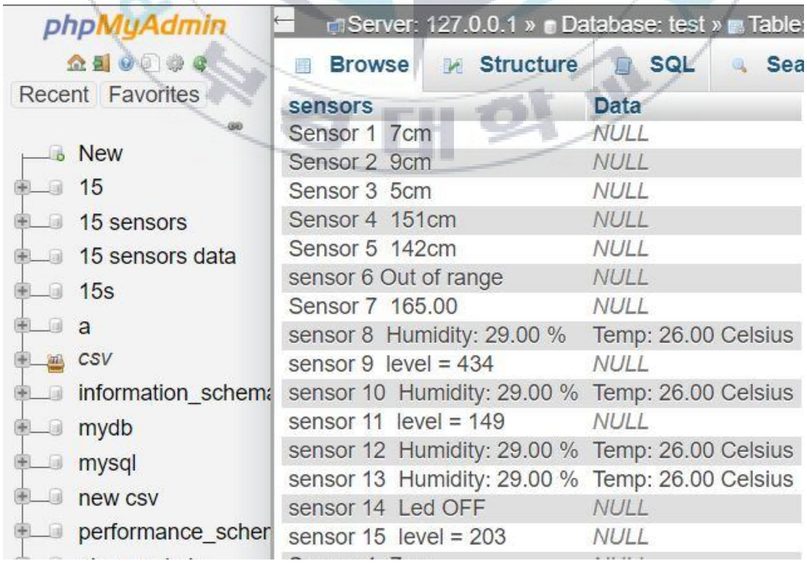

Figure 25. Sever Database Table

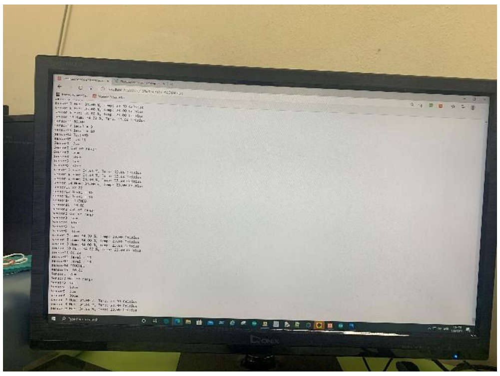

Figure 27. Data observed through computer 1 from the server

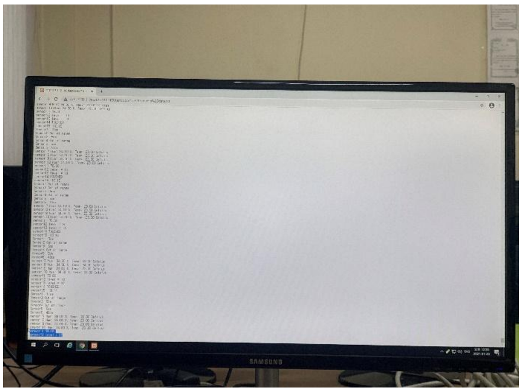

Figure 26. Data observed through computer 2 from the server

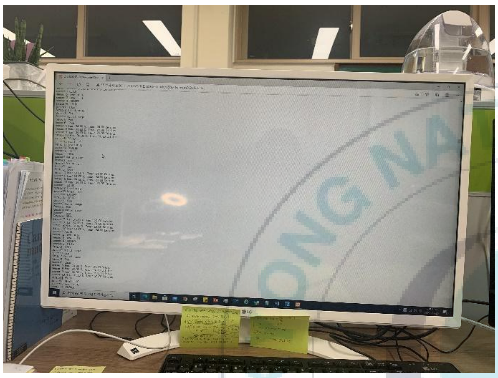

Figure 29. Data observed through computer 3 from the server

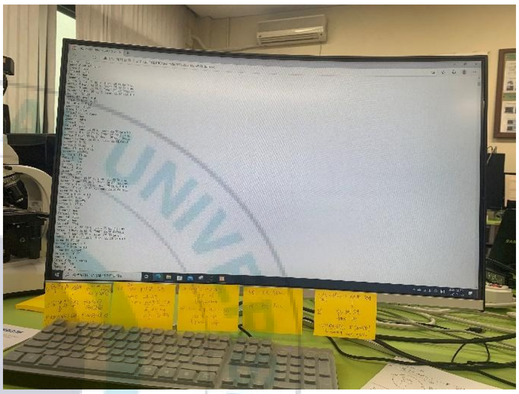

Figure 28. Data observed through computer 4 from the server

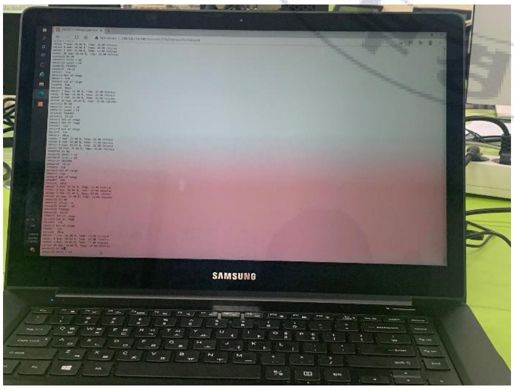

Figure 31. Data observed through computer 5 from the server

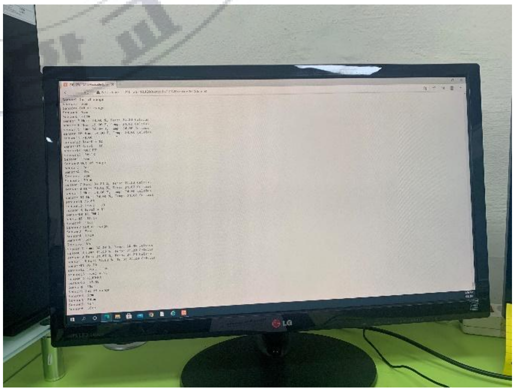

Figure 30. Data observed through computer 6 from the server

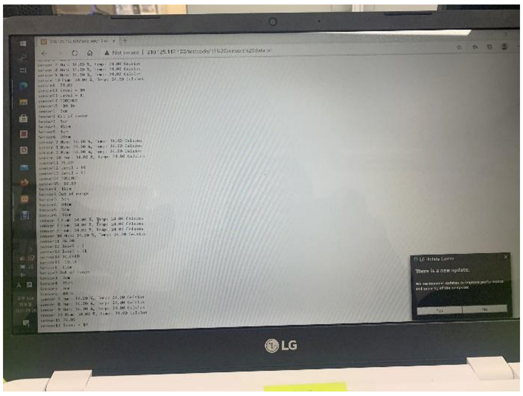

Figure 32. Data observed through computer 7 from the server

IV. Conclusion

we proposed a system that has both hardware and software part for data collection, processing and monitoring. The system has an ability to connect the micro-controller to web-server for monitoring and save the data to the database at a reasonable accuracy and real time as shown from the figures in the fourth section. The hardware part reads the physical data and post them to be recorded in the software part.

The whole system operates based on a local network and can access the database server remotely from multiple computers. Operators get sensor data information simultaneously and without delay. There will be no resource waste since the information saved in the database can be accessed at any moment using this framework.

This system low cost, low power consumption and is a convenient way to control real-time monitoring. Furthermore, it may be used to monitor indoor living conditions, greenhouse conditions, climate conditions, and forest conditions. These techniques have been shown to be a viable alternative to the traditional strategy of using manpower to monitor the environment, improving the performance, resilience, and efficiency of the monitoring system.

However, future development can extend the system to access the server based on IP and able to control several task.

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