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Smart Watering System Based on Internet of Things for Urban Planting

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ABSTRACT: People in the city of Jakarta are busy people. Many Jakarta residents do not have time to look after plants. In fact, as a resident of the city of Jakarta, plant maintenance is very good for exchanging contaminated air into clean air. Plants must be watered every day to be able to photosynthesize. However, the busyness of the citizens of the city of Jakarta makes the residents do not have time to water their plants. Therefore, in this proposed study, a system that can water plants will be created automatically. The system consists of microcontroller as a control device, mobile-web app as the application which used by user and RabbitMQ as a server that control request from user. Microcontroller connected to internet use Wifi network and connected to RabbitMQ through MQTT protocol. Microcontroller as a control device connected with water pump through relay. When the given time has arrived, the water will automatically flow a few mili litters according to the needs of the tree from a bucket filled with water. The results of this research are expected to help urban communities in Jakarta to care for and maintain plants in the midst of their busy life.

KEYWORDS: Smart System, Internet of Things, Urban Planting

I. INTRODUCTION

The people of Jakarta are mostly urban people or its residents are people who have moved from other cities to Jakarta. Jakarta is also one of the most populous and busiest cities in the world. The busyness and density of the people of the city of Jakarta makes this city less healthy to live in. Pollution occurs everywhere and the trees in the city of Jakarta are not yet able to handle the existing pollution. So, to overcome this, a practical solution is needed for the citizens of Jakarta(1).

One way to make the air of the city of Jakarta better is to have plants that are nurtured and cared for by its residents (2). Pollution in Jakarta can be reduced if every house has plants that can change the air every day (3). Residents can take advantage of small plants that are maintained through potting media. However, the busyness of the citizens of Jakarta does not allow them to care for plants in a sustainable manner. One important aspect of plant care is the availability of water. Jakarta residents may be able to take care of plants to fertilize, for example once a month, but have difficulty finding time to water the plants every day.

This research will create a tool that can water plants automatically. This tool uses a microcontroller as a processing tool. The microcontroller will connect the mini water pump, mini-LCD, and timer(4). This research will focus on the process of automating the reading of instructions from the MQTT server by a microcontroller. This automation process will instruct the water pump which is set to turn on at a certain time. Later, the user can set the time for the pump to turn on. Users can schedule for automatic irrigation on certain days and certain hours. This tool will use battery power embedded in the device so that it is easy for the public to use. The battery used is a 2000MAh lithium battery which can be recharged via a power supply reserve (power bank) or using a charger with a micro-USB interface. Charging the battery will be assisted by an indicator light that is embedded in the tool to be created. If the battery is full, the indicator light will stop flashing and the user can be disconnected from the charging media.

This research is expected to produce a tool for watering plants automatically. This tool can be used for urban people who are busy and unable to care for plants every day. It is hoped that the existence of appropriate research can help reduce air pollution in the city of Jakarta by taking advantage of the limited environmental conditions.

II. LITERATURE REVIEW

Research entitled "Prototype of an Automatic Plant Watering Tool using a Soil Moisture Sensor with Whatsapp Notifications". This research examines each plant that wants to absorb water content as needed from the soil for its growth. If the soil has become dry and the moisture content has been reduced below a certain limit so that the plant is about to face wilting, it is the same if the water content in the soil is too dry so that it will lower the oxygen content in the soil and cause breathing problems at the base (root

respiration), reduce the volume at the base of the soil. increase resistance to lift water and nutrient factors through the base and the occurrence of toxins.

The formulation of the problem from this research consists of (i) How is the method of obtaining automatic plant watering notifications using a soil moisture sensor using the WhatsApp application ?, (ii) What is the method of testing automatic plant watering equipment? The purpose of this research is (i)

Can share watering plant notifications using a soil moisture sensor with the WhatsApp application, (ii) Can recognize soil moisture and display it on the LCD. Procedures for this research include (i) analysis consisting of needs analysis and analysis of work methods, (ii) design consisting of hard feature design and network design, (iii) implementation consisting of implementing hard features and implementing soft features, (iv)) testing consisting of soil moisture sensor testing, led lamp testing, lcd testing, relay testing, water pump testing and WhatsApp testing. From the test results on the automatic plant sprinkler equipment using a soil moisture sensor with whatsaap notification, the soil moisture sensor test results obtained soil moisture exceeding 6.5 so that the water pump automatically turns on.

The conclusions of this research are (i) Obtaining WhatsApp notification on each watering process from automatic plant sprinklers using a soil moisture sensor and (ii) Obtaining soil moisture data that is displayed on the LCD screen (5).

Research entitled "Arduino Uno-Based Plant Watering Design Using YL-39 and YL-69 Humidity Sensors". This research examines the experiment of watering plants manually. However, sometimes humans don't have enough time to water the plants and don't know how much water the plants need. Therefore, an automatic plant watering system was created to facilitate human work in watering plants. By using this equipment, it is hoped that watering the plants with the amount of water that the plants need can be tried at the right time.

This research was tried by designing something that could water plants using the YL-69 soil moisture sensor controlled by Arduino Uno and instructed Android to show the soil moisture value according to soil pH. The plant watering system that has been made can water the plants automatically. Android will accept and show the value of the soil condition whether dry, humid or wet according to the reading from the soil moisture sensor (4).

The research entitled "Design of Automatic Plant Watering Equipment Using Soil Moisture Sensor". This research examines food self-sufficiency, a government program that is currently being intensified, so that Indonesia can be independent in food supply by the end of 2019. Indonesia is not only a maritime country, it is an agricultural country with productive land with 2 periods, the rainy period and the period of rain. dry. During the rainy period, generally food plants do not need to be watered because they have received a decent amount of rainwater. On the other hand, during the dry season, the plants must be watered in an orderly manner in accordance with the moisture condition of the soil. Farmers generally do not plant food plants during the dry season for fear that they will not develop properly and run aground. The dependence of farmers with mass causes the creation of farmers to shrink and becomes an obstacle to the success of the food self-sufficiency program. In order to overcome the barriers of the dry period and so that farmers can always cultivate crops during the dry season, it requires a product of agricultural equipment based on data technology and communication in the form of a programmable microcontroller chip so that it can control the watering of plants automatically sourced from soil moisture which is detected using an artificial soil moisture sensor in country. This equipment wants to find out whether the soil on which to grow crops is dry so that the equipment can control watering automatically when the soil lacks the water factor. So farmers don't need to do watering manually. So that plants can continue to develop productively even in the dry season. Not only helping farmers, this equipment can also be installed in plantations, nurseries, urban gardens, hotels, offices, and in homes that have yards or plants that need regular watering (6).

Research entitled "Prototype of Automatic Plant Watering Tool with Atmega 8535 Microcontroller Based Moisture Sensor". This research presents the design and realization of soil moisture measuring equipment based on the ATMega 8535 microcontroller. The soil moisture sensor is in the form of 2 probes of type yl- 69. This humidity sensor is connected to a signal generator. If the soil moisture changes, the sensor impedance will change, so that the generator output signal frequency changes according to soil moisture. This frequency shift is then detected and used to identify soil moisture levels. From the test results, it was found that the equipment was made to operate as expected. The equipment made is also equipped with an on-off control signal, so that the equipment made can be used for controlling soil moisture (7).

Research entitled "Automatic Plant Watering Tool Using Arduino Uno". This research identifies a tool or technology that can help human work, so that technology becomes a necessity for humans. This final project is made of a feature that can carry out the job of watering the chili plants automatically. This equipment aims to make manual work automatic. the properties obtained from this equipment can facilitate human work in watering chili plants. This equipment uses a soil moisture sensor which acts like a soil moisture detector and sends commands to Arduino uno to turn on the relay driver so that the pump can flush water according to soil needs automatically. This final project was tried by designing, making and implementing system components including Arduino unit as a controller, relay driver for blowing and turning off the water pump, LCD to

show the humidity value of the stage. The results of the research confirm that the equipment is made to function properly and can be raised as expected. Equipment can play a role when soil moisture is above 300 PH, it does not play a role if soil moisture is less than 300 PH (8).

III.RESEARCH METHODOLOGY

This research has stages which can be seen in Figure 1 below:

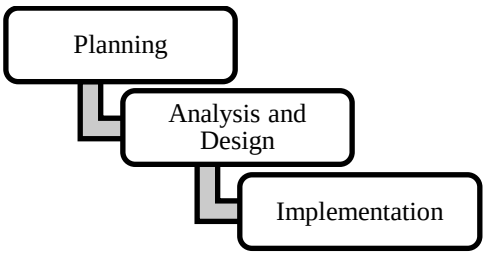

Figure. 1. Research Methodology.

A. Planning

In this research, experimental and descriptive methods were used, the method used was literature research. Experimental procedures are used to design an automatic plant sprinkler system after that build the system and carry out tests on the system that has been made to recognize the reliability of the system that has been designed after that analyze the results of the system. The design and manufacture includes the mechanical design that is formed, the program on Arduino uses the Arduino IDE, and the interfacing circuit, on the other hand, the descriptive procedure is used to describe the cases reviewed in the research (2).

B. Analysis and Design

In this session, explain what is needed when designing. Certainly this research requires hardware and software. The hardware uses a microcontroller and various kinds of sensors. The software uses the Arduino IDE program to program the microcontroller and use the Windows Operating System media. The design stage consists of the entire communication data diagram and the hardware circuit. This stage aims to share a reflection of the network process and information communication in this research (9)(10).

C. Implementation

Implementation or application stages consists of 2, namely the application of hardware and application of software. The application of hardware in this research is a series of Wemos D1 R1, Relay, LCD I2C, and Water Pump. While the application of the software in this study consists of making an Arduino program or sourcode to run Arduino's performance and creating a php syntax to connect the Arduino with a microcontroller. The implementation stages in this research include the flow of the system, the implementation of hard features and the implementation of soft features.

System Flow At this stage of the research system flow is the assembly or installation of all the components that were tried to be implemented in the system in full. The implementation or implementation of the program aims to identify whether the system being formed is compatible with the design. Stages of implementation or implementation in the hard features, the initial hard features were tried, installing Wemos D1 R1 like a program processor, after the process is tried until the next process is the installation of output hard features such as LCD I2C, relay and water pump.

Communication between hard features and soft features requires a programming language command using the C language. The next process is to connect the Wemos D1 R1 with I2C using a jumper cable, connect the cable with the pin on the Wemos D1 R1 according to what was previously set, connect the other side of the jumper cable to I2C. The MQTT protocol will be used to communicate data between the Wemos D1 R1 and RabbitMQ (11).

The MQTT protocol is a centralized data communication system, which means it can be accessed by a variety of platforms (12) The next stage is testing by connecting the relay driver pin to the Wemos D1 material and programming it to recognize whether the relay can work or not and distributing High and Low values on the exit leading to the relay.

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IV.RESULT AND DISCUSSION

This research has resulted in the development of a device known as an edge, which has the ability to turn on the pump and drain the water. A mobile-web-based application can be used to control Edge automatically. The MQTT protocol is used for data communication in this system, with messages sent by the mobile-web application and accessed by the edge. This type of data communication system has been used in a number of previous studies. There are two functions provided by this data communication system: publish and subscribe. The communication diagram for the publish function is shown below.

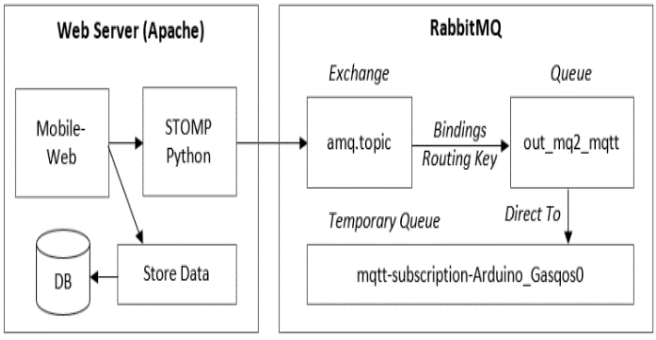

Figure 2. Diagram of Message Publish.

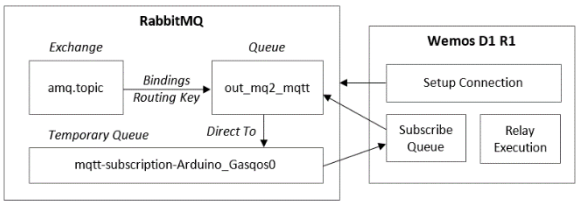

Figure 3. Diagram of Message Subscribe.

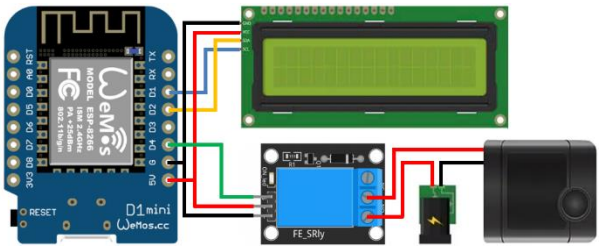

Figure. 4. Hardware Circuit of Edge.

HTML and PHP programming are used to create web applications. The architecture of the publish function used by web applications to send messages to the RabbitMQ server via the MQTT protocol is shown in Figure 2a. The process begins with the web application receiving user commands, followed by the execution of Python program code that functions to send messages to the RabbitMQ server via the STOMP library. Incoming messages will be received by the exchange amq.topic and stored in the queue out mq2 mqtt. Message storage in out mq2 mqtt via the bindings process, specifically by utilizing the routing key feature of the exchange amq.topic. Messages in the out mq2 mqtt queue will be saved in the mqtt-subscription-Arduino Gasqos0 temporary queue, which is formed when the Wemos D1 R1 connects to the RabbitMQ server.

Furthermore, the web application runs a script to store data in the MariaDB database. Date, time, and commands entered by the user are all stored data. The second function of this system is subscribe, which is depicted in the diagram figure 2b. In the second function, the edge Wemos D1 R1 will connect to the RabbitMQ server and subscribe to the queue out mq2 mqtt. Messages received by the edge through a temporary queue. The read message will be checked, and the outcome of the check will determine whether the relay is turned on or off. In order to turn on the water pump, a relay is used as a switch. The relay's initial condition is open, indicating that the water pump is turned off. If a message is received to turn on the water pump, the relay will close, causing the water pump to turn on. Edge is made up of several parts, including a Wemos D1 R1, a relay, an LCD I2C, and a water pump. The edge circuit diagram is shown below.

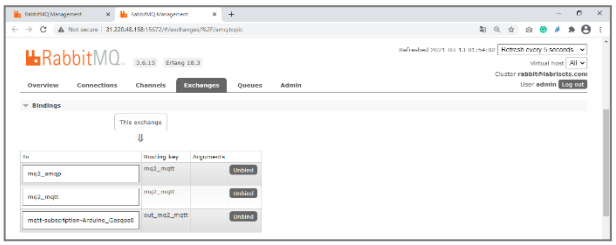

Figure. 5. Configuration of Exchange amq.topic

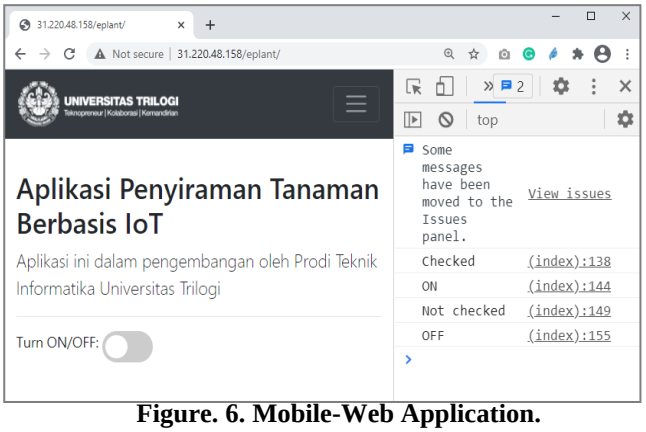

Figure. 6. Mobile-Web Application.

The edge is represented by 5 modules in Figure 3a above. The first module, Wemos, is linked to a 16x2 I2C LCD via SCL and SDA pins, and it is also linked to the relay via pin D4. The voltage employed is 5V. A relay and a water pump are linked to the socket connection module. A 5V adapter can be connected to the socket connection module. The following step ensures that the RabbitMQ server is configured and operational. Here's an overview of the RabbitMQ server. Figure 3b shows that in RabbitMQ, there is an exchange amq.topic that handles incoming messages via the MQTT protocol. Messages from Wemos will be automatically stored in a temporary queue called mqtt-subscription-Arduino Gasqos0. Bindings must be performed into the out-mq2 mqtt queue in the amq.topic configuration, so that any messages that enter through the temporary queue are directly stored in the out mq2 mqtt queue. The following stage is the development and testing of mobile-web and edge applications. The first step is to send messages from the mobile-web application to the RabbitMQ server, which is then accessed by Wemos. The mobile-web application is shown Figure 4a.

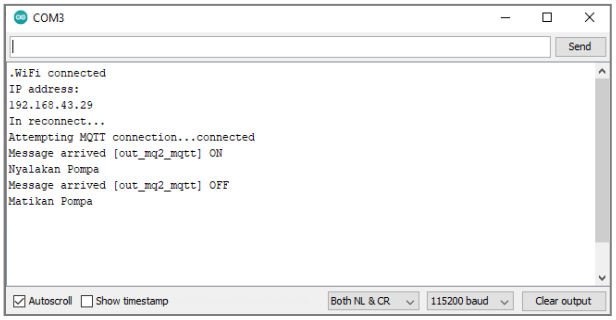

Figure. 7. Wemos Serial Monitor.

Figure 4a above is divided into two sections: the display of the mobile-web application and the display of the web browser console. The Javascript programming language is used to display the message in the console section. When the ON / OFF button is pressed, the application sends a message to the RabbitMQ server using the STOMP protocol, which is then stored in the out mq2 mqtt queue. The application saves the action taken in the database after sending the message. The information saved includes actions (ON / OFF), time, and date.

The console web browser will display any message notifications that have been sent. The following testing is done on Wemos with a serial monitor. The serial monitor, which is used to detect incoming messages to Wemos, is shown on Figure 4a. Figure 4a shows a procedure that starts with checking the internet connection and then connects to the RabbitMQ server using the MQTT protocol. Continue to subscribe to the queue out mq2 mqtt once the connection to the RabbitMQ server is successful. Wemos will read any messages that have been stored in the out mq2 mqtt queue. The message includes an ON/OFF command. Depending on the message, Wemos turns the relay on or off.

CONCLUSION

This research produces an automatic plant sprinkler that can be controlled remotely which can assist the people of Jakarta in watering their plants at predetermined intervals of time. This sprinkler is made from a microcontroller as a control device, a mobile web application as an application used by users and RabbitMQ as a server that controls requests from users. Microcontroller connected to the internet using a Wifi network and connected to RabbitMQ via the MQTT protocol. This research can help the people of Jakarta to water their plants automatically.

ACKNOWLEDGMENT

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