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Application of IoT for Filling and Monitoring Water Tanks Using NodeMCU ESP8266 and MQTT Protocol

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ABSTRACT

In this research, a system has been designed that aims to prevent water wastage every time you fill a water reservoir. The design of the system is in the form of filling and monitoring automatic water reservoirs that go through 5 stages, namely tool prototype design, prototype making, making a series of tools, measuring and analyzing data. This tool utilizes the HC-SR04 sensor which will detect the water level in the water reservoir if the water level is 1-23 cm then the water reservoir is filled automatically and when the sensor distance from the water is 20 cm then the water reservoir will not be refilled. In designing this system using a NodeMCU ESP8266 microcontroller and the MQTT protocol which will run the control process on the system and process input data from sensors. The output will be displayed on the LCD (Liquid Crystal Display), MQTT Dash and Node-Red Dashboard in the form of the water level in the reservoir. The added relay functions as an automatic switch when turning off and turning on the water flowing in the reservoir. This can reduce the use of water as a medium for ablution that is wasted so that it becomes more effective and efficient.

1. Introduction

The parameter of technological progress at this time and in the future is the mastery of technology in the IoT field. Internet of Things is a concept that certain objects have the ability to be able to send data through interactions between humans and computers. humans or humans with computers [1]. All can be carried out automatically by a program. Internet of Things or commonly referred to as IoT, this technology has developed rapidly starting from wireless technology, micro-electromechanical systems (MEMS) and the internet [2]. The application of the Internet of things has been widely used in human life activities, one of which is carrying out the water use management process needed in every place [3].

Internet of Things has been widely used in human life activities, one of which is carrying out the water use management process needed in every place [4]. The current Internet of Things technology can be used to detect every use of water to the automatic recording process of every water use, so that the process of monitoring water use can be carried out by every community [5].

The obstacles in the management of filling water reservoirs and management are still using a manual system and there are often vacancies in the contents of water reservoirs which result in customers not being able to use water [6]. So to provide a solution, a setting is needed which includes a water reservoir filling system using NodeMCU[7] and ultrasonic sensor HC-SR04[8].

In the current development of topology technology, the need for data exchange is getting higher. One effort that can be taken by using LAN or Wi-Fi to be configured between networks is using an application called MQTT (Message Queuing Telemetry Transport), the application is a protocol that runs TCP / IP and has a data packet size with a small low overhead (minimum 2 bytes) so that it has an effect on power supply consumption which is also quite small based on Nodemcu ESP8266[9]. MQTT is designed as a very lightweight transport protocol with the concept of publish and subscribe [10], so that a series can be made to monitor and control the state of the water reservoir automatically.

2. Method

2.1 Prototype Method

The prototype method [11] is the key behind the process of designing the water reservoir monitoring circuit. The following is an explanation of each stage in the prototype method:

1. Listen to Customer

   At this stage is the identification of user needs, this process is carried out so that the author can obtain information about the problems that occur by the client.

2. Build and Revise Mock-up

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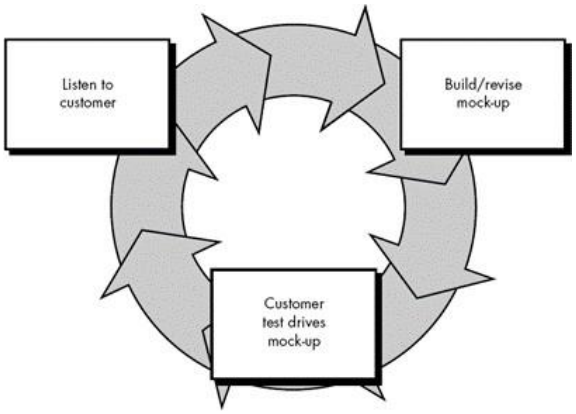

Figure 1. Prototype Modeling Flow

3. Customer Test Drive Mock-up

   At this stage, testing will be carried out on the prototype system that has been made, and evaluate whether the prototype system that has been made is as expected. If the results of testing the prototype have not met the needs of the client (stakeholders), then the developer will carry out the process of re-prototyping until the prototype becomes a final system and is actually accepted or in accordance with the wishes of the user. The process of testing the system prototype will use black box testing techniques [12].

2.2 Alternative Troubleshooting

Based on the problems encountered in the running system, several solutions were made that can help Memboemi Café, among others:

1. Creating a monitoring tool and filling water reservoirs in a more modern Memboemi Café by utilizing a microcontroller and the Internet of Things. This monitoring and filling tool for water reservoirs means that officers do not have to operate the motor pump manually. Because with the monitoring tool and filling the water reservoir, it will automatically operate the motor pump that has been programmed in the system if the water volume exceeds or is less than the predetermined limit. Officers can also view data from the volume of water detected online using a Smartphone.
2. Adding a jobdesk for one of the employees to monitor and control water use when customers are busy.
3. Provide information about the condition of the water contained in the water reservoir, so that the management can control the amount of water input that enters
4. Provides convenience in managing water needs that will be used by Memboemi Café in supporting daily activities

3. Result and Discussion

3.1 Proposed New Procedure

Monitoring and filling tool for water reservoirs at Memboemi Café based on IOT and Microcontroller with the MQTT protocol to assist officers in creating visitor comfort in the café environment, where the tool will be placed in the water tower which aims if the volume of water is more or less in the water reservoir it will filling water reservoirs automatically so that officers do not need to turn on or turn off the water pump manually and can be monitored using the Node-Red Dashboard[13], MQTT Dash[14] and the website[15].

This monitoring tool also serves to provide convenience in carrying out water management, thereby providing financial benefits for management through efficient use of water. This tool also functions as a notification for management in the water filling process, so that management knows that the water filled in the water reservoir has met its capacity and will stop automatically if it meets the set water reservoir height standards.

The process of managing the water discharge carried out can be described by the flowchar method, where the processes and flows in the management of water discharge can be precisely identified so that the implementation process in the system can be carried out properly and in accordance with the expected standards. Flowchar also describes the mechanism and system response to the amount of water discharge filled in the water reservoir at Memboemi Café

3.2 System Design Diagram

Flowchart or flow chart is a diagram that displays the steps and decisions to carry out a process of a program. Each step is depicted in the form of a diagram and connected by a line or arrow direction

1. Flowchart System

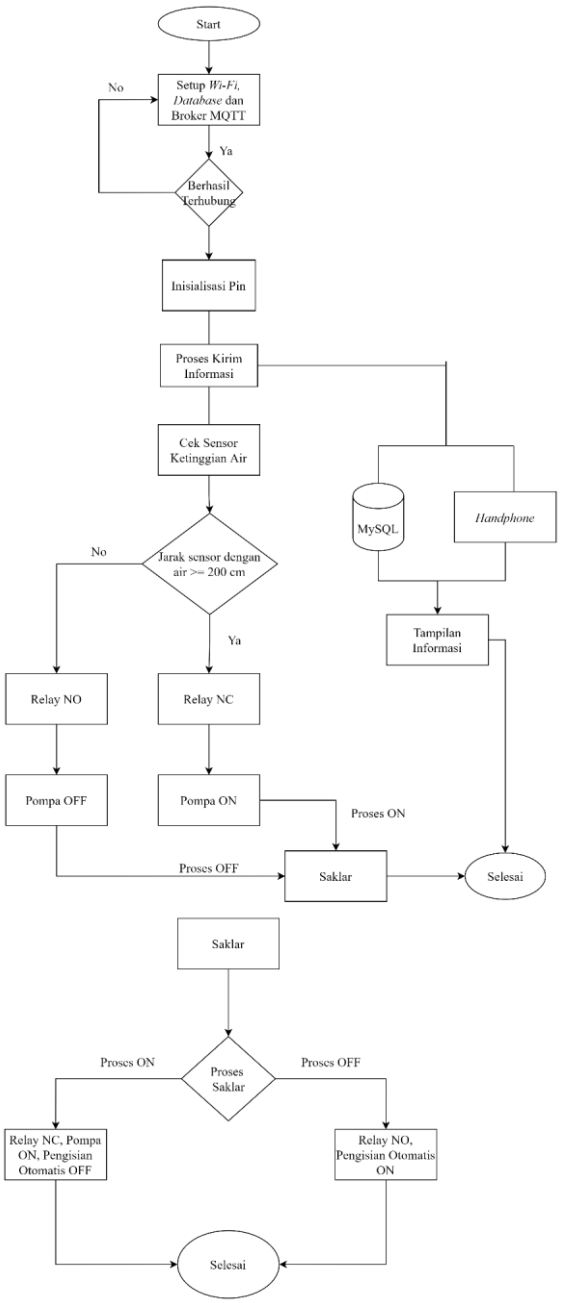

Figure 2. *Proposed Flowchart System*

System Flowchart Explanation from Figure 2 The proposed system flowchart is as follows suggest:

1. Setup Wi-Fi, database, and MQTT broker in the microcontroller that will be used in the circuit.
2. Then initialize the port which serves to define the microcontroller I/O pins that will be used in the circuit.
3. Give the command to read the water level to the ultrasonic sensor HC-SR04.
4. Censors reads water level
5. Censors data displayed on LCD
6. Censors data is displayed on the smartphone
7. Censors data is displayed on the Node-Red Dashboard
8. Censors data is displayed on the website
9. Censors data is sent to the database
10. After getting data from the sensor, then the data is processed and if the sensor distance with water is more than 200 cm then the pump will automatically turn on and if the sensor distance is less than 50 cm then the pump will automatically turn off.
11. Then if the distance between the sensor and water is less than 200 cm and still above 50 cm, the pump will still turn off.
12. If the SPDT switch is used, regardless of the distance between the sensor and the water, the pump will work according to the output produced by the switch.

3.3 Display Design

1. Circuit Design

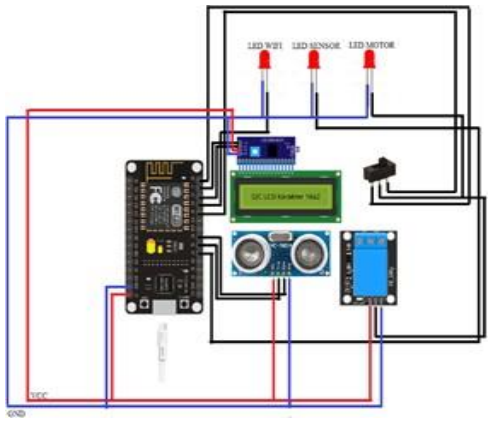

Figure 3. Ciscuit Design

Figure 3 is a circuit schematic of all the components that are applied. The circuit scheme is made in order to make it easier to design a tool to be made.

2. Dashboard Node-Red Design

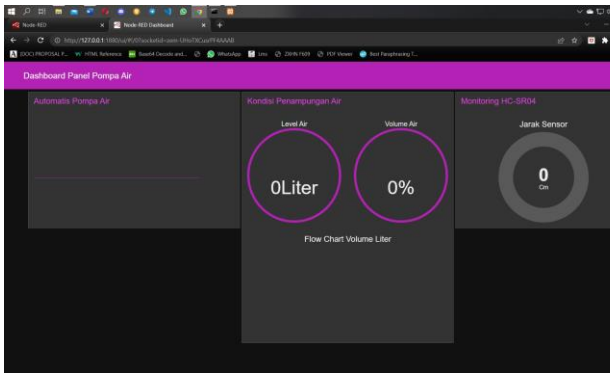

Figure 4. Node-Red Dashboard

Figure 4 is a view of the Node-Red Dashboard that users can view via the internet. Node-Red itself can display various kinds of data that are interconnected with the MQTT protocol so that it can make it easier to help monitor the state of the water reservoir.

Table 1. Censors work experiments with a configuration of 64 cm high, max 35 cm and min 15 cm

Trial to	ON	OFF
1	15	34
2	14	31
3	15	34
4	15	32
5	14	34
Average	14.4	33
AVG Error	4%	5,71%

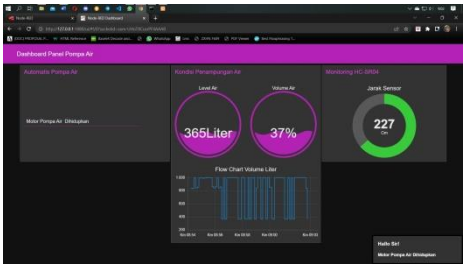

Figure 5 Monitoring Graph of Node-Red Dashboard Water Reservoir Running Out of Water

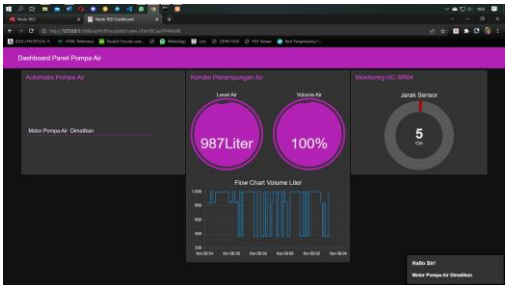

Figure 6 Monitoring Graph of Water Reservoir Node-Red Dashboard Full of Water

3. View Of MQTT Dash

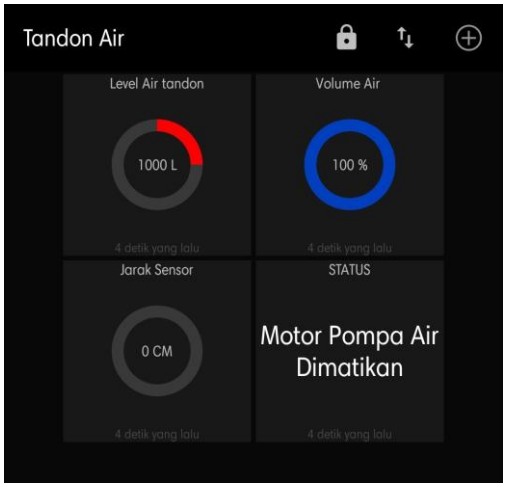

Figure 7 MQTT Dash Display

MQTT Dash is an android application that can help monitor using smartphones that are connected to each other using the MQTT protocol so that it can make it easier to monitor water reservoirs anywhere

Figure 8 Monitoring of Out of Water Reservoir

Figure 9 Monitoring of Out of Water Reservoir

4. Web Design

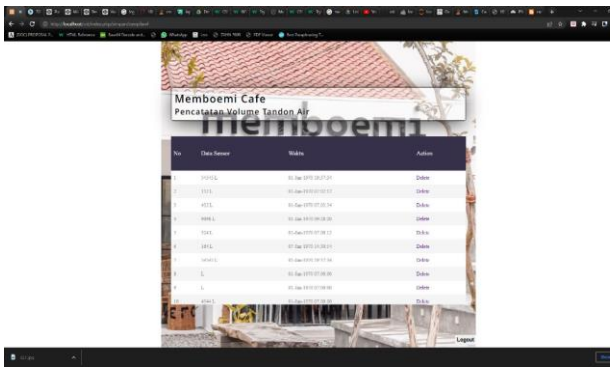

Figure 9. Website Display

the data recorded by the NodeMCU ESP8266 is sent to various outputs that can be generated and the data is also stored and can be displayed via the website that has been created.

4. Conclusions and Suggestions

4.1 Conclusion

Based on the results of research that has been carried out, several conclusions are obtained as follows::

1. The current filling of water reservoirs at Memboemi Café before the implementation of the new system is not optimal in water management that occurs at Memboemi Café because it is still manual.
2. The obstacle faced at the current Memboemi Café is that the filling of water reservoirs is manual and will.
3. This water reservoir monitoring tool uses several hardware and software. Among them for hardware are NodeMCU, ultrasonic sensors, relays, LEDs and I2C LCDs, as well as for software using Arduino IDE and Visual Studio Code

4.2 Suggestion

Based on the results of research that has been done, some suggestions are obtained as follows:

1. The tools built are expected to be developed both in terms of design or adding more components or sensors used.
2. The appearance that still needs to be improved in terms of layout and giving special colors according to the identity of Memboemi Café.
3. The SMS Gateway feature can be added which can provide notifications when the water reservoir is empty or full.
4. Theres need more complex security from server.

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