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A Study on Cloud Platform for Multiple IoT Nodes with Enviormental Sensor

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Abstract: A new and rapidly expanding concept, the "Internet of Things" (IOT), has developed in recent years. To recover from the current financial and economic instability, the global economy has to establish new economic development growth spots. The Internet of Things (IoT) might greatly increase economic benefits and reduce costs. As a result, all related industries are growing at a breakneck pace. Multiple industries, including cloud server and IoT module manufacturing, are competing to provide the most effective system, device, and platform to back R&D and meet market demand. Because of this, IoT businesses are vying to prove themselves as the most trustworthy and capable in order to attract customers and generate revenue. Users at varying levels of expertise also need their own independent, trustworthy system. The goals are to design a cloud platform for multiple IoT nodes with environmental sensor are relevant to be apply on simple or even complex task based on demand of the usage. The system that been design are created having a reliable data communication within the system and were constructed with effective workflow.

Keywords: Internet of Things, NodeMCU ESP8266, Thingspeak

1. Introduction

Over the last decade, the notion of the "Internet of Things" (IOT) has emerged and grown at a fast pace. 10 years ago, when leaders in China and the United States declared a commitment to the growth of IOT, it finally began to get the attention it deserved. New economic development growth points are essential to reviving the global economy in the wake of the recent financial and economic turmoil [7].

MIT was the first to suggest the term "internet of things" (IOT) back in 1999. ITU (The International Telecommunication Union) published an annual report titled "Internet of Things" in 2005 at the "World Summit on the Information Society" (WSIS) in Tunisia, officially proposing the idea and expanding it [10].

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The "Internet of Things," also known as the "Sensing Network," is a network management and control system in which objects communicate with one another by means of embedded information sensing equipments like Radio Frequency Identification (RFID) tags, infrared sensors, global positioning system (GPS) receivers, laser scanners, and so on, which then link up with the Internet or a mobile telecom network to form a massive intelligent network capable of implementing intelligent object management [9].

The Internet of Things (IoT) has the potential to boost economic advantages and decrease expenses significantly, while also providing the 2 technological muscle needed to revive economies throughout the world. Alexander Resources predicts that by 2010, the M2M business will be worth $223.45 billion. The Internet of Things is predicted to become a $1 trillion business over the next decade.

Due to rapidly growth and demand in Internet of Things, all the corresponding sector are also developing like a greased lightning. Cloud server, IoT module manufacturing, and a lot more are trying to produce the best system, device and platform to support research and development to full field the demand. The vast usage of IoT leads to academic study been conduct to younger generation for them to explore as preparation for leading in future industry.

The industrial proponent is also demanding a simple but reliable system that need to be employ to complete the project or task. As the result, the IoT companies are competing to be most reliable and competent to capture the attention and making sales. At the same time, user in multiple layer from beginner to expert need to find their own reliable system. Thus, a simple, easy to understand, and reliable system that also can process multiple nodes of data from module need to be specify and test as for a suggestion for multiple layer of user use in their work or task.

There are three objectives to be achieve in this project: i. To identify the functionality of Internet of Things cloud platform in data collection and device management ii. To design a reliable data communication for multiple sensor nodes with environmental sensors using IoT cloud platform and propose effective development workflow iii. To evaluate the reliability of data communication between multiple sensor nodes to the use.

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2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study. A few papers are referred and studied to obtain the design of project such as, Design and Implementation of Internet of Things and Cloud Technology in Flood Risk Mitigation [1], Flood surveillance and alert system an advance the IoT [2], Flooding Forecasting System Based on Water Monitoring with IoT Technology [3], Real Time Flood Monitoring and Prevention Using IoT Sensors in Developing Countries [4], Real Time Flood Monitoring and Prevention Using IoT Sensors in Developing Countries [5], Sistem Internet of Things (IoT) Berbasis Cloud Computing dalam Campus Area Network [8].

2.1 Project Design

In order to attain the desired results, this project is separated into phases. Its purpose is to ensure that project development proceeds smoothly. Proper project planning is required to ensure that the job is completed on schedule. Figure 2.1 displays the process's several steps, which are as follows:

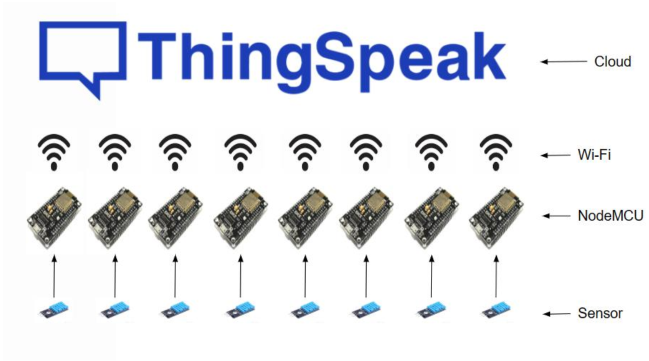


Figure 2.1: System Architecture

Figure 2.1 depicts the entire system process's system architecture. This system is divided into two parts, The first part is during data from sensors DHT11 are collected in NodeMCU and gateway is configured for cloud transmission.

In the second part, data transmitted from NodeMCU to Thingspeak by specified gateway set up are being allocated to designated chart. All 8 data from 3 difference NodeMCU are projected in Thingspeak with suitable chart. Figure 2.2 and 2.3 showing the Thingspeak layout and planned system flowchart

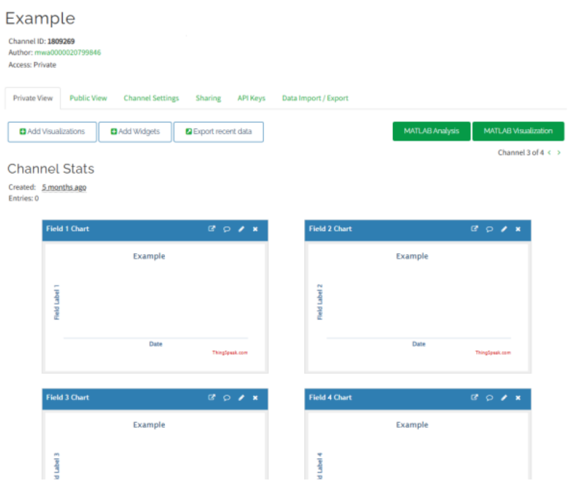


Figure 2.2: Thingspeak Layout

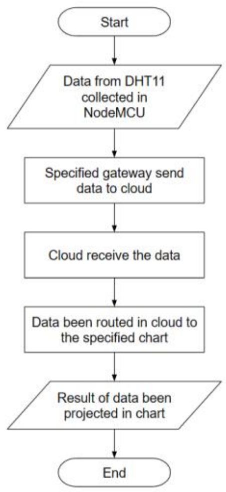


Figure 2.3: System Flowchart

2.2 Hardware Setup

The hardware and software components of the installation of IoT in gateway and cloud system are the two primary components. As a result, this section will go through the hardware in greater depth. The hardware design of the gadget comprises the device's base and body. All of the circuits will be connected to it, as well as the circuit holding the microcontroller circuit, which serves as the device's brain. This system's microcontroller is an NodeMCU ESP8266. This section contains a brief summary of the components utilised in this project based on study and deliberation [10]. Before beginning to develop the device's hardware, Table 2.1 shows a number of key components for the device's electronic circuits.

Table 2.1: List of Hardware

No.	Component	Function	Unit
1	NodeMCU V3 ESP8266	Act as microcontroller	8
2	DHT11 sensor	To obtain the data about surrounding temperature	8

Due of sensor are connecting to single NodeMCU the connection of data input need to be allocated to avoid the problem and proper management [6]. Table 2.2 shows a connection for the device's electronic circuits. Figure 2.4 are showing the result of hardware connection.

Table 2.2: Hardware Data Connection to NodeMCU

No of NodeMCU	DHT11 Sensor	PinOut Used
First NodeMCU	Data	D1
	Positive Point	3V3
	Negative Point	GND

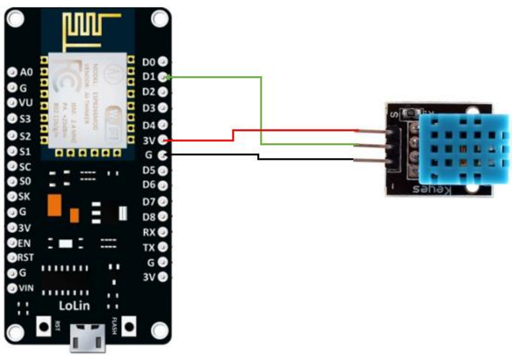


Figure 2.4: Hardware Connection

2.3 Software Setup

The software development phase follows the hardware development phase. Because the microcontroller utilised in this phase is an NodeMCU V3 ESP8266, the software that will be used is the Arduino IDE, as illustrated in Figure 3.3. The system's programming is integrated to guarantee that the system runs smoothly. It is used to programme and upload Arduino boards. The IDE's source code is available under the GNU General Public License. The Arduino IDE supports the programming languages C and C++ by employing unique code organisation conventions. The Arduino IDE includes a software library from the Wiring project that includes a variety of standard input and output processes. With the GNU toolchain and the IDE distribution, user written code only requires two fundamental functions, initiating the sketch and the main programme loop, which are built and linked with a programme stub main () into an executable cyclic executive programme. The Arduino IDE uses the software to convert executable code to a text file in hexadecimal encoding, which is then loaded into the Arduino board by a loader programme in the board's firmware.

2.3.1 Installing & Setting Up Arduino IDE

Installing Arduino IDE and set it up to desired configuration is important to make it useable.

2.3.2 Important Keyword in Software Configuration

During the software build there is some declaration need to be done to make sure every task needed to be complete.

2.3.3 Nodes Differentiation

In this project are using 8 nodes so all nodes need to be differentiate to able the record their own data then transferring to their own respecting field of data to be project. In Thingspeak every field can be used to store a data. The configuration that need to be done in void loop:

```
postStr +="&field3=";
```

The number 3 need to be change based on selection on field.

2.4 Thingspeak Setup

During the Thingspeak build there is some setting need to be done to make sure every data been routed to correct path and produce the right chart. Here list of setting that important to apply that showed in figure 2.5:

1. Cloud naming and description and field set up

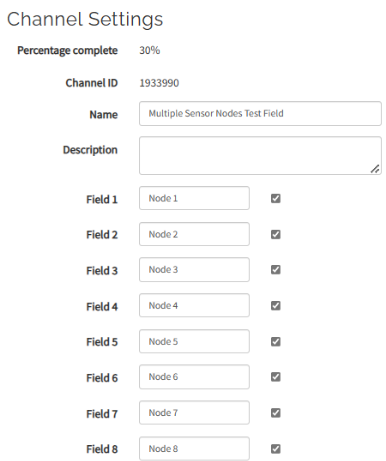


Figure 2.5: Thingspeak Set Up

2.5 Reliability Test

The test is conducted to measure the reliability of system to keep consisting sending data to cloud and display it. Consistency is important due to demand of new fresh data in every desired interval for situation observation and be able to response as fast as they can to certain condition that occurred. Thingspeak have a function to print out 100 intervals of data in the spreadsheet format (CSV). By using this function, we decide to test the reliability. We will consider the system will have latency if they have more than 3 minutes of no data been upload to Thingspeak channel from 4 nodes. We count the amount of times the data that have latency and calculate the amount of percentage of it happening

$$Reliability = 100\% - (Amount\ of\ latency \frac{3\ minute\ without\ data}{The\ amount\ of\ data\ that\ been\ send} * 100\%$$

3. Results and Discussion

After the system has been effectively constructed, the analysis will be performed to establish whether all of the system's components are operational. The study includes the electrical and mechanical components, as well as the challenges and issues encountered throughout the development process. A few tests have been carried out in this project to guarantee that the project's objectives are met. Troubleshooting is done in stages until a solution is found. The experiment aids in identifying any component difficulties that may arise in order to assess the project's appropriateness. After the project was completed successfully, an analysis was performed to confirm the efficacy of this system. This study is required to assess the project's abilities, weaknesses, benefits, drawbacks, circuit function, and programming challenge. The collected data will be converted into tables and charts for simple evaluation and analysis.

3.1 Effective Workflow

In this part, the theory in methodology are being tested to decide that does it can be used practically during project that been showed in figure 3.1.

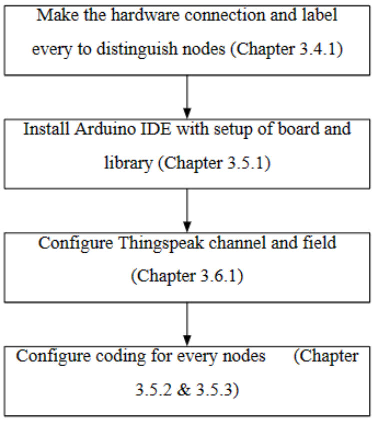


Figure 3.1: Effective Workflow in Multiple Node Connection

3.2 Hardware and Coding Result

The nodes connections have been carefully managed and to avoid of confusion every it has been labelled. Multiple checks have been performed on the connection in order to exclude the possibility of a missed connection, which might result in damage to the DHT11 environmental sensor. Figure 3.2 and 3.3 are showing the setup of hardware connection of 8 nodes.

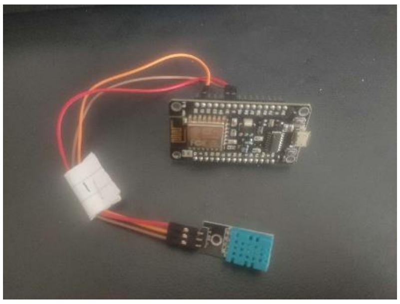


Figure 3.2: Hardware Connection 1

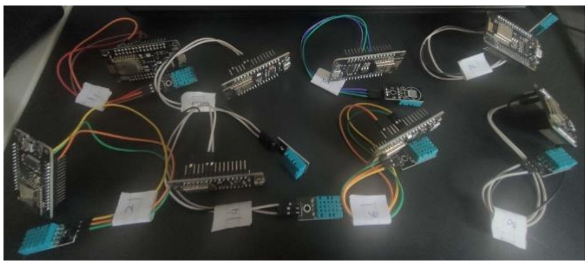


Figure 3.3: Hardware Connection 2

After the connection are been done the process of coding making been conducted with designated field of every node. All the library is checked again before conducting for avoid any failure due to unavailable resource. The connection of network and channel Thingspeak been specified to be able projecting the data to each field. All the coding is being compile and export into NodeMCU with blinking light command been address to show that nodes are powered and ready to be use. All this step and command been done to all nodes. Figure 3.4, 3.5, 3.6 are proving the coding are working as intended.

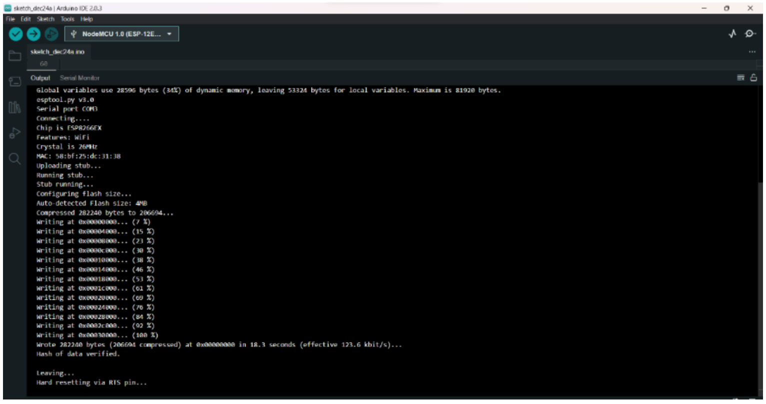
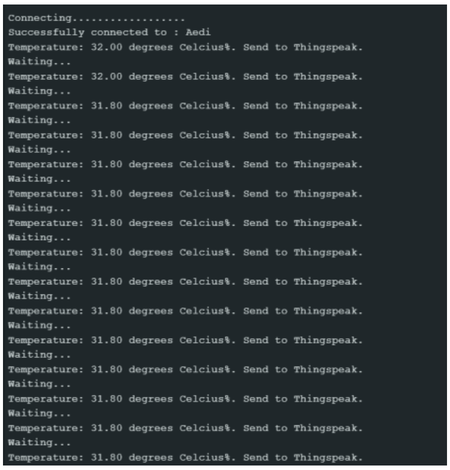


Figure 3.4: Exporting Command to Nodes



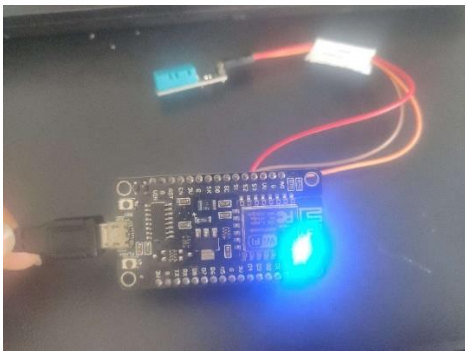


Figure 3.5: Response in Serial Monitor **Figure 3.6: The Node are being Powered**

3.3 The Thingspeak Result

After configuration of hardware devices with each designated coding the data should be in the Thingspeak and we need to check is there any data in every field in the channel. Before that every field need to be set up and show the information that are required. The channel need to be configure to be able to projecting 8 data field. Then every field to been set up to show the correct title, x and y axis also the maximum amount of data that be able to been show based on preference. Figure 3.7 and 3.8 are channel and field setting for every node involved. Meanwhile figure 3.9 – 3.13 are result for 8 field of data.

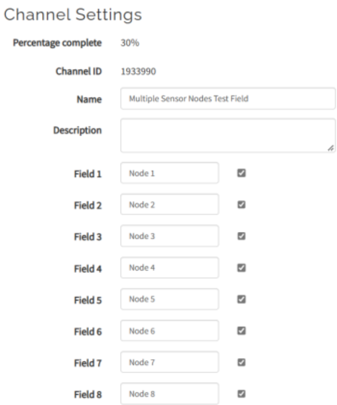


Figure 3.7: Channel Setting

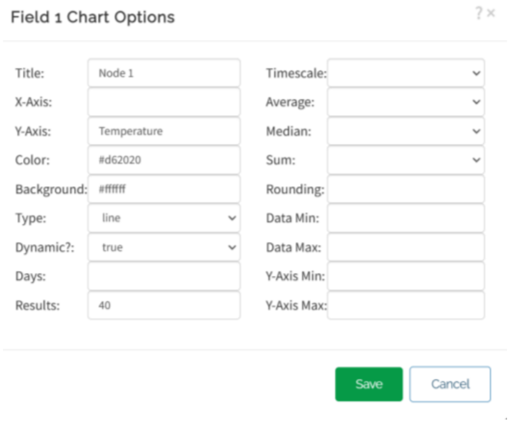


Figure 3.8: Field Setting

After the set up every field are been observed to making sure that every nodes be able to project their data.

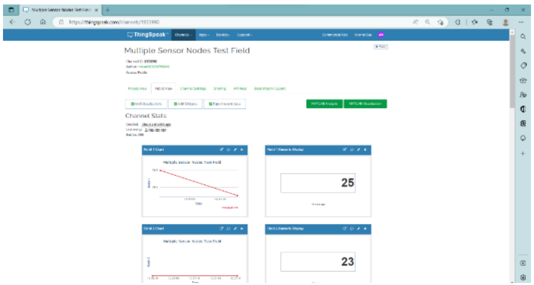


Figure 3.9: Channel Page

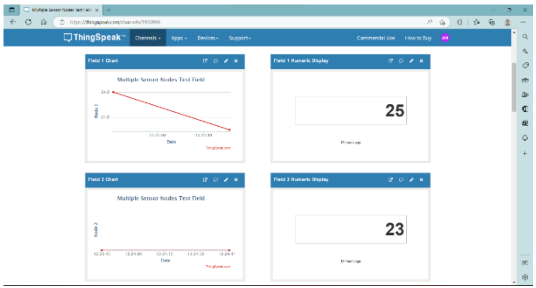


Figure 3.10: Field 1 & 2

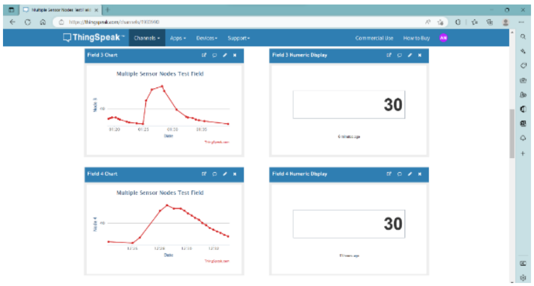


Figure 3.11: Field 3 & 4

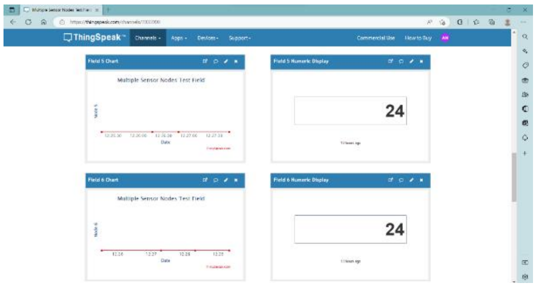


Figure 3.12: Field 5 & 6

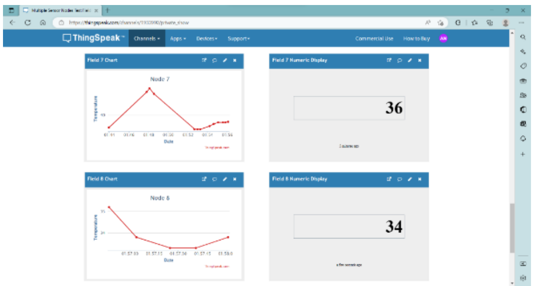


Figure 3.13: Field 7 & 8

3.4 Reliability Test Result

In this part, the reliability of system is being tested for every latency (3 minute/180 seconds without data) and percentage of it occurred. We try to define the possible of reason that affect the latency and suggestion of solving it. The test been conduct using 4 nodes (node 2,3,4,5). The result is being attach in appendix(D). The time of every interval are been calculated for each node the first interval been counted from first data received to the second data, meanwhile last data been counted from second last data to last data received from nodes. Below is the way that are used for checking the reliability, 100% is higher reliability.

$$Reliability = 100\% - (Amount\ of\ latency \frac{3\ minute\ without\ data}{The\ amount\ of\ data\ that\ been\ send} * 100\%$$

Node 2: 26 intervals Node 3: 22 intervals Node 4: 24 interval Node 5: 24 interval

Table 3.1: Nodes Latency

	Node 2		
No	Time of First Data	Time of Second Data	Time Gap(s)
1	2023-01-12 12:28:10 UTC	2023-01-12 12:31:17 UTC	187
2	2023-01-12 12:38:43 UTC	2023-01-12 12:42:50 UTC	247
	Node 3		
No	Time of First Data	Time of Second Data	Time Gap(s)
1	2023-01-12 12:29:04 UTC	2023-01-12 12:35:04 UTC	360
2	2023-01-12 12:42:32 UTC	2023-01-12 12:45:49 UTC	197
3	2023-01-12 12:47:25 UTC	2023-01-12 12:50:37 UTC	192
	Node 4		
No	Time of First Data	Time of Second Data	Time Gap(s)
1	2023-01-12 12:44:41 UTC	2023-01-12 12:47:44 UTC	183
	Node 5		
No	Time of First Data	Time of Second Data	Time Gap(s)
1	2023-01-12 12:44:10 UTC	2023-01-12 12:52:35 UTC	505

Node 2 Reliability = 100% - (2/ 26) *100% = 92.31%

Node 3 Reliability = 100% - (3/ 22) *100% = 86.36%

Node 4 Reliability = 100% - (1/ 24) *100% = 95.83%

Node 5 Reliability = 100% - (1/ 24) *100% = 95.83%

Average reliability = (Node 2 +3 +4 +5)/4 = 92.58%

For node 2, we able to collect data consisting 26 intervals and 2 of them are have a huge latency of 187 and 247 second which resulting to 92.31% of reliability. For node 3, we able to collect data consisting 22 intervals and 3 of them are have a huge latency of 360, 197 and 192 second which resulting to 86.36% of reliability. 40 For node 4, we able to collect data consisting 22 intervals and 1 of them are have a huge latency of 183 second which resulting to 92.31% of reliability. For node 5, we able to collect data consisting 22 intervals and 1 of them are have a huge latency of 505 second that are the highest time of latency that occurred during this whole study which resulting to 92.31% of reliability. The average of reliability is 92.58%. This number is can be considered high and prove this system that been apply are reliable to send data to cloud at least every 3 minutes with 92.58% of times data been transferred within 3 minutes.

This result is obtained with consideration of possible latency effecting manipulator which is stability and strongness of network connection. The stability and strongness of network connection are manipulated by multiple reason such as type of connection wired or wireless like been used in this study, distance between nodes and network provider, physical obstacle or any disturbance occurred due to there is multiple wireless connection device at surrounding which able to interface the connection making a latency.

The solution or improvement of case study can be held with idea of reducing the amount of factor that can disturb the study which lead to latency and drop the efficiency and reliability of the system. The study can be held with the consider of distance between nodes and network provider to be shorter or even use wired connection, reduce the amount of obstacle and wireless connection in are that can be effecting the result.

4. Conclusion

The design of a study on cloud platform for multiple IoT nodes with environmental sensor are relevant to be apply on simple or even complex task based on demand of the usage. The system that been proposed in this paper using NodeMCU ESP8266 using Thingspeak as cloud server, be able to offer sufficient detail about important and emerging aspects that been demanded in developing IoT industry.

Along this study 3 main aspect on deciding a good IoT system able to be provided which is fog/edge computing support, IoT computation topology management, and IoT visualisation systems. The concept that been commercialise by Thingspeak are very user friendly and be able to be used by multiple layer of user, from academic study to expert in industry.

During the test of reliability, by conducting using 4 nodes we obtain the result of average is 92.58%. This number is can be considered high and prove this system that been apply are reliable to send data to cloud at least every 3 minutes with 92.58% of times data been transferred within 3 minutes.

Throughout this study, we also can define the improvement of case study can be held with idea of reducing the amount of factor that can disturb the study which lead to latency and drop the efficiency and reliability of the system. The study can be held with the consider of distance between nodes and network provider to be shorter or even use wired connection, reduce the amount of obstacle and wireless connection in are that can be effecting the result. Also this Study can be conducted in various situation to obtain the on field test and result

Acknowledgement

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