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Development of Environmental Monitoring System for Aquaculture Application

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Abstract

Good quality of water is important for maintaining the quality of the aquaculture. The water quality index can be improved using a real-time monitoring system for analysis, monitoring, and observation. Sungai Pahang is known as the largest river in Malaysia and contributes in freshwater aquaculture industry. The habitat of aquaculture can be affected in term of environmental, water quality and parasite. Mostly the pollution factor is from bauxite, deforestation, and due to dry and flood season. This paper aims for observation of the environmental factors in term of turbidity, total dissolved solid and temperature using wireless sensor network. Higher percentage of the dissolved solid and turbidity in the waters could decrease the percentage of oxygen. The sensors used are temperature sensor, turbidity sensor and total dissolved solid sensor for collecting the data. The project used LoRa Dragino LG01-S gateway for transmitting the data based on real-time monitoring. By using Arduino as microcontroller, the sensors collect the data and transmit the data through LoRa nodes to be displayed in FRED application. The result revealed the characteristic of turbidity, total dissolved solid and temperature for 3 different scenario of river, puyu pond and catfish pond. Thus, this research is expected to realize the advantage of monitoring the environment not only for aquaculture but also for human and other living thing. The low strength of LoRa WAN communication is expected due to the suburban area. However, the signal strength could be improved using more sensor nodes as medium of transmission.

Keywords**;** *Wireless sensor network, aquaculture, Long range, water quality monitoring*.

I. INTRODUCTION

Malaysia is known as federal constitutional monarchy in South Asia. Malaysia consist thirteen states and surrounded by sea. The aquatic ecosystem in Malaysia is from salt water fish and freshwater fish. The daily protein diet for Malaysia citizen is aquatic. The average 20 percent of their food is fish. Fish consumed index in 2011 is 53.1kg and be expected to increase 61.1kg in 2020 [1].

Freshwater fish, shrimp, and clamp are one of the products for aquaculture. Water is the environmental habitat for the aquaculture; therefore a good quality index is a must. Freshwater fish spend their live in the river of lakes with salinity less than 0.05%. The range of the salinity of freshwater fish and salt water fish is different. The different of salinity affect the osmoregulation of fish to regulate the salt in the body [2]. The different type of environmental can affect the fish regulate system.

The modification of habitat for agriculture such as bauxite pollution is the potential and widespread threat to aquatic [3]. Bauxite and deforest is a main topic which caused a large scale effect in agriculture and aquaculture. Nevertheless, the bauxite pollution is uncontrolled activities with great potential to

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create huge impact for agriculture and quality of water surrounding [4].

The long range communication is one of advantage for suburban and urban area. The wireless sensor network is a communication node between the transmitter and receiver to collect and monitor the information by using a radio signal. Efficient data transmission in wireless sensor network as LoRa WAN is useful for long range with lower power consumption. A wireless sensor network consists of nodes for transmitter and receiver which are a base station and sensor nodes [5]. The LoRa Wan is introduced as a long-range wireless sensor network with lower power consumption. Communicate between sensor nodes for data using signal strength in urban area such as a building is a disadvantage for a wireless sensor network in long-range communication [6].

The advantage of wireless communication which is cable reduces, install cable and manpower installation, but wireless communication has the biggest disadvantage in term of signal strength for long distance. There are new evaluations of wireless communication from ZigBee to LoRa WAN in term of strength and signal strength. Refer the figure 1-1 the sensor point needs to communicate with sensor nodes for collecting the data and the data will send to the Ethernet for the application to read the data [7-9]. It will use the IoT platform for the data display. The signal strength for data transmit is determined by the strength of Ethernet.

II. METHODOLOGY

A. Flowchart

The sensors are used during the experiment to test the water quality and send the information to Arduino Uno. The Arduino Uno with transmit the data to the gateway by using Lora Shield. The gateway need the router as the path for the data to be received. The stability of signal from the router determined the speed of data to be received. If the transmitter connection is expected to be low in The Thing Network, the coverage need to be checkedand strength of router. The data will be displayed in FRED application.

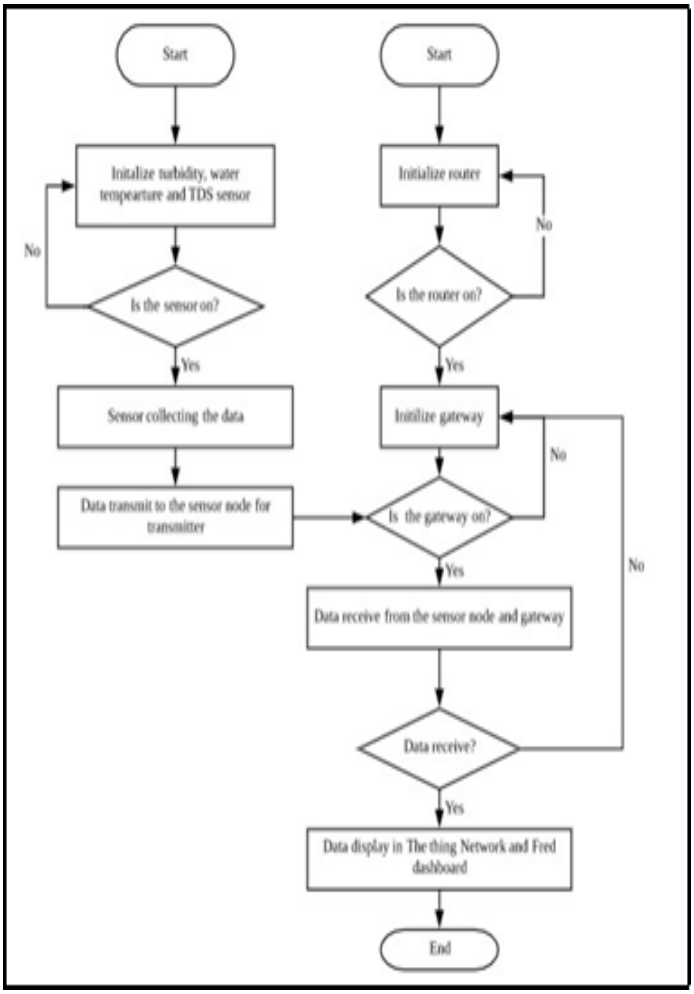

Fig. 1. The flowchart of environmental monitoring for aquaculture

B. Hardware development

The hardware equipment are turbidity sensor, total dissolved solid sensor, temperature sensor, Arduino Uno, LoRa Dragino shield and Dragino LG01-S gateway used to measure the turbidity, total dissolved solid and temperature.

Arduino Uno is used as a microcontroller for collecting the output and the data will be transmitted by the LoRa shied to the gateway using a portable network.

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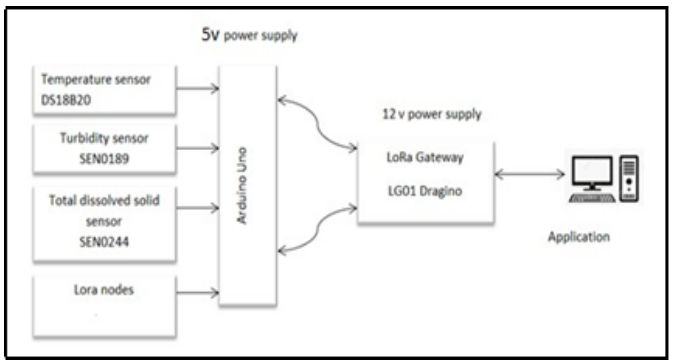

Fig. 2. The block diagram of the system

Figure 1 shows the block diagram of the system. The LoRa shield and the sensor will be placed on the Arduino for transmitting part. The Arduino required 5V to be operated. The Dragino gateway will is used to send the data to the FRED dashboard The Thing Network application.

The sensor part will used the pin A0, pin AI and pin 5 in port provide in Arduino Uno, meanwhile Dragino Shield only used for transmitter and receiver port in Arduino Uno as shown in figure 3 to 6.

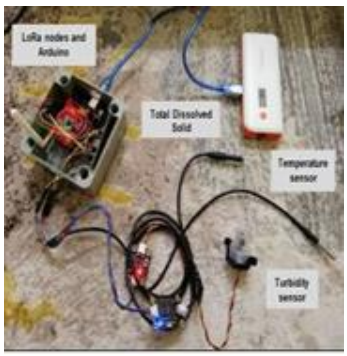

Fig. 3. The transmitter and the receiver of the system

Fig. 4. The LoRa Gateway for receiver part

Fig. 5. The prototype of the system

Fig. 6. The experiment at catfish pond

C. Experiment

Fig. 7. The catfish pond

Fig. 8. The river

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Fig. 9. The Puyu pond

The research is conducted using 3 different scenarios as shown in figure 7 to 9. The testing sample is taken from puyu pond, Catfish Pond and river water. This is to determine the 3 type of characteristic of the water.

III. RESULT

The data collection is based on serial monitor Arduino Ide, The Thing network and FRED applications. The data is collected from three different scenarios which are from the river, puyu pond and catfish pond. The collection of data is done in real time within the same time interval. Each of the water type is monitored and measured in term of turbidity, temperature and total dissolved solid.

A. The data

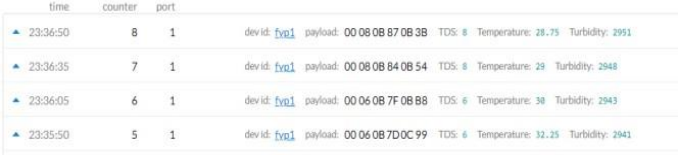

Fig. 10. Application data in the Thing Network

Figure 10 shows the outputs result of data transmit from transmitter to receiver in term of payload, counter, time and output value

B. Data measurement

Figure 11 to 13 show the result for turbidity of puyu pond, catfish pond and river in the time interval between 1201 to 1230 hours.

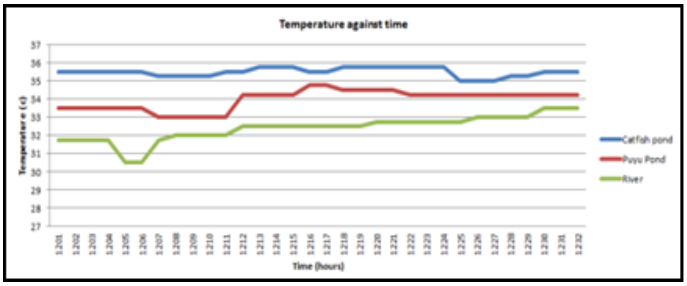

Fig. 11. Graph of temperature against time

Figure 11 shows the temperature in the puyu pond, river and catfish pond. Therefore, the higher temperature range is catfish pond in range 35 c to 35.75 c. The lower temperature range is river with range 31.75C to 33.5 C

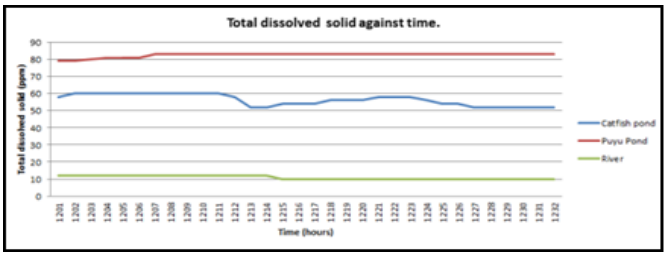

Fig. 12. Graph of total dissolved solid against time

Figure 12 shows the result of total dissolved solid of puyu pond, catfish pond and river. The higher total dissolved solid range is from puyu pond with the range of 79 ppm to 83 ppm. The lower total dissolved solid range is from river with the range of10 ppm to 12 ppm

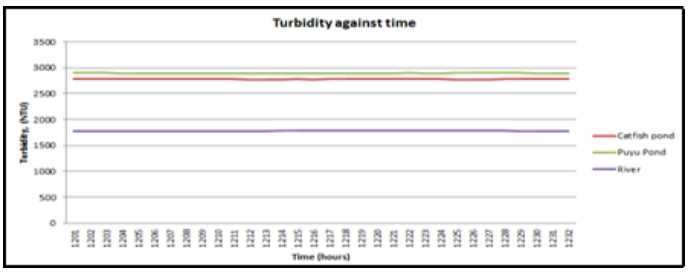

Fig 13. Graph of turbidity against time

- Figure 13 shows that puyu pond has higher turbidity range with value between 2777 NTU to 2782 NTU. While the river shows lower turbidity value with a range between 1775 NTU to 1790 NTU.

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IV. DISCUSSION

The time interval for data to be sent to the gateway is different for each time. Based on figure 8, the counter 5 to counter 6 took 15 seconds and counter 7 from counter 6 took 20 seconds of time interval. This is happen due to the signal strength and the obstacle of the line of sight.

The temperature data is taken in a same time which is from 1200 until 1230 hours. The data for the 3 scenario is different depending on the scenario. The catfish pond is the highest temperature as compared to puyu pond and river. The concentration on the surface of water is one of the main reasons. On the surface of catfish pond, there have oil surface. The oily water is produced from the fish food as catfish fish eat organ of chicken. The condition of the water more oily compare to puyu pond and river. Therefore, the temperature of water for catfish pond is highest than river and puyu pond. But, the temperature for the catfish is normal to their habitat.

The turbidity for puyu pond is approximate to catfish pond but the highest among these three scenario. The habitat of puyu fish is different from the catfish fish. Puyu fish known as rugged freshwater fish as they can life over watery land. The sediment in puyu pond is from the dead algae and dust sand which cause by the puyu fish habitat. The turbidity of the river is the lowest and below 15 NTU. It shows the color and sediment in the river is clear. The total dissolved solid for puyu pond is higher total in range 79 ppm to 83 ppm. The lower total dissolved solid range is river with range 10 ppm to 12 ppm. It shows that the solid in puyu pond such as dead algae and sand is higher than the river. The color structure in puyu pond is darker than the catfish pond.

The project shows the characteristic of water quality for the aquatic habitat. The different turbidity, total dissolved solid and temperature can be seen by in this project. The higher the temperature, total dissolved solid and turbidity in the aquatic habitat, the lower the oxygen concentration in the river. The better the environment aquatic habitats, then it will produce a better the production of fish.

V. CONCLUSION

The environmental monitoring is one of incentives for a fish breeder to improve the production of the fish. The project was improved from the water monitoring using cable wired to wireless networks. The project is an advantage to suburban area to minimize their cost in term of worker and care for the cage. This project can be advantage not only for aquatic but for living human to improvement their quality of living nature in term of water quality. With the water quality monitoring project will help the breeder to improve their economy to a better future. The most improvement in the project is microcontroller. As the main processor, the working task is unlimited. From Arduino Uno, the project can be upgraded to Raspberry Pi 3+ for a better controller. Raspberry Pi is known as minicomputer which can handle multi-task.

The second improvement which can make is adding more sensor such as pH sensor, dissolved oxygen sensor and ammonia sensor. The current sensor in this project is more focus on the turbidity and solid in the river. By adding those sensors, the output data can be more accurate to classify the water index quality.

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