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Original Research Paper

IoT Water Level Monitoring System

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Abstract: In the era of globalization today, especially in Malaysia, the Malaysians are often busy with their career and forgot their responsibility to take care the water container or pail at their home which they used to fill water in. This research is designed to solve the problem by detect the level of water inside a container. It also give notification when the container was full. This research also designed to make easier to turn off the water tap whenever the container is filled up. Through this research, it also helps people surrounding to keep them remind about the level of water. The development of this research is using Arduino and Blynk application.

Keywords: Arduino, Blynk App, Internet of Things, Water Level Detector.

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1. Introduction

This research IOT Water Level Monitoring system is a very innovative system which will inform the users about the level of water and will prevent it from overflowing. The water level monitor system introduced order to prevent water overflow. Besides that, with the help of Iot devices such as water level monitoring system, users can monitor and manage their water level anytime and from anywhere through the internet. Moreover, it is a real time based water level monitoring system to send the data about the water level to the users on time to time by using application and display different colors of light based on the water level. The thing that I improvised in my research is notification and buzzer, siren and beep sound to notify the water level to user [1].

Water source is fundamental for all and a significant factor in agriculture, cultivating and it's a key for nature of our life. Monitoring water level of a water supply, For example, Water tap, Lakes, River, Waterways and Pond etc., plays a major part in home, country, rural and agricultural. Even it's helpful for our everyday needs. This report proposes a prototype system design, implementation and description of needed devices and technologies to improve Internet of Things (IoT) based water level monitoring and keep track of frequent water level in pails, rivers, waterway, lakes and ponds which can be implemented in future Malaysia.

There are several objectives that have been identified in order to achieve the aim of the research. The objectives of this research are:

1. IOT based Water level monitoring research enables the user in level detection of any water and continuously monitor it over the internet.
2. Provide reliable water level monitoring system for users.
3. Make users able to update the users on the current situation of the container, thus enabling the users to take appropriate actions based on the data received.

2. Literatur Review

2.1. Internet of Things

Internet of Things (IoT) is involved in all aspects of human life, work, health and social areas, which will have a significant impact on the future development of the global economy society. Perception and recognition technology is the basis of the IoT and data fusion and anti-collision technology are the sensor network and radio frequency identification research focus [2]. Because current definitions of IoT invariably imply a similar approach to the high-level architecture of a system, the ubiquitous use of the term IoT refer to the use of digital techonologies in industry is unhelpful as it hinders the analysis of alternative system architectures, including the location and the nature of the data or information processing and associated performance and security issues [3].

The previous method was to send data or instructions to the IoT device from a central device, through a user name and password authentication mechanism. However, most IoT devices are used by non-technicians who may not modify the default factory username and password. In recent years, hackers have launched several major network attacks using this vulnerability [4].

Some of the interesting research using IoT can be seen below:

- Zariman, et al [5] develop a garbage monitoring using Arduino and ESP WiFi that can be used in the garbage management system in the city.
- Azahar, et al [6] develop intelligent egg incubator using Arduino Uno, PIR Sensor, and ESP8266 that can be used to control the temperature of the incubator.
- Ismail, et al [7] develop smart water level indicator using Arduino Uno, Servo Motor, and NodeMCU ESP32 that can be used to provide early warnings and control the dam of the river.
- Husin and Hisham [8] develop smart charger that can be used to control the charging time to preserve battery lifetime.
- Latif, et al [9] develop smart mirror using Arduino Uno, Raspberry Pi 3, and NodeMCU that can be used to provide latest news updates while the user do activity in front of mirror.
- Ghani and Zariman [10] develop smart cane to help provide safe navigation for user with vision disability.
- Hazhari, et al [11] develop smart delivery that help delivery items faster.
- Azizi and Zariman [12] develop health display based on ESP 8266 NodeMCU and pulse sensor to help display pulse rate.
- Saidatin, et al [13] develop automate feeder using ESP 8266 to help feeding birds.

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- Hermansyah, et al [14] develop a remote monitoring and control system to switch main energy source to backup when main source goes out.

The work process of IoT can be broadly divided into data collection, data transmission, data processing and service, according to these three different processes, its architecture is divided into perception layer, network layer and application layer [15].

2.2. Flood Warning Systems

Natural hazards such as floods, storms, tsunamis and others pose a significant threat to lives and property around the world. Historical records have shown that flood is the most frequent natural hazard, accounting for 41% of all natural perils that occurred globally in the last decade. In this period alone (2009 to 2019), there were over 1566 flood occurrences affecting 0.754 billion people around the world with 51,002 deaths recorded and damage estimated at $371.8 billion. The global impact of a flood would be more alarming if these statistics incorporated other numerous small-scale floods where less than 10 people may have died [16].

This study provides an opportunity to update readers on recent advancements in flood monitoring, and how technology is used in the literature to map the flood events [17]. There is a lot of options for how to monitor water levels. There are many hardware manufacturers and various technologies available. There is common IoT water sensors you can choose, which are:

- Ultrasonic Level Sensors
- Pressure transducers
- Radar level sensors.

For everything from robots and a heating pad hand warming blanket to honest fortune-telling machines, and even a Dungeons and Dragons dice-throwing gauntlet, the Arduino can be used as the brains behind almost any electronics research [18].

2.3. Component of Equipment

2.3.1. Arduino IDE

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring research, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware [19].

2.3.2. Water Level Sensor

Water Level Sensors are used to detect the level of substances that can flow. Such measurements can be used to determine the amount of materials within a closed container or the flow of water in open channels [20].

2.3.3. Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistor are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses [21].

2.3.4. LED

In the simplest terms, a Light-Emitting Diode (LED) is a semiconductor device that emits light when an electric current is passed through. Light is produced when the particles that carry the current (known as electrons and holes) combine together within the semiconductor material. Since light is generated within the solid semiconductor material, LEDs are described as solid-state devices. LEDs are comprised of compound semiconductor materials, which are made up of elements from group III and group V of the periodic table (these are known as III-V materials). Examples of III-V materials commonly used to make LEDs are gallium arsenide (Gas) and gallium phosphide (GaP).

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2.3.5. Jumper Wire

A jumper wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jumper wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or piece of test equipment. Jumper wires typically come in three versions: male-to-male, male-to-female and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into tings, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often [18].

2.3.6. USB Type-B Cable

One of two standard USB connectors, the USB Type-B connector (technically known as a "Standard B" connector) is roughly square in appearance, with a square protrusion on top. Type-B ports are found on many USB non-host devices. Typically, the type-B connector is the other end of a standard USB cable that plugs into peripheral device. It is also known as type B-male. On the peripheral device, the USB port is called type B-female [22].

2.3.7. NodeMCU (ESP 8266)

NodeMCU is an open source LUA based firmware developed for ESP8266 Wi-Fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Expressive Systems with TCP/IP protocol [23].

2.3.8. Micro USB Cable

The Micro USB cable allows you to connect your NodeMCU to your computer for programming. It also supplies power to the device. The NodeMCU only works with specific cables. Some USB cables are 'charging only', and have only 2 wires inside, meaning they can only provide power and can't transfer data. Cables with 4 wires can transfer data, which is what we need. In addition, you need a cable that can provide enough current to power the NodeMCU. Look for a high quality, high speed, CE certified USB 2.0+ cable with at least 1 Amp of current and thickness of 28 AWG [24].

2.3.9. Buzzer

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Son alert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off [25].

3. Methodology

A methodology does not set out to provide solutions – it is, therefore, not the same thing as a method. Instead, it offers the theoretical underpinning for understanding which method, set of methods or best practices which can be applied to specific case [26].

Prototyping is used to allow the users evaluate. Prototype methodology is defined as a Software Development model in which a prototype is built, test and then reworked when needed until an acceptable prototype is achieved. At this stage, there is a reasonable understanding of the system and its needs are unclear or likely to change. Based on the feedback, the initial requirements are modifies to produce that final requirements specification, which is the used to develop the production quality system. Figure below shows the phases of the prototype methodology [27].

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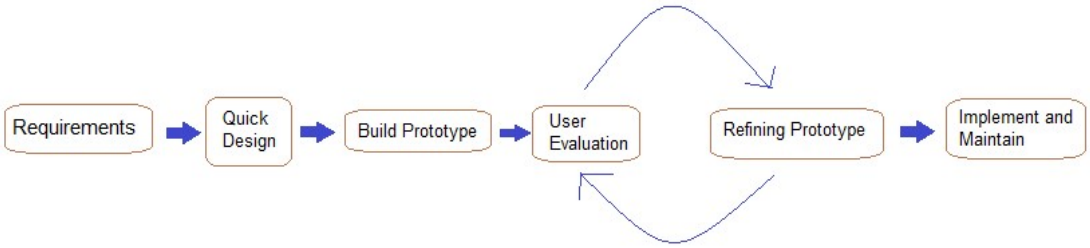

Figure 1. Prototype Model

The methodology that has been chosen for this research is the Prototype methodology. The reason why this methodology was chosen is because the basic idea in this methodology is that instead of freezing the requirements before a design or coding can proceed, a throwaway prototype is built to understand the requirements. This prototype is developed based on the currently known requirements. Prototype methodology is a software development model. By using this prototype, the client can get an "actual feel" of the system, since the interactions with prototype can enable the client to better understand the requirements of the desired system.

Prototyping is an attractive idea for complicated systems for which there is no manual process to help determining the requirements. It is an iterative, trial and error method which take place between the developer and the client.

3.1. Quick Design Phase

The second phase is a preliminary design or a quick design. In this stage, a simple design of the system is created. It gives a brief idea of the system to the user. This phase helps in developing the prototype. The figures below shows sketch diagram and schematic diagram of the research.

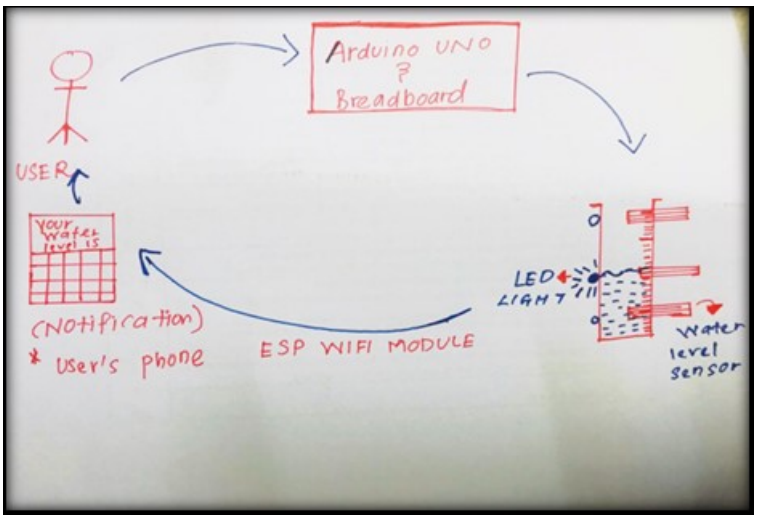

Figure 2. Sketch Diagram

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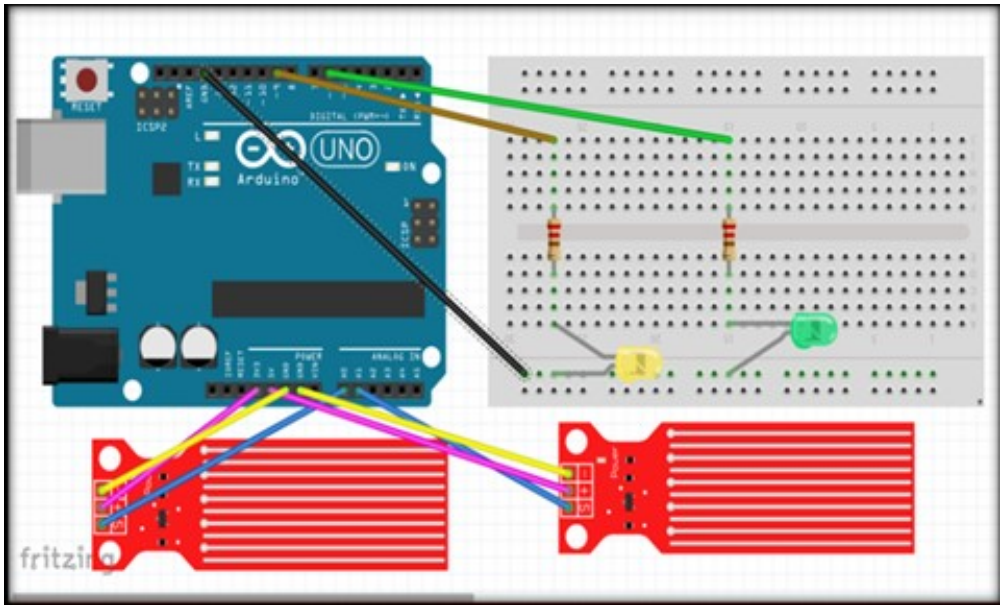

Figure 3. Schematic Diagram: 1

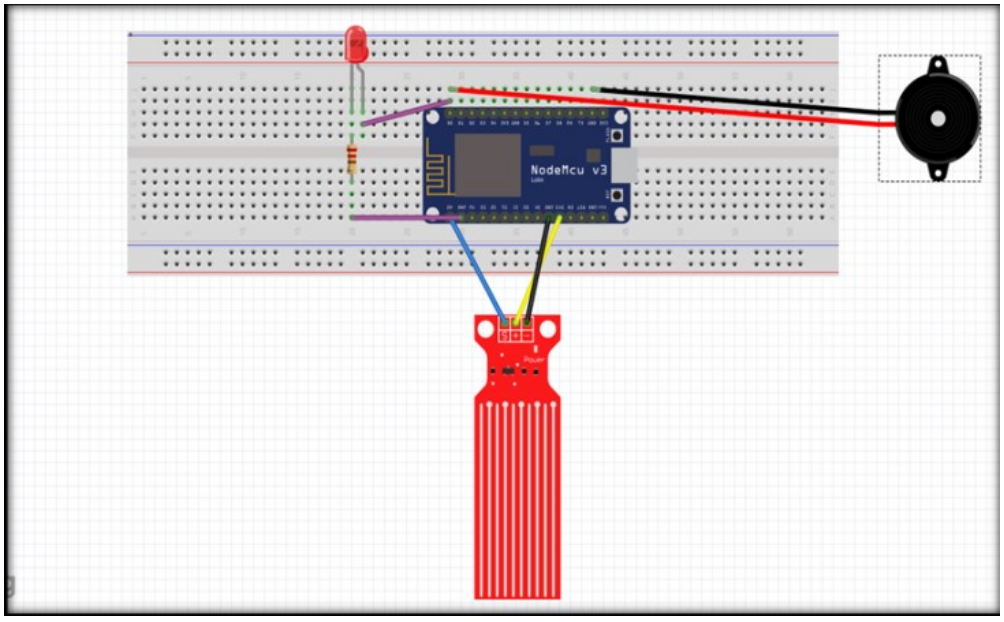

Figure 4. Schematic Diagram: 2

3.2. System Requirement

For the prototype to be used efficiently, it needs certain hardware components or other software resources to be present on a computer. The selection of the hardware also can saves time and cost during the prototype development. The appropriate hardware and software are important as to ensure that the product will be developed id fulfil the user requirements and not experiencing any problems. There are two types of system requirements that will be focused on this sub-chapter, which are hardware requirement and software requirement.

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3.2.1. Hardware Requirement

A list of hardware requirements for developing proposal application is shown in Table 1.

Table 1. Hardware Reuirement

Hardware	Specification	Description
Processor	Intel® Celeron® 3550 CPU @ 1.10 GHz	Indicates how fast computer performs certain functions.
RAM	4.00 GB	Stores information on the computer including files and software programs.
Operating System	Microsoft Windows 10 Pro (64-bit)	The latest operating system is the requirement of many online programs.
Input Device	Keyboard Mouse	Input device to enter data.
Arduino	Arduino Uno R3	Arduino is and open source electronic platform based on easy-to-use hardware and software.

3.2.2. Software Requirement

A list of software requirements for developing proposal application is shown in Table 2.

Table 2. Software Reuirement

Software	Specification	Description
Cross-platform Application	Arduino IDE	It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.
Application Platform	Blynk	It is a digital dashboard where developer can build a graphic interface for their research by simply dragging and dropping widgets.
Free open source Platform	Thinger.io	Things platform designed to vertical applications. It has been designed with the developer in mind, so it is really easy to create.

3.3. Build Prototype Phase

In this phase, an actual prototype is designed based in the information gathered from quick design phase. It is a small working model of the required system. The prototype that will be build must match all the requirement that have already documented earlier to avoid untallied between document and the prototype.

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3.4. Development Method

Steps used as follow:

Step 1 **Components Required**

You will need the following materials for making your own IoT water level monitoring system.

- Arduino Uno
- Breadboard
- LED (red, green, yellow)
- Buzzer (x1)
- Jumper wires (male to male)
- Water level sensor (x3)
- 220 ohms resistor (x3)

Step 2 **Assemble the LED on breadboard**

Use LED of 3 different colours for indicating the water level. In my case, I used RED (indicating extremely high level), YELLOW (indicating half water level), and GREEN (indicating low water level). Connect the cathode of each led to power rail (blue rail) on breadboard which would be the ground supply. At the same time, connect the anode of LED's to different nodes and connect 220 ohms resistor in series with each LED.

Step 3 **Make Connections with Arduino and LED**

Make connections for LED with digital pins on arduino as follows:

- YELLOW = Digital pin 6
- GREEN = Digital pin 9

Step 4 **Connect the Water Sensor with Arduino**

Connect the two water level sensors to arduino as follows:

- Water Sensor pins = Arduino pins
- (-) = GND
- (+) = 5v
- S = A0

Step 5 **Connect the highest Water Level Sensor with NodeMCU**

- Water Sensor pins => NodeMCU pins
- (-) => GND
- (+) => 3v
- S => A0

Step 6 **Make connections for LED and Buzzer with digital pins on NodeMCU as follows:**

- Red = D0
- Buzzer = D0
- Ground the cathode of the LED and black wire of the buzzer which is (-)

Step 7 **Verify the sketch**

Verify the sketch to your Arduino uno and NodeMcu using the Arduino IDE.

Step 8 **Setup your Bylnk application**

Register to bylnk application using e-mail and you will receive a token through e-mail from Bylnk. After login the application you have to create a new research and drag the notification icon from widget.

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Step 9 **Upload the sketch**
Upload the sketch to your Arduino uno and NodeMcu using the Arduino IDE.

Step 10 **Done, start experimenting**
Start experimenting the research and you will see light display of from the LED, alert from buzzer and notification to your phone from Bylnk application.

4. Finding and Discussion

Implementation is made up of two parts, namely device implementation Hardware and Software implementation.

4.1. Hardware Implementation

Hardware implementation involves the use of the device being used. Know your device's workflow from a microcontroller for reading sensors, relay control and data transmission to the server. Prototype the system has been made visible in Figure 5.

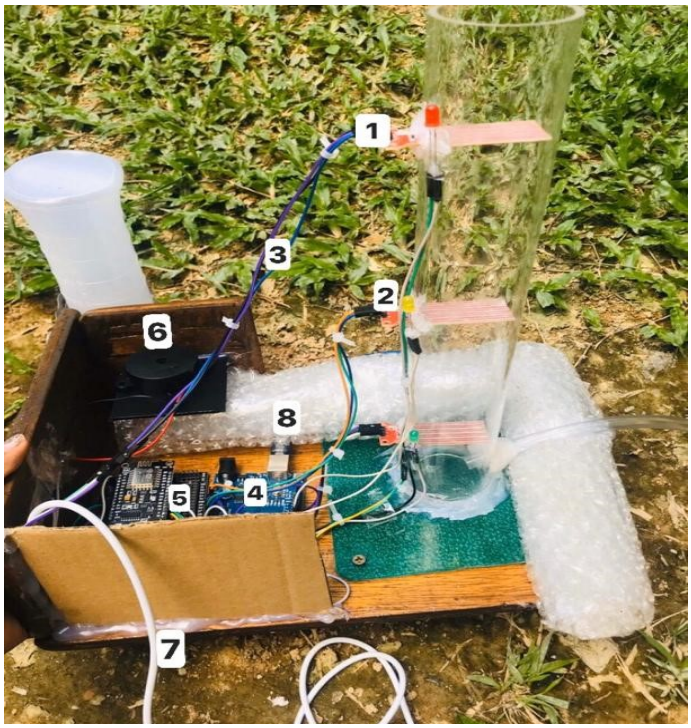

Figure 6. System Prototype

Explanation:

1 3 Water level sensor
2 Led (3 different colors)
3 Jumper wire (male to male, male to female, female to female)
4 Arduino Uno
5 NodeMcu (ESP 8266)
6 Buzzer
7 Micro USB cable
8 Arduino cable

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4.2. Software Implementation

Software implementation is intended for deployment and use applications into the system. Software Configuration with *Arduino Program.*

Figure 7. Arduino

4.3. Database

Thinger.io is an Internet of Things platform designed for building vertical applications. It has been designed with the developer in mind, so it is really easy to create IoT solutions from scratch. This is the database software which I worked with and this platform can be freely deployed in your own cloud using Ubuntu Core, have Sigfox integration, and can be connected to other microcontrollers or systems for real-time sensing and actuating over a REST API.

The main features of the platform are:

1. Full device management and API interaction; endpoints for interacting with third party services or sending notifications
2. Data buckets for storing and exporting information
3. Access management for granting to access your devices and data from other applications, and
4. Dashboards for real-time data visualization.

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4.4. System Testing

Figure 8 shows the final product of the IoT Water Level Monitoring System.

Figure 8. System Testing

4.5. Evaluation Testing

An evaluation survey using Google Doc and those who have been tested the application had answered this survey. Figure 9 showsthe questions and responses from the Evaluation survey.

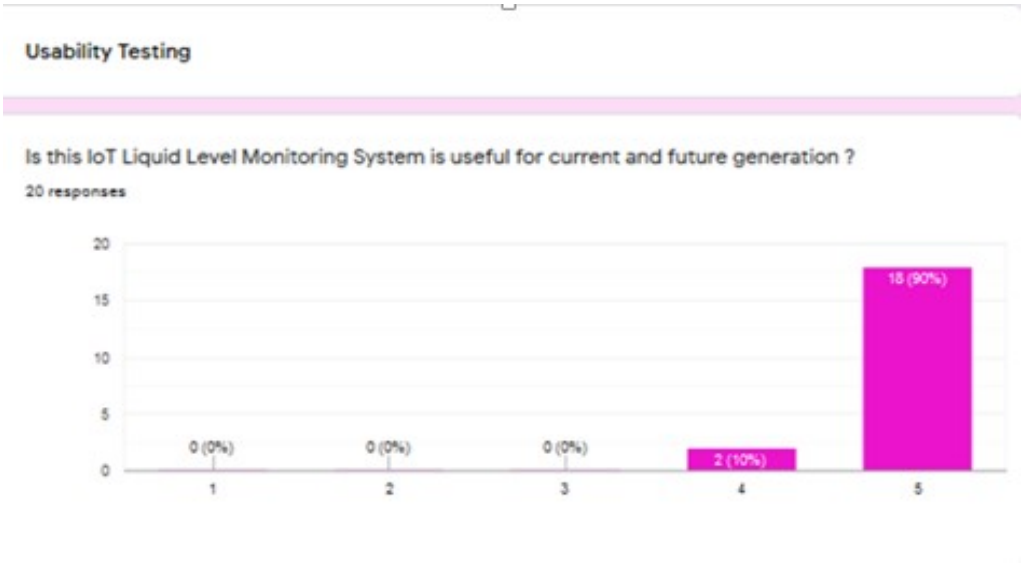

Figure 9. Usefulness of the Application

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4.6. Problems and Solutions

Table 3 shows the problem and solution during the developing.

Table 3. Problem and Solution

Problems	Solutions
Bought low ohm resistors (200ohm)	Bought the required component (220ohm)
Parcel took so long to reach me since the parcel is from china.	Borrowed the particular components from my friends.
LED burned since it is turned on for too long	Replace with a new LED
NodeMCU ESP 8266 reset automatically after uploading it into the sketch and it is damaged	Bought a new NodeMCU and replaced it.
Pouring the water from upwards causes all the LEDs to turn on	Drilled a hole below the sensors for hose and pour the water from the hose.
Could not find a very small funnel to pour the water through the hose	Bought a small plastic sos container and cut into two. Insert the upside of the container into the hose and backside of the container to pour the water in.
Always facing water leakage problem	Used silicone glue to fixed it
People can see the board and the components straight away and comment about that.	Drilled a wooden pallet and attach in the side and front so that people cannot see through the components.
After applying so much of flue the hose become ugly	Decided to put some decorations on the glue so that can hide the flaw of the container.
Connecting thinger.io with my research	Watched many Youtube videos and combined thinger.io code with bylnk code
Hose cannot be glued since the hose is always in use	Take all the glue out and glued again and dried it for 3 days.
All the components are messy on the table	Designed a board for components which is maded from wood and fixed it.
The water level container could not bought it from shop. It is not ready made	Bought a cylinder and base for the cylinder separately and glued it both.
The container is separated from the components since I fixed the components in board.	Drilled the container onto the board and make all the components and container together.
The hose's funnel is separated from the board	Made a place for the funnel in board to hang on so that easy to use whenever it is needed.
The newly bought nodeMCU ESP 8266 is v3 which means bigger than the breadboard so that could not insert some wires and lack of pins in breadboard.	Bought a new NodeMCU baseboard for fix the nodeMCU ESP 8266 onto the baseboard.
Since I used three sensors, many wires are required to use and after fixed all the wired the board looks clumsy and messy	Used cellphone tape and few materials to organize the board and make it neater.

5. Conclusion

As the system for the research has been completed, the objectives of the research have been achieved. All the phases that involves are need in order to achieved the research aims and objectives will be describes in the next few paragraphs. The first objective of this research is to prevent the water overflow. There are several activities that have been done to achieve the first objective. The activities are gathering the requirements, analyze the requirements and lastly document the requirement. All of the activities are done by interacting with distribute the questionnaire, observing the existing application and reviewing the existing documents resulting in delivering the

deliverables for the first objective. Next, to design the suitable diagram for the guideline in development phase. After all requirements had been collected, it must be proceeded to design phase where the development team can have the guideline on how to build the research and meet the requirement. The next objective of this research is to develop a complete system. As the system is completed, the final objective is achieved. Lastly, the research that have been made must be test to ensure the requirement that been gathered earlier had been reached to give full satisfaction to the user who use IoT Water level monitoring system.

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