Monitoring Pesticide Watering on Plants Shallot Using Mosquitto Network (MQTT) Client-Server Network

Muhammad Yaafi Melindra[a,1], Hendrick [a,2*], Nadia Alfitri[a,3], Rahmat [b,1], Dedi Kurniadi [a,5]

[a] *Department of Electrical Engineering, Politeknik Negeri Padang, Indonesia*
[b]*Agriculture Water Management, Politeknik Enjiniring Pertanian, Indonesia*

[a,2] *hendrick@pnp.ac.id*
* *corresponding author*

ABSTRACTS

Shallots are one of the leading commodities in several regions in Indonesia. In the cultivation of shallot plants there are pests that can reduce the quality of shallots. Along with the times, and to overcome the problem of watering pesticides for shallot plants, an automation tool is designed to make it easier for farmers to water pesticides. The design of this tool uses the concept of Internet of Thing (IoT) where the application used is Node-RED with the MQTT protocol. The optimum humidity for the growth and development of shallot plants is 50-70%, so soil moisture sensors are used to measure soil moisture. Pesticide watering also looks at weather conditions such as rain. Therefore, the raindrop sensor is used to detect rain. From several trials that have been carried out, it produces one experimental result that shows soil moisture of 35% where weather conditions are not raining and, the relay is active to perform pesticide watering. This indicates that the pesticide watering of shallot plants using the MQTT client-server network is successful carried out.

KEYWORDS

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Node-RED, MQTT, Soil Moisture Sensor, Raindrop Sensor, Relay

1. INTRODUCTION

Shallots are one of the leading commodities in several regions in Indonesia. Shallots are an important commodity in Indonesia and this plant can adapt to various environmental conditions in Indonesia. In the process of cultivating or planting shallots there are pests and diseases that attack shallot plants [1]

In shallot plants, farmers still get several problems such as watering and spraying pesticides which are still done manually in the form of objects such as buckets made of zinc iron which are made elongated with each end given many small holes as a place for water to come out more evenly and pests that often appear at night. This is a problem for farmers because they have to drain energy and time to water plants, spray pesticides and turn on and off lights that are still manual.

Plant Pest Organisms (PHP) of shallots are in habitats where the ecosystem is very dynamic. The presence of onion pests is latent and it often happens that before or by the time the commodity is planted, populations have reached levels close to the control threshold. Potential yield loss by major onion pests can reach 138.4 billion [2] . The use of insecticides by farmers tends to be unwise and not environmentally friendly so that it can have a negative impact on the environment, some beneficial organisms due to not in accordance with the five right rules in applying insecticides with an intensity of spraying 2-3 times every week [3]. Watering pesticides on shallot plants must also look at soil moisture levels where to achieve good and satisfying shallot agricultural results, the optimum humidity for the growth and development of shallot plants is 50-70%. If the soil moisture in the onion plant is high then the onion will not grow perfectly as a result the onion will rot quickly [4].

Currently, the rapid development of IoT (Internet of Thing) has many challenges. To overcome these challenges, a system management process is needed on the device to monitor the availability of IoT devices using a monitoring system. The monitoring system on IoT devices is a system used to monitor the IoT device itself both from resources, networks and disks. So that if there are disturbances and problems on the device, it can be known immediately the problems that occur on the IoT device. The process of collecting data from the device itself is carried out by the monitoring system which then maximizes the resources owned by analyzing it [5].

The implementation of IoT with Node-RED to monitor watering in plants can provide benefits for agriculture. With this technology, farmers can optimize plant growth. This can increase agricultural production and minimize losses due to plant pests. By utilizing IoT technology, farmers can increase their crop yields and maintain the sustainability of their agricultural business.

This system is designed using the MQTT (Message Queuing Telemetry Transport) protocol, because the MQTT protocol is a delivery system that can support IoT design. The MQTT protocol is also one of the TCP / IP type protocols that is effectively used for data transmission [6].

2. RESEARCH METHODOLOGY

2.1. Raindrop Sensor

Raindrop sensor is a type of sensor that functions to detect whether it is raining or not, which can be used in all kinds of applications in everyday life. The working principle of this sensor module is that when rain falls and hits the sensor panel, an electrolyzation process will occur by rainwater. And because rainwater is included in the electrolyte liquid group where the liquid will conduct electric current.

In this rain sensor there is a comparator which is the output of the sensor. From this sensor can be in the form of logic high and low (on or off). In this sensor module there is an output in the form of voltage as well. So that it can be connected to a special Arduino pin, namely the Analog Digital Converter. In short, this sensor can be used to monitor the condition of whether there is rain in the outside environment where the output of this sensor can be an analog signal or digital signal.

2.2. Soil Moisture

The soil moisture sensor is a sensor that can detect an object's moisture. This sensor consists of two probes to pass current through the object. The fork-shaped probes with two open conductors act as variable resistors (similar to potentiometers) whose resistance varies with the moisture content of the object. This resistance is inversely proportional to the moisture of the object the more water in the object, the better the conductivity and the lower the resistance. The less water inside the object, the lower the conductivity and thus the higher the resistance.

2.3. Node MCU

Node MCU is a module derived from the development of the IoT (Internet of Things) platform module ESP8266 family type ESP-12. In function and principle, this module is almost similar to the arduino module platform, but the difference is that it is only specialized for connecting to the internet [7].

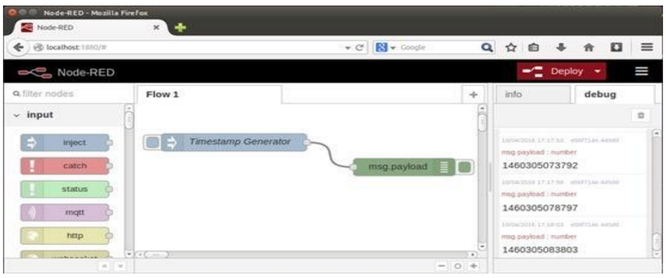
NodeMCU can be analogized as an ESP8266 arduino board. The ESP8266 program is a little difficult because it requires several wiring techniques and additional USB to serial modules to download the program. However, NodeMCU has been packaged by ESP8266 into a compact board with various features like a microcontroller with wifi access capabilities as well as a USB to serial communication chip. So that to program it only requires a USB data cable extension exactly used by charging smartphones.

2.4. Relay

Relay is an electrically operated switch and is an Electromechanical component consisting of 2 main parts (coil) and mechanical (a set of switch / switch contacts). Relays use electromagnetic principles to move the switch contacts so that with a small electric current (low power) can deliver higher voltage electricity. For example, with a relay that uses 5V and 50 mA electromagnets able to move the relay armature (which functions as a switch) to deliver 220V 2A electricity [8].

2.5. Node-RED

Node-RED is a browser-based tool for building Internet of Things (IoT) applications whose visual programming environment makes it easy for users to create applications as a flow [9]. Object-oriented programming languages currently rule the programming world, but there are alternatives for software development or production and also for prototyping ideas quickly. Node-RED has this alternative path for software development. Node-RED is a visual programming language. Compared to building an application with many lines of code, Node-RED is very easy to use because it focuses on building the program as a flow.



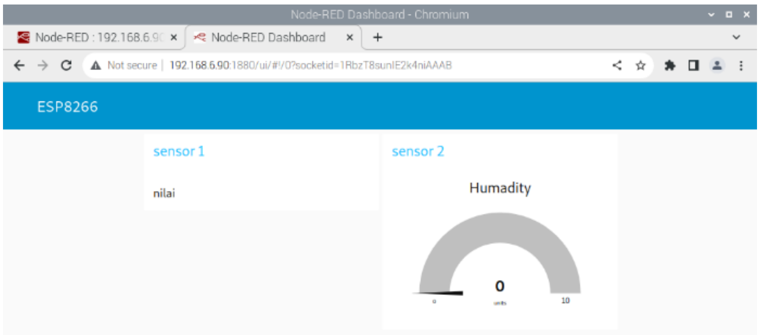


FIG 1. Flow and dashboard Node-RED

2.6 Arduino IDE

Arduino is a microcontroller board or open source electronic circuit board originating from Italy. The microcontroller itself is a chip or Integrated Circuit (IC) that can be programmed using a computer. The purpose of embedding a program in a microcontroller is so that an electronic circuit can read input, process it and produce the desired output. So the microcontroller serves as the 'brain' that controls the input, process and output of the electronic circuit. Because the main component of the arduino is a microcontroller, the arduino can be programmed using a computer as needed. Another component in arduino is the Integrated Development Environment (IDE) software which is an integrated environment for development. It is called an environment because through this software arduino programming for existing functions through programming syntax.

2.7. Raspberry PI

Raspberry Pi is a credit card-sized Single Board Computer or SBC that can be used to run office programs, computer games, and as a media player for up to high-resolution video. The Raspberry Pi was developed by a non-profit foundation, the Rasberry Pi Foundation with the aim of learning programming.

Raspberry Pi can be used like a conventional PC, such as for typing documents or just browsing. However, Raspberry Pi can also be used to create innovative ideas such as making robots equipped with Raspberry Pi and cameras, or maybe making a super computer made from several Raspberry Pi. Raspberry Pi completeness includes having a port or connection for a display in the form of a TV or monitor and a USB connection for a keyboard and mouse.

2.8. MQTT

The MQTT (Message Queuing Telemetry Transport) protocol is a protocol that runs on top of the TCP/IP stack and has a data packet size with a small low overhead (minimum 2 bytes) so that the effect on power supply consumption is also quite small. This protocol is a type of data agnostic protocol which means you can send any data such as binary data, text and even XML or JSON and this protocol uses a publish/subscribe model rather than a client-server model.

MQTT was originally designed for Machine-to-Machine communication. MQTT sends data as a byte array, which is an advantage of the MQTT protocol because the data sent is very small. When the MQTT protocol was tested with a 3G network, the MQTT protocol was 93 times faster than HTTP, because the header packet was only 2 bytes. The publisher sends data/messages with certain topics to the broker. Data transmission can be via WiFi, GSM, LTE, etc. Subcriber then retrieves the required data/messages with specific topics at the broker.

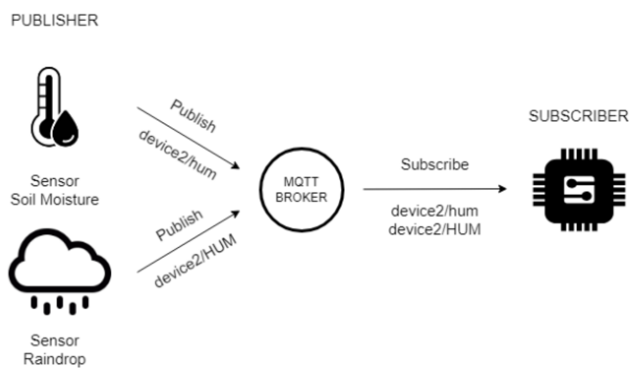


FIG 2. Diagram block MQTT

Brokers in MQTT function to handle publish and subscribe data from various devices, which can be likened to a server that has a dedicated IP address. Some examples of brokers include Mosquitto, HiveMQ and Mosca. Publish is a way for a device to send its data to subscribers. Usually this publisher is a device connected to a particular sensor.

Subscribe is a way for a device to receive various kinds of data from the publisher. Subscribers can be sensor monitoring applications and so on, this subscriber will later request data from the publisher. Topic is like grouping data in a certain category. In this MQTT protocol work system, topics are mandatory. Every data transaction between the publisher and subscriber must have a certain topic.

2.9. IoT (Internet of Things)

IoT (Internet of Things) is a device that has the ability to collect and send information over the internet without any human intervention. The technology contained in IoT devices that have been embedded in objects will help IoT devices to interact with the internal and external environment and will help in the decision-making process. In short, IoT is a concept to connect all devices to the internet and have the ability to communicate with each other via the internet. IoT is a vast network of devices that are connected to the internet and collect and share information on how to operate these devices.

IoT is a global network infrastructure, which can connect hardware and virtual devices through the exploitation of data capture and communication capabilities. The infrastructure consists of existing networks and the internet along with network development. Thus, IoT offers objects, sensors and connection capabilities in order to provide independent co-operative services and applications. According to (Association, 2014), the Internet of things (IoT) is defined as a network with each object embedded with sensors connected to the internet network [10]..

3. RESULTS AND DISCUSSION

Overall tool analysis discusses how the tool works as a whole starting from input, process, and output. In the section. The input consists of 2 sensors, namely the rain sensor and soil moisture sensor, the process uses the ESP8266 Microcontroller using the MQTT client-server network and relays as output.

Soil moisture will be placed on the ground near the roots of shallot plants to measure soil moisture levels. The data will enter through Node-RED and will be displayed on a dashboard. Similarly, the rain sensor detects rain with high and low data results that will be displayed on the Node-RED dashboard. The water pump used is a 12 v water pump. The water pump will be active to water the pesticide, if the soil moisture sensor reads soil moisture below 50% and the raindrop sensor detects no rain. Water Pump is not active if there are several possibilities, the first water pump is not active if the soil moisture sensor reads soil moisture above 50% and at the same time the raindrop sensor does not detect rain, the second water pump is not active if the soil moisture sensor reads soil moisture below 50% while the raindrop sensor detects rain.

3.1 IP Address Checking

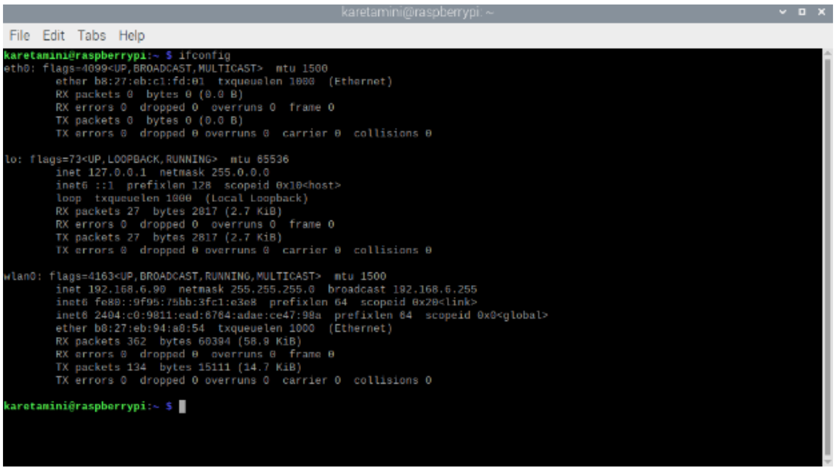


FIG 3. IP address checking

Checking the IP Address is to make it easier to process communication on the network. With IP Address every device that uses the internet can connect to each other. So that devices can communicate with each other. Checking the IP Address is by opening the terminal and making the command "ifconfig". After making the command, the IP Address that will be used for communication between networks appears.

3.2 Open Node-RED and MQTT Broker Checking

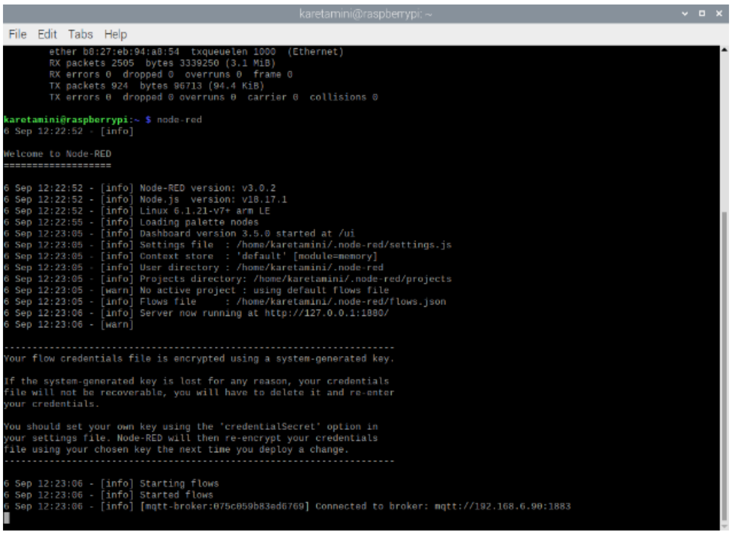


FIG 4. Open Node-RED and MQTT broker checking

The communication center in MQTT is also called a server. This broker functions to filter incoming messages and distribute them to clients who are interested in receiving these messages. When creating the "node-red" command, the Node-RED will be active and at the same time the MQTT Broker will be connected.

3.3 Moisture soil sensor and raindrop sensor testing

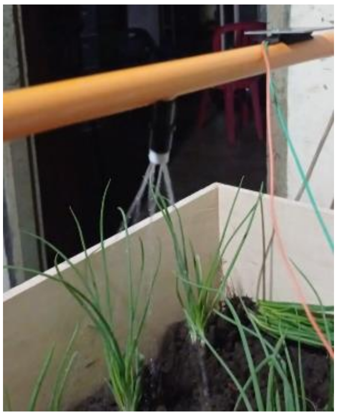


FIG 5. Sensor Testing

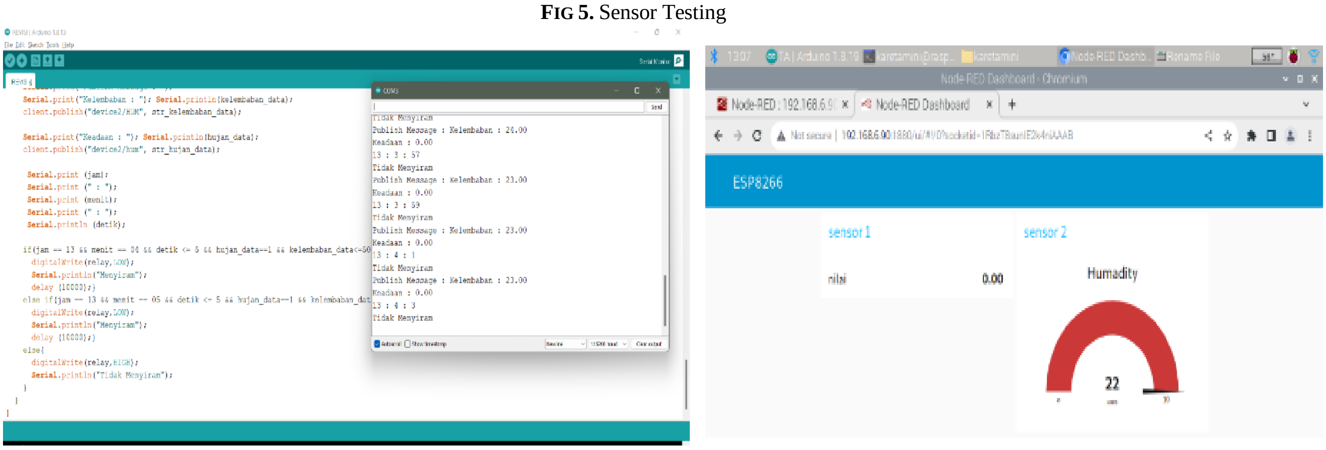


FIG 6. Running Program and dashboard Node-RED

Sensor testing when the soil moisture reads below 50% and the rain sensor detects rain with the time set through the RTC, the relay that is read is in a dead condition and the water pump is not watering. Dashboard data for soil moisture sensors that read sensor data below the setpoint and raindrop sensors read a value of 0 or low.

TABLE 1. Experiment 1

No	Sensor Soil Moisture (%)	Sensor Raindrop (*High*/*Low*)	Keadaan Water Pump (*On*/*Off*)
1	22	*Low*	*Off*

Experiment 1 data from monitoring pesticide watering of shallot plants. The soil moisture sensor data is 22% and the raindrop sensor detects rain or low value and the water pump is off or not watering.

3.4 Overall Experiment

TABLE 2. Overall experiment

NO	SENSOR SOIL MOISTURE (%)	SENSOR RAINDROP (*HIGH*/*LOW*)	KEADAAN WATER PUMP(*ON*/*OFF*)
1	22	*LOW*	*OFF*
2	35	*HIGH*	*ON*
3	52	*LOW*	*OFF*
4	39	*HIGH*	*ON*
5	45	*LOW*	*OFF*
6	42	*HIGH*	*ON*
7	44	*HIGH*	*ON*
8	49	*HIGH*	*ON*
9	51	*LOW*	*OFF*
10	45	*HIGH*	*ON*
11	54	*HIGH*	*OFF*
12	57	*HIGH*	*OFF*
13	32	*HIGH*	*ON*
14	48	*HIGH*	*ON*
15	56	*LOW*	*OFF*
16	48	*HIGH*	*ON*
17	63	*HIGH*	*OFF*
18	38	*LOW*	*OFF*
29	40	*HIGH*	*ON*
20	43	*HIGH*	*ON*
21	47	*HIGH*	*ON*
22	51	*LOW*	*OFF*
23	55	*HIGH*	*OFF*
24	46	*HIGH*	*ON*
25	48	*HIGH*	*ON*

Based on Table 3, the table is the overall table data of testing soil moisture sensors and raindrop sensors on pesticide watering of shallot plants. s. In the 7th experiment, the soil moisture sensor data was obtained measuring soil moisture with a percentage of 44% and the raindrop sensor detected no rain or a logic high value, so the water pump was on or watering. In the 15th experiment, the soil moisture sensor data was obtained with a presentation of 56% indicating that the shallot soil was moist and the raindrop sensor detected rain with a low logic value, so the water pump was off or not watering.

4. CONCLUSIONS

The use of the MQTT protocol on pesticide watering of shallot plants has 4 factors, namely the first, the broker as an IP address/server that can be accessed by publishers and subscribers. Second, the publisher as sending data to the subscriber. Third, the subscriber as the recipient of data from the publisher through the broker. Fourth, the topic is the client of the subscriber. Taken from 2 experimental data. The first experimental data, when soil moisture is measured by the soil moisture sensor, the data is 22% and the raindrop sensor detects no rain with a high logic, the water pump is active for watering pesticides on shallot plants. The second trial data, where the soil moisture sensor measures soil moisture with data of 54% and the raindrop sensor detects rain, the water pump is not active and watering pesticides on shallot plants is not carried out.

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