Automatic Irrigation System for Shrimp Pond Using Float Level Sensors and MQTT

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Abstract: Indonesia is the number 5 shrimp producing country in the world. The Indone-sian Ministry of Maritime Affairs and Fisheries wants to develop shrimp farming into one of the leading export commodities by 2024 by increasing production by 250%. Although that doesn't mean that shrimp farmers don't have problems, one of the problems farmers face every year is the difficulty of finding water during summer which can cause crop failure, therefore farmers need help with water ir-rigation in shrimp ponds. Therefore, in this study we created a system that can automatically fill water in shrimp ponds using a Float Level Sensor which is used as an indicator of whether or not water should be filled. This study also uses the MQTT Protocol to transmit data from the automatic irrigation system to the user's smartphone so that the user can also monitor the pond. The automatic irrigation system can also be activated via the user's smartphone by sending orders from the mobile phone which will be transferred to the system using MQTT. From the ex-periments conducted, it was found that the use of MQTT is more appropriate for this system than other protocols in the data exchange process.

1 INTRODUCTION

The shrimp market in Indonesia is quite large and Indonesia is one of the 5 (five) largest shrimp producers in the world, is a great opportunity to continue to encourage increased shrimp production in Indonesia. That's why Marine and Fisheries Ministry Indonesia make a program to develop shrimp cultivation to become one of the leading export commodities by increasing the production up to 250% in 2024 (Wati, 2018).

Even though the government has made a program to increase shrimp cultivation, so far the cultivators still have some problems, especially when the summer comes, farmers have difficulty getting water because farmers often experience crop failure, therefore farmers still need help to help. to get water and increase shrimp production, one of which is a tool that can help and facilitate farmers in automatically irrigating shrimp ponds.

Several studies have been conducted regarding the system automation, the MQTT protocol, and irrigation are among the studies by (Khujamatov et al., 2019) in the journal entitled "Modeling and Research of Automatic Sun Tracking System on the bases of IoT and Arduino UNO" in 2019 explained about automatioc system using IoT. solar panel automatic modeling is a software model environment. IoT that based automatic Sun Tracking depend on the angle of the sun's rays on the surface. Modeling the solar panels and power systems require self-propelled driving equipment are designed for maximum output energy. The Automatic Sun Tracking system moving in relation to solar radiation (Khujamatov et al., 2019).

There is also studies by (Dinculeană and Cheng, 2019) who proposed a MQTT. Message Queue Telemetry Transport (MQTT) is a protocol used for communication within an IoT environment that the functions work on top TCP/IP. MQTT created by IBM as a machine-to-machine, lightweight communication method. MQTT is a messaging protocol that uses the publish and subscribe communication method, where user did not need to update by themselves, because of that MQTT is the best choice to transfer data because it had low bandwidth environment.

There is also studies by S.K. Luthra et al. in the journal "Design and development of an auto irrigation system" that explained about auto irrigation system, In scientific irrigation scheduling water should be

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applied to a crop at an appropriate soil water tension to fulfil its evapotranspiration requirement. This can be achieved by developing an automatic irrigation system. In this system soil water tension is sensed through a modified manometer type tensiometer. The design provides control of irrigation at the predecided soil water tensions and preprogrammed timer (Luthra at al., 1997).

That's why in this research we make a system that can automatically turn on a pump and fill in water to the pond when the water in pond is runs out by using float level sensor. This research also using MQTT Protocol to sending data from system to user smartphone device.

2 OVERVIEW OF AUTOMATION SYSTEM

Automation System (Domingues et al., 2016) is a system that oriented to the computerized control and management of building services. The architecture of this system can be organized into three layers:

1. The lowest layer or Field Layer where the interaction with devices such a sensor.
2. The middle layer is the Automation Layer, where the measurements are processed.
3. The top layer is the Management Layer, where activities like system data presentation, forwarding, trending, logging, and archival take place

Modern automation system tend to separate the automation logic from the user interface through service-oriented abstractions, providing flexible access to the system from several different platforms and locations (Mufid et al., 2018).

3 OVERVIEW OF MQTT

Message Queuing Telemetry Transport (MQTT) is a protocol that runs on top of the TCP/IP and specially designed for machine-to-machine special address. MQTT working system apply Publish and subscribe date and on implementation, the device will be connected to a Broker and have a certain topic (Mufid et al., 2020).

- Broker : Broker ad a function to handle publish data and subscribe from various device, can be linked to server that has a dedicated IP address. Some examples of existing brokers such as Mosquitto, HiveMQ and Mosca.
- Publish : publish is a way for device to send data to subscribers. Usually in this publisher is the device that connected to a particular sensor.
- Subscribe : subscribe is a way for a device to receive various data from publishers, subscriber can be used to save data request from sensor and send it to the publisher when the request is asked.
- Topic : topis had a function to grouping data by certain category.

4 SYSTEM DESIGN

Figure 1 show that this system will be 3 float sensor level that will be connected to microcontroller, 1 sensor for the bottom part of the pond, 1 sensor in the top part of the pond, and 1 sensor that will be placed on the ditch.

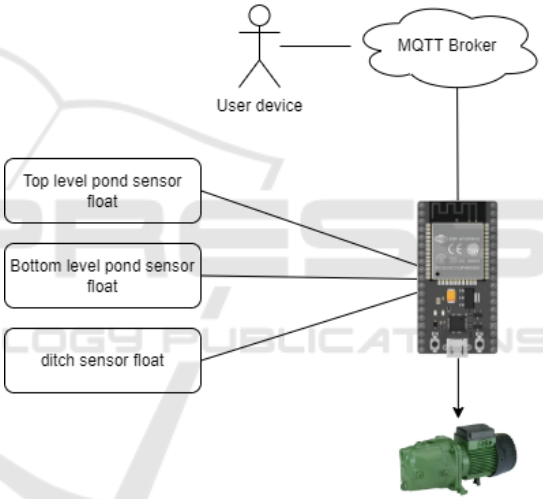

Figure 1: System Design.

Each sensor level will receive their data to microcontroller and microcontroller will processing each data which will later become an order in accordance with what has been formulated below. Formula description with 1 is True or ON and 0 is False or OFF.

Table 1: Float Level Sensor Formula.

No	Bottom level sensor	Top level sensor	Pitch sensor	Pump
1	0	0	0	0
2	0	0	1	1
3	1	0	1	1
4	1	1	1	0
5	1	0	0	0

4.1 Use Case Diagram of this System

Use case diagram is a tecinique that used to develop a software or information system for functional purpose from the system. Use case explaning about interaction between user and sytem. From the figure 2 we can see that user will have some fiture from the system like, turn on the pump manually from smartphone, monitoring water condition, and also changing each sensor condition.

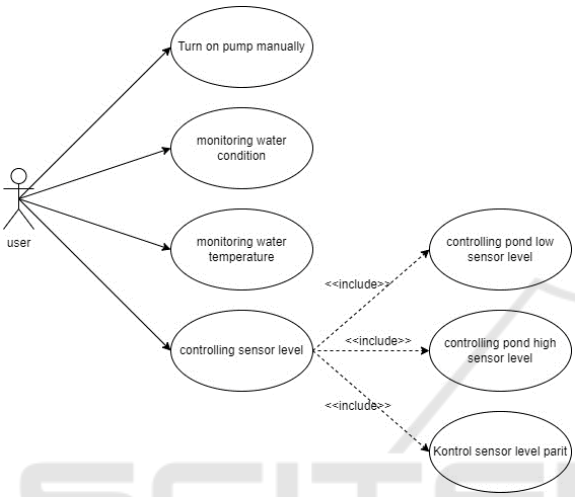

Figure 2: Usecase Diagram.

4.2 Activity Diagram of this System

Activity diagram used to describe varion activity that will be designed in the system, where each plot will be had start, decision from system, and the end of the system. In figure 3 can show where user can see each sensor condition from sensor, user also can turn on the pump manually from smartphone. The data will be collected from each sensor and will be subscribed, and published to MQTT broker from system.

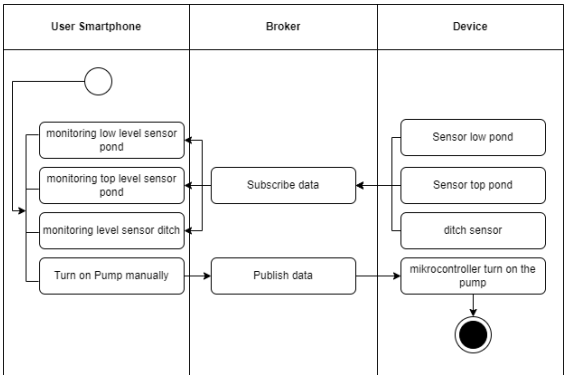

Figure 3: Activity Diagram.

4.3 Design Interface of this Application

Smartphone design interface used to describe menu and the interface for the smartphone application. Figure 4 show that there will be only 1 interface for the smartphone application, on that interface user can monitoring each sensor condition in smartphone, user also can turn on the pump manually by using the switch button.

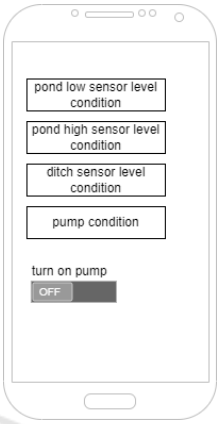

Figure 4: Design Interface.

4.4 Design Circuit of this System

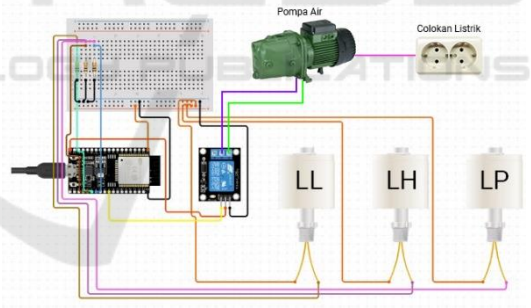

Figure 5: Design Circuit.

From the desiign circuit in figure 5, we can see there is microcontroller esp 32 that already had wifi modul, and there will be relay that used to switch on or off the pump and there.

5 PERFORMANCE EVALUATION

Figure 6 show the built of the device, where there is microcontroller that used to processing data that been send by sensor float level, there is also relay that will control the power of water pump.

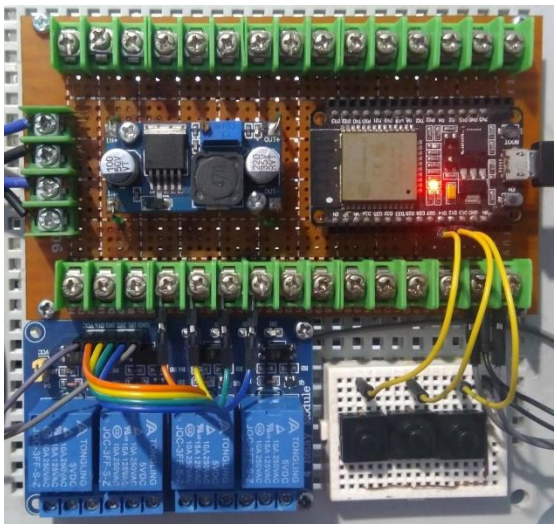

Figure 6: Automation device.

We also make application like in figure 7 for user to control the system via wifi. In the application user can control and monitoring the condition of the 3 sensor, user also can tunr on or turn of the pump by switching the function.

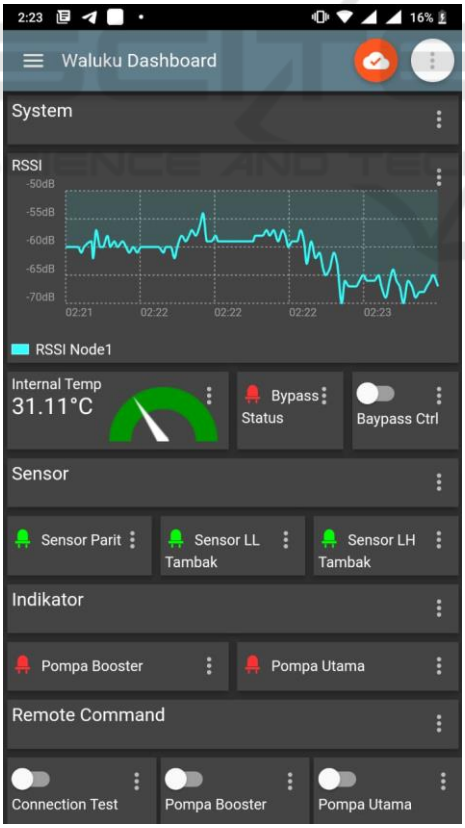

Figure 7: User smartphone application interface.

There is also some difference between MQTT and other protocol like HTTP and XMPP show in figure 8, one thing that make MQTT is the best protocol is because MQTT had low bandwidth environment that made the data transfer faster than other protocol.

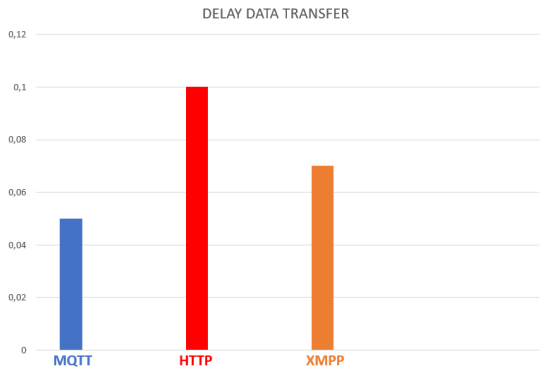

Figure 8: Protocol graph delay data transfer.

In the reporting process. Device already work properly where is in automatic mode or manual like what we can see in the graph below.

Table 2: Testing Scenario.

No	Task	Manual	Automatic
1	Turn on the pump	Work properly	Work properly
2	Turn off the pump	Work properly	Work properly

6 CONCLUSION

One of the problem that often occur for shrimp farmer is the difficulty to get water especially when summer season. So in this research we make a automation system for water irrigation that will be implemented on water pump. This automation system used float level sensor to become the indicator when the water in the pomp draining and when the water come to the ditch. This research we used MQTT protocol to send data from the system to user smartphone device so that user can monitoring and turn on the pump manually from smartphone from the device testing. We get the conclusion that the device works well with the manual method and the automatic method using the MQTT protocol because of the lower bandwidth usage compared to other protocols. For further research, it is recommended not only to build an irrigation system but also to be equipped with a recommendation system for fertilization.

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