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Design and Implementation Internet of Things for Monitoring Temperature and Water Level in Aquascape

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Abstract: Internet of Things (IoT) is a technology that can be implemented in daily life. At this time, IoT is implemented in smart homes, smart cities, etc. IoT Technology can be implemented on Aquascape as a keep fish hobby. Water Quality on Aquascape is an essential component in decorative fish and plant habitats on Aquascape, and some things need to be considered: water level and temperature. In this Research authors want to make solutions like water Controllers by the temperature sensor and ultrasonic based on the internet of things using NodeMCU. The thingspeak platform as storage of the temperature sensor for reading temperature using DS18b20 and ultrasonic as a reading difference of water level. The experiment of each component by using different methods according to component requirements. Based on experiment results, we can conclude that the water reduction rate on Aquascape by using an IoT device has a smaller value than on Aquascape without an IoT device. On Aquascape, which uses an IoT device, the fan's condition only turns on when the temperature is more than 27 degrees Celsius. That condition can reduce the water evaporation caused by the chiller.

Keywords: *Aquascape, Internet of Things, Thingspeak, NodeMCU*

1. Introduction

Internet of Things (IoT) is concept of connecting smart device with other smart devices that both of that used to exchange data and for control purposes via internet. By the time By the time for now, IoT concept have many used on object around us. By the estimated in 2020 on 50 billion object will be connected to internet[1]. At this time IoT implemented on *smart home, smart city* and etc. one of the implementation of technology IoT there is Aquascape. That is a fishing keeping hobby. *Aquascape* is an artistic activity in organizing, planting water plants, stones, and driftwood naturally and beautiful in a aquarium. Like a gardening in water. *Aquascape* usually consists of a fish as well as plants, but this time the fish isn't the main subject, but only for making view of aquarium looks beautiful. The object that must be considered in this research are condition of water in aquarium and severals parameter for determine the water is suitable or not for fish and aquatic plants such as pH, nutrition and temperature. The value parameters must be suitable with specification of fish and plants in aquascape[2]. Water high also one of factor that must stability because water height is able to change the direction the angel of light so can be affected the intensity of the light entering the aquascape. Using IoT in agriculture field especially aquascape to increase the efficiency in modern era especially in monitoring and controlling with IoT to get data network without direct interaction with human to human and human to computer.[3]

In Fitria Renanda journal's the title is "Aquascape kit based on Internet of Things" this aquascape kit design using pH sensor, filer and LED. pH sensor used to reading value of pH and LCD 16x2 to display pH and value of ADC, and using Bylink application to monitoring for long distance.[4] Asmanditya Hibatullah the title "Smart Aquarium based on IoT" planning device for detection water turbidity and the notification was sent via internet to the aquarium owner. This device was designed by microcontroller ESP32 for connecting the device to internet using wifi as a interface and sensor turbidity as a sensor water turbidity aquarium[5]. Based on Efany Danarti journal the title is "Automatic Water Quality Control in Aquascape" by using Arduino Uno as a controlling for pump control, and air conditioner. The value of detection will display on LCD 16x2 and as a input data for microcontroller Arduino Uno to controlling water circulation and temperature accordance with plants condition[6].

Jayti bhatt, Jignesh published "Real time water quality monitoring system". This research ensures a safe supply of drinking water. This system consists of different water parameters. The data is processed by microcontroller. At last data from the sensors is viewed in the web server [10]. Ning [11] designed monitoring system for water quality

From the literature review, the authors do research about **Design And Implementation Internet of Things for Monitoring Temperature and Water Height in Aquascape** by using sensor ultrasonic and temperature DS18b20 for monitoring water volume using Node MCU, and as a interface sensor to internet and continuous to platform thingspeak. From that system has been used automation which will be monitored for stabilize of water height and temperature as a request by smartphone and website user.

2. Research Methods

Design Device in this research make in flowchart research as a systematic tools design and this is a device system flowchart that was made.

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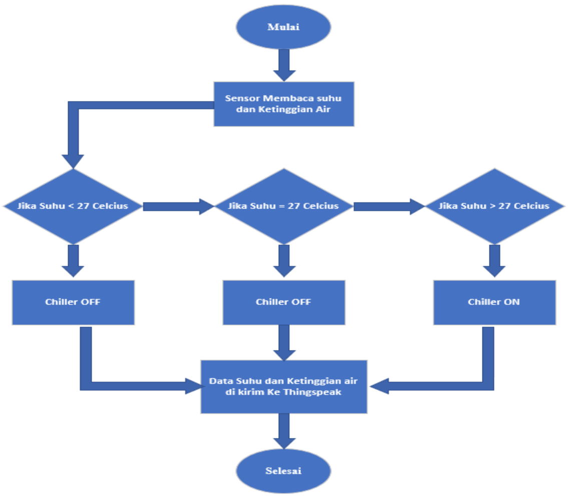

Fig 1: Device System Flowchart

Based on figure 1 device system flowchart, the system will start with reading every parameter by sensor. And than if the temperature sensor reads values in water less than C = 27 Or if sensor reads a temperature value of C = If the temperature sensor reads a temperature value of C = 27, the Chiller is active. When the Chiller condition has been carried out, the temperature and water level data are sent to the thingspeak platform.

Design system consist of design hardware and software. Tools and materials are using NodeMCU as microcontroller, temperature sensor as a detection of temperature in Aquascape. And ultrasonic as a detection distance water height in aquascape. NodeMCU as a interface wifi for connecting to internet. Diagram block system hardware display on figure 2.

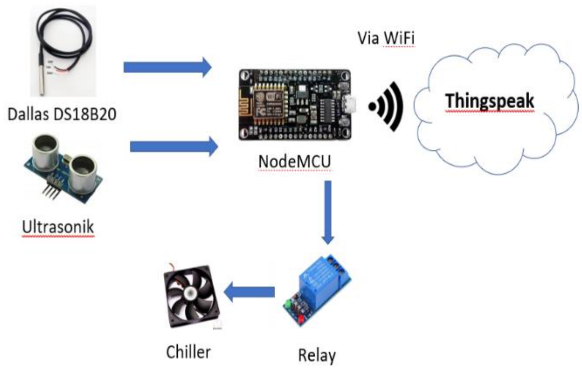

Fig 2: Diagram Block System

In diagram block design system for monitoring temperature and water height in aquascape as mind core of device is esp8266. Ultrasonic sensor and Dallas DS18b20 temperature is input data which were ultrasonic sensor and temperature send data to NodeMCU. When data was received, the data will be processed in NodeMCU and the Output is Relay. Relay working for optimization temperature which is the relay would connected to chiller for bring down the temperature, if the temperature bringing up so to relay will be active. The data from other sensor that transmit will send to platform thinkspark. NodeMCU sends data to Thingspeak and will display on application integrated with platform thingspeak there is *thingsview* in *Smartphone*. Which is the data will transmit to thingspeak cloud by NodeMCU by connection internet *wifi*. Transmit Data to platform can be see in figure 3.

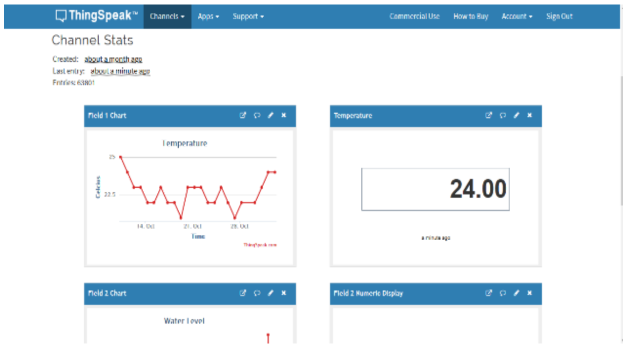

Fig 3: Display Thingspeak *Dashboard Platform*

Figure 3 explain about transmit parameter requirement and display by using graph in application channel thingspeak. For display on application in android there are thingsview seen as in figure 2.

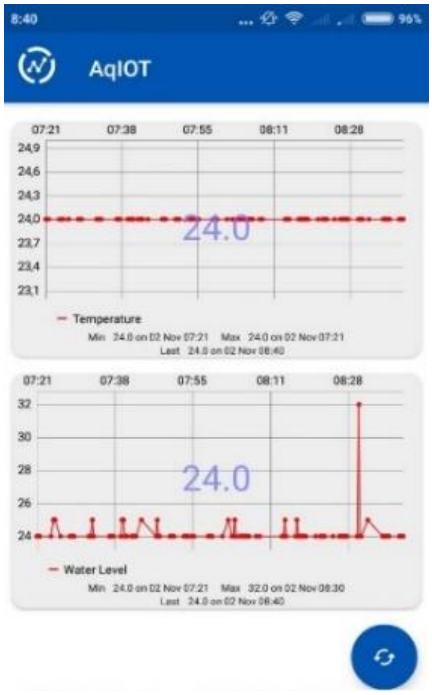

Fig 4: Display Thingsview on android

The parameters display on Thingsview have the same values and graph as those on thingspeak. The difference in the application dashboard, Thingsview consist of android application that have been integrated with thingspeak database

3. Results and Discussions

3.1. Device Installation and Device Experiment

Device installation that has been made can be seen in figure 5.

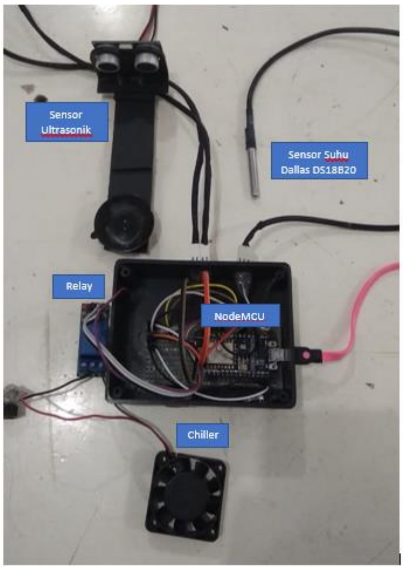

Fig 5: Aquascape Device System

Figure 5 is a device that is in accordance with system planning. To find out which devices have been made according to system planning, overall system testing is needed. System Testing is done to find out whether a system has worked in accordance with the conditions expected so that it can know the level of success of a device that has been made. The automation system created is the Chiller condition automation which is triggered by the temperature value in Aquascape water. The parameters tested on the test system are the condition of the fan when the temperature reaches less than C < 27, the temperature at C = 27, and the temperature is more than C > 27. then the temperature and water level data is sent to the configured Thingspeak platform. Based on the test results, the condition of the system can be seen as in Table 1.

Table 1. Result of System Experiment

Temperature (C)	**Water Height (cm)**	**Chiller Condition**	**Data Transmit thingspeak**	**System Status**
<27	24	Off	Sent	Success
<27	24	Off	Sent	Success
27	23	Off	Sent	Success
27	23	Off	Sent	Success
>27	22	On	Sent	Success
>27	22	On	Sent	Success

Based on the results of system experiment, it can be seen that from several conditions measured by the sensor, the Chiller output is in accordance with the parameter values determined that the fan turns on if the temperature in the aquascape is at a value of more than C > 27Then for the measured water level using ultrasonic sensors as soon as they are in accordance with actual conditions. For status data sent from an IoT device, in the system test the status data was sent to the Thinkscape Platform.

3.2. Experiment Result of Dallas DS18b20 Temperature Sensor

This is the results and discussion from Dallas DS18b20 sensor with 10 times trial experiment every 5 minutes and in 3 conditions for test the temperature measurement there are in normal condition, temperature up to 30 degrees Celsius (hot water), and temperature under 20 degrees Celsius (cold water).

a. Experiment water temperature sensor at normal temperature (C=27)

Table 2. Water Temperature Sensor Test Result at Normal Temperature

No	**Termometer (Celcius) (a)**	**Temperature Sensor (Celcius) (b)**	**Minutes**	**Error percentage (%)** $C = \frac{a - b}{a} \times 100$
1	26	27	5	3.85%
2	25	26.12	5	4.48%
3	25	26	5	4.00%
4	26	25.94	5	0.23%
5	26	25.87	5	0.50%
6	26	25.87	5	0.50%
7	26	25.87	5	0.50%
8	25	25.87	5	3.48%
9	25	25.87	5	3.48%
10	26	25.87	5	0.50%
Average Error				2.15%

In table 2 is the result of 10 times experiments in every 5 minutes in a time, once 50 minutes and values obtained on the thermometer and temperature sensor shows numbers that are not much different. The conclusions in table 1 are the experiments obtained the results of measurement with normal water temperature which shows a value C = 26, The results of 10 times hot water experiments show an average error percentage 2,15% which mean the sensor is good in working. In the experiments is show that sensor is working with well in normal water temperature. The condition has shown that the sensor is functioning properly with small percentage error.

b. Experiment Water Temperature Sensor at Hot Water

Table 3. Water Temperature Sensor Experiment Result at Hot Water Temperature

No	**Termometer (Celcius) (a)**	**Temperature Sensor (Celcius) (b)**	**Minutes**	**Error Percentage (%)** $C = \frac{a - b}{a} \times 100$
1	31	30.69	5	1.00%
2	32	30.94	5	3.31%
3	32	30.94	5	3.31%
4	30	30.87	5	2.90%
5	31	30.87	5	0.42%
6	31	30.87	5	0.42%
7	30	31.44	5	4.80%
8	33	30.94	5	6.24%
9	33	30.87	5	6.45%
10	32	30.87	5	3.53%
Average *Error*				3.24%

In table 3 was shown the results of 10 times experiments in every 5 minutes in a time, once 50 minutes and obtained the values on the thermometer and temperature sensor which shows the number is not much different. The conclusions in table 2 are the result of measurement with hot water which shows a value of C = 31, the results of 10 hot water experiment show an average percentage error of 3.24% which means the sensor is working well. Conduct above it, the temperature sensor in hot water condition has shown that the sensor is functioning properly with a small percentage of error results.

c. Experiment Water Temperature Sensor at Temperature below 20 Degrees Celcius.

Table 4: Water Temperature Sensor Results at Cold Water Temperature

No	Thermometer (Celcius) (a)	Temperature Sensor (Celcius) (b)	Minutes	Error Percentage (%) C = x 100
1	14.50	14.49	5	0.07%
2	14.55	14.75	5	1.37%
3	14.20	14.56	5	2.54%
4	14.25	14.50	5	1.75%
5	14.25	14.50	5	1.75%
6	14.30	14.56	5	1.82%
7	14,50	14.56	5	0.41%
8	14,30	14.50	5	1.40%
9	14,30	14.38	5	0.56%
10	14,30	14.13	5	1.19%
Average *Error*				1.29%

In table 4 is the results of 10 times experiments conduct 5 minutes in a tim3, once 50 minutes and the values obtained on the thermometer sensor and temperature sensor show that the figure the number of values the experiment not much different. The conclusions in table 3 are the results of measurements obtained with cold water which shows a value of C = 14, the results of 10 attempts of cold water show an average percentage error of 1,29% which means the sensor is working well. In experiments conduct above it, show that temperature sensor in cold water conditions has shown that the sensor is functioning properly with a small percentage error.

3.3. Ultrasonic Sensor Experiment Results As a Measurer of Water Height.

Table 5: The Results of Ultrasonic Sensor Measurement.

No	Distance Real/Ruler (cm) (a)	Ultrasonic Sensor (cm) (b)	Error Percentage (%) C = $a - b\frac{v}{-}$ x 100
1	3	3.2	6.67%
2	6	6.6	10.00%
3	10	10.3	3.00%
4	12	11.9	0.83%
5	15	14.7	2.00%
6	20	21.0	5.00%
7	24	24.6	2.50%
8	28	28.5	1.79%
9	30	31.1	3.67%
Average *Error*			3,55%

In table 5 is the result of 10 experiments and the values obtained on the Ultrasonic sensor which shows the number of value isn't much different. The conclusions in table 4 show that the results obtained by the measurement have a difference that is not too significant. The results of 10 measurement experiments show an average percentage error of 3.55% which means the sensor is working well. In the experiments conducted above, it can be said that the Ultrasonic sensor is functioning properly with a small percentage error.

3.4. Results of Comparasion of Level Water Reduction using IoT Device and Without IoT Device.

In this experiment carried out within 2 weeks, one week aquascape experiment without using IoT device, and one week aquascape experiment using IoT device. The parameter measured is the amount of water that recedes in time every day.

Table 6: The result of Experiment Aquascape Water Level Reduction.

Day-n	Without Device (cm)	With Device (cm)
1	2	1
2	3	2
3	3	1
4	2	1
5	3	2
6	3	2
7	3	2

Based on table 6 it can be concluded that the level of water reduction in Aquascape using IoT devices has a smaller value compared to aquascape without IoT. That is because of Aquascape using an IoT device, the fan condition only turns on when the temperature is more than 27 degrees Celsius. Whereas in Aquascape without an IoT Device, the condition of the fan turns on for 24 hours so that the water evaporates more.

3.5. Results of QoS Measurements at Distance of 5m, 10m, and 20m.

3.5.1. Delay at a distance of 5 meters

Delay measurement of a distance of 5 meters, a measurement of 50 times was sampled. The measurement results can be seen in Figure 6.

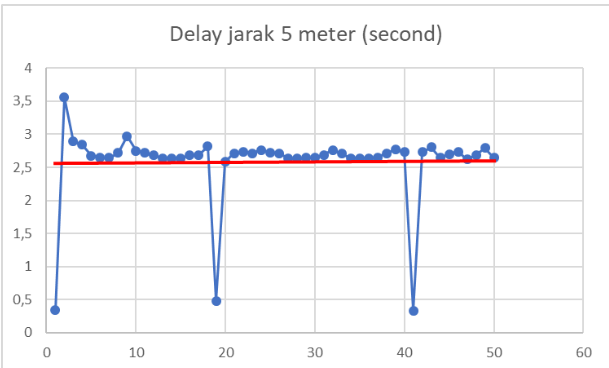

Fig 6: Results of Delay Experiment at Distance 5m

Based on Figure 6 it can be seen that the average data delivery delay at a distance of 5 meters is 2.59 second.

3.5.2. Delay at a Distance of 10 meter

In the measurement of the delay distance of 10 meters, is a measurement of 50 times was sampled. The measurement results can be seen in figure 7.

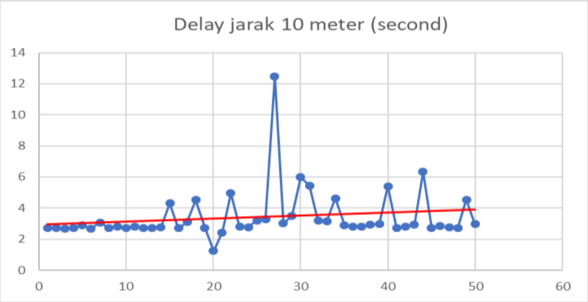

Fig 7: Result of Delay Experiment at Distance 10m

Based on figure 7 can be know as delay average sending data at 10 meter there are 3.241 seconds.

3.5.3. Delay at Distance of 20 meter

In delay measurement at distance 20 meters, was taken the results and can be seen in figure 8.

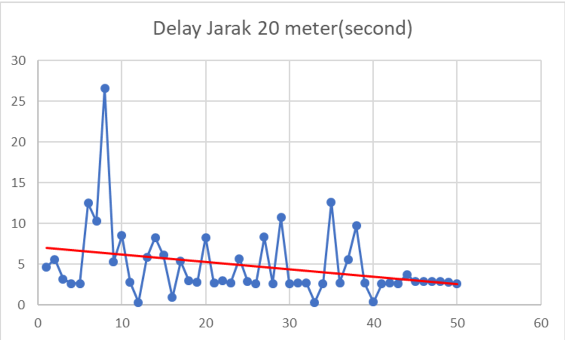

Fig 8. Experiment Results Graph of Delay with a distance 20m

Based on Figure 8 it can be seen that the average Delay of sending data at a distance of 20 meters is 4.81 seconds.

3.5.4. Average Delay

3.5.4.1. Delay

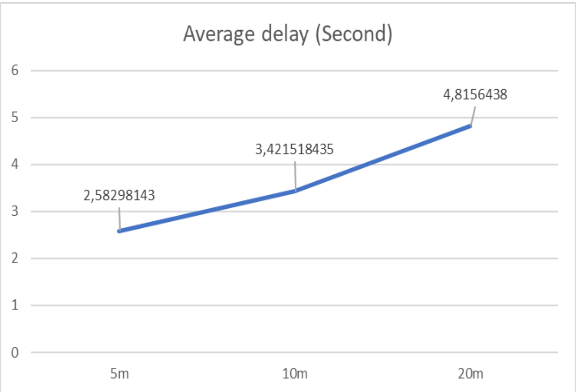

Fig 9: Experiment Results Graph Average Delay.

In the Delay test conducted for 50 experiments at a distance of 5m, 10m, and 20m produces a different delay. Based on the graph in Figure 9 it can be concluded that the data transmission delay. It can be learned from the measurement results Delay at a distance of 20 m which has a value of 4,8156 seconds.

3.5.4.2. Throughput

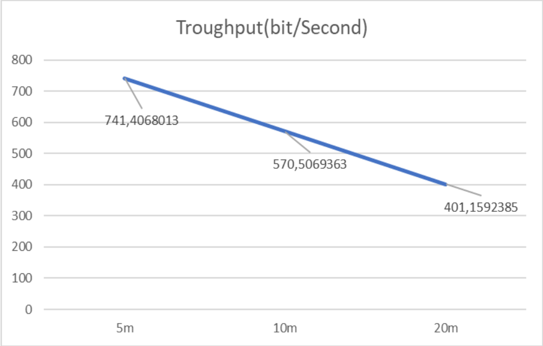

Fig 10: Throughput Experiment Graph Result

In the Throughput test which is carried out for 50 experiments at a distance of 5m, 10m, and 20m produces a different Throughput. It can be concluded that in this Throughput test the amount of data and the Delay affect the value of the resulting

3.5.4.3. Packet Loss

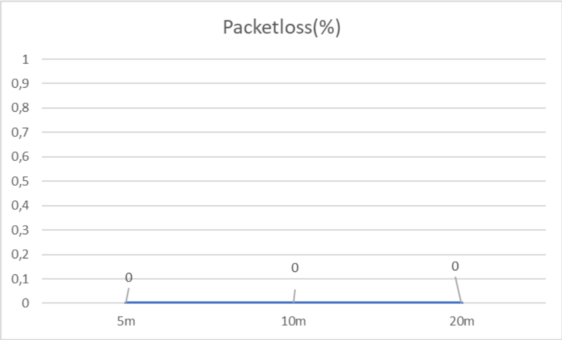

Fig 11: Experiment Results Graph of Packet Loss

In Packet Loss tech which is carried out for 50 trials with a distance of 5m, 10m, and 20m. The number of packets captured depends on the amount of data by NodeMCU, so a Packet loss, connectivity between WiFi sources an devices is very influential. Packet Loss engerated after several attempts have the same result which is 0% This shows that NodeMCU has successfully sent all data sent to WiFi Source.

4. Conclusion

In the measurement of water temperature it can be concluded that the sensor works well. It can be known based on the results of measurements at normal temperatures, hot, and cold have an average percentage error below 5%. The level of water reduction in Aquascape using IoT devices has a smaller value compared to Aquascape without IoT. That is caused by Aquascape using IoT devices, the fan condition only turns on when the temperature is more than 27 degrees Celsius, so it can reduce the evaporation of water caused by the Chiller.

Distance is one of the things that can affect the data transmission delay. The farther the device is, the greater the shipping delay. The large amount of data and delay affects the value of the resulting throughput. The greater the Delay value, the smaller the Throughput value. The number of packets captured depends on the amount of data sent by NodeMCU. Packet Loss generated after several attempts has the same results 0% which indicates that NodeMCU has successfully sent data.

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