Telemonitoring System for Turbidity and Water pH for Draining and Automatic Chlorine Provision in Smartphone-Based Swimming Pools

Kalam Achmad Nabila[1], Aisah [2], Abdul Rasyid [3]
[1]Program Study of Digital Telecommunication Networks
Department of Electrical Engineering, State Polytechnic of Malang, Malang, 65141, Indonesia
[2,3]Program Study of Telecommunication Engineering
Department of Electrical Engineering, State Polytechnic of Malang, Malang, 65141, Indonesia
[1]kalamachmad@gmail.com, [2]aisah@polinema.ac.id, [3]abdul.rasyid@polinema.ac.id

Abstract— Monitoring the quality of swimming pool water is a sanitation effort, namely by providing liquid chlorine to reduce organic substances and disinfection against microorganisms. The system is applied to a small swimming pool which consists of four sensors, namely pH sensor, turbidity sensor, ultrasonic sensor, water flow sensor. The four sensors will send data to ESP32 to be processed according to the system created. After the ESP32 has finished processing, it is then sent to firebase and an application on a smartphone to make monitoring and controlling water easier. The test results show that the proposed system can process data from the pH sensor, turbidity sensor, water flow sensor, an ultrasonic sensor. Then the results of the pH data have the highest pH value of 7.9 and the lowest of 6.9. Furthermore, the turbidity sensor data results have a value of 0 NTU with the highest ADC of 3827. The drain is automatically divided into 2, namely monitoring and controlling. Furthermore, the quality of the WiFi network tested using Wireshark when sending data in terms of delay has an average value of 0.188389435, packet loss of 1.178, and throughput of 7428 Kb/s.

Keyword : ESP32, pH Sensor, Turbidity Sensor, Sensor Ultrasonic, Waterflow Sensor

I. INTRODUCTION

Swimming is an activity that is loved by the community. However, without realizing it, some swimming pools think that the water quality is not good enough to become a medium for transmitting diseases in the water.

Water quality in a swimming pool can be seen from several aspects, including turbidity and water pH levels. The turbidity of the water in the swimming pool is usually influenced by the pH level in the swimming pool water, which is too high, which will form stains that can fade the colour on the walls of the pool and cause cloudy swimming pool water.

Monitoring the quality of swimming pool water is a sanitation effort, namely by providing liquid chlorine to reduce organic substances and disinfection against microorganisms. The use of chlorine must be within safe limits. Chlorine with a low concentration causes microorganisms not to be adequately disinfected, while chlorine with an excess concentration results in residual chlorine, which negatively impacts human health [1].

According to the Regulation of the Minister of Health of the Republic of Indonesia No. 32 the Year 2017, there are several physical and chemical parameters on environmental health standards for swimming pool water media. Where for turbidity it has a maximum standard of 0.5 NTU, for pH, the value is in the range of 7 to 7.8, for the remaining free chlorine, the value is in the range of 1 to 1.5 mg/L, and the remaining bound chlorine is worth 3 mg/L [2].

Most swimming pool owners often ignore the cleanliness or turbidity of the pool water, and the provision of chlorine that is not within the safe limits by swimming pool owners often causes problems in transmitting diseases such as eye irritation, respiratory problems, and skin infections. With this in mind, this "Telemonitoring System for Turbidity and Water pH Against Draining and Automatic Chlorine Provision in Smartphone-Based Swimming Pools" was created[3]-[6]. The system consists of a pH sensor that will detect the pH level in the water, a turbidity sensor that will detect turbidity in the water, and a system for measuring chlorine automatically. There is a water flow sensor in the system to calculate how many ml of concentrated chlorine and pH down water will be given to the swimming pool[7]-[11]. With the system design, this study aims to reduce the risk of disease transmission in water and ease the existing work.

II. SYSTEM MODEL

We consider determining the flow of the water quality telemonitoring system in a miniature swimming pool as shown in Fig. 1.

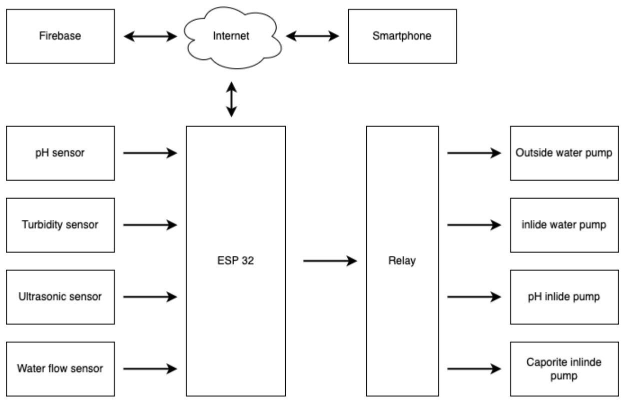

Fig. 1. System model.

The steps of the work system on the block diagram can be explained in the flowchart in Fig. 2.

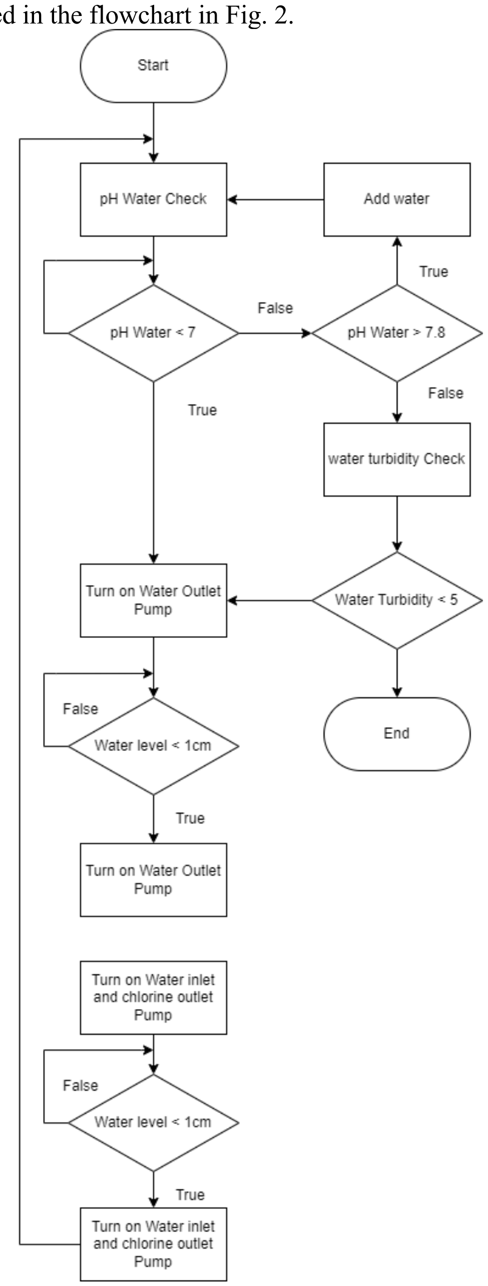

Fig. 2. Flowchart system works

Fig. 2 is a work flowchart on the drainage system, and the first step is to check the pH of the water. Suppose the pH of the water is <7, the system will perform a draining process to raise the pH, but when the pH of the water is >7.8, the system will add liquid pH down to lower the pH. After giving the pH down or draining the water due to the pH value < 7, the system will recheck the pH of the water. When the pH of the water meets the standard value of 7-7.8, a turbidity check will be carried out. If the turbidity is more than 0.5 NTU, then the water will be drained, but the system has finished working when the turbidity is 0.5 NTU.

In draining the water, the pool drain pump is ON, and the ultrasonic sensor checks the water level until the water level reaches 1 cm. When the water level is 1 cm, the ultrasonic sensor reads a height of 18 cm because the ultrasonic sensor reads from the ultrasonic sensor location to the bottom surface of the water. When the ultrasonic sensor gains a height of 18cm, the pool drain pump is OFF. Next, the ON pool water filling pump fills the water until it is full, and the chlorine liquid pump is ON to add chlorine to the water. When the water filling process is in progress, the ultrasonic sensor collects data from the maximum height of the pool water, 14 cm, with an ultrasonic sensor reading of 5 cm. If the pool water reaches a height of 5cm on the ultrasonic sensor reading, the water filling pump is OFF. Then the system will check the pH value and the turbidity value of the water again.

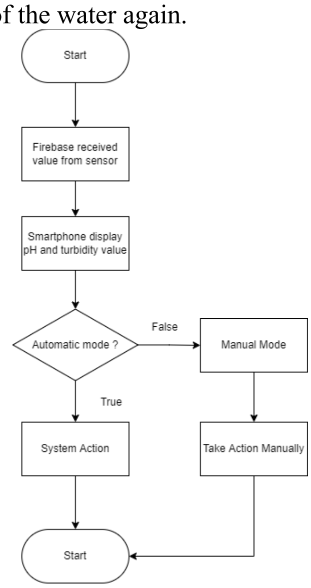

Fig. 3. Flowchart Application

The results obtained from the pH sensor and turbidity sensor will be sent to the ESP32. Then ESP32 will process sensor data which will be sent to firebase via the wifi module on ESP32 [12]-[19]. Furthermore, firebase will send the results of the pH sensor and turbidity sensor on the smartphone, then the data results that have been obtained from the pH sensor and turbidity sensor will be displayed in the smartphone application.

III. EXPERIMENT RESULTS

In section III is an explanation of the research results and a discussion of the results of each parameter test that has been carried out.

A. pH Sensor test

Testing the pH sensor as a water pH detector and the results of the data from the pH sensor will be compared with the results of the pH value on the pH meter to get the accuracy of the sensor test results. Tests on the pH sensor are carried out every day at 06.00 AM, 12.00 PM and 05.00 PM to monitor the pH of the water and maintain water quality.

Fig. 4, is a graph of the results of testing the pH sensor and pH meter. In the graph, the results of the pH sensor and pH meter measurements can be said to be accurate, because from the comparison the results of the two values have the largest error rate of 0.071429%. The average pH value is still within normal limits between 7-7.8, but on Tuesday at 05.00 PM the pH value exceeds 7.8 so that on that day the pH is lowered by concentrating the pH down, then on Friday the value is pH 6.9 so that volume of water was drained to increase the pH of the water.

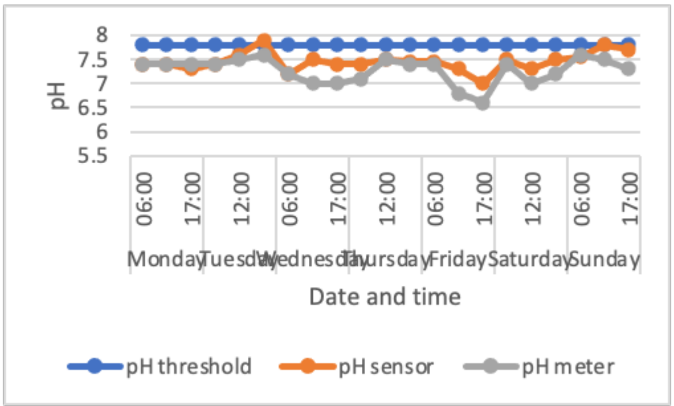

Fig. 4. pH sensor test vs time

B. *Turbidity Test*

Ultrasonic sensor testing as a water turbidity detector. Tests on the turbidity sensor are carried out every day at 06.00 AM, 12.00 PM and 05.00 PM to monitor water turbidity and maintain water quality.

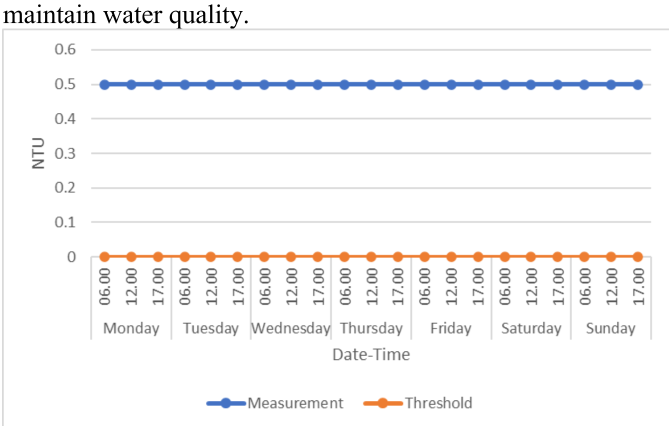

Fig 5. Turbidity test vs time

Fig. 5 is the results of the turbidity sensor test. In the graph it can be stated that the results of the turbidity sensor have a turbidity value of 0 NTU where the value is below the predetermined standard value of 0.5 NTU.

C. *Ultrasonik Test*

Ultrasonic sensor testing as a water level detection limit for draining or filling water automatically. The data from the ultrasonic sensor will be compared with the readings of the ruler measuring instrument as a comparison to get the accuracy of the sensor test results.

Fig. 6 is a the results of testing ultrasonic sensors and rulers. In the graph it can be stated that the value of the ultrasonic sensor and measuring instrument ruler is accurate, because it has the largest error rate of 0.076923%. The difference in test results between the ultrasonic sensor and the ruler is due to the ultrasonic sensor being less effective when reading the water level data. This is evidenced when there is a wave in the water (water conditions are not calm) then the ultrasonic sensor will retrieve the data for the height of the water wave so that the sensor cannot process the average water level.

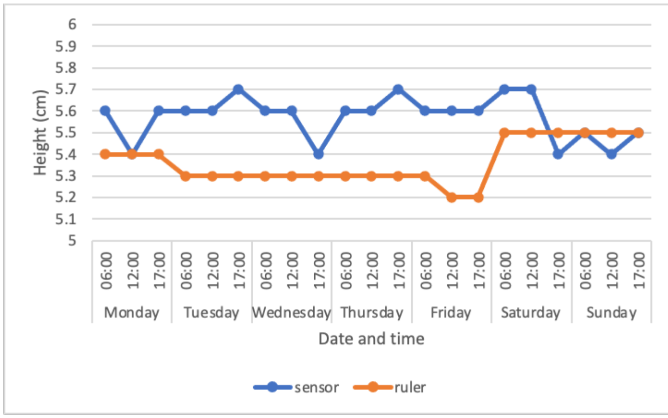

Fig. 6. Ultrasonik test vs time

D. *Delay test*

The results of network quality delay parameters from wireshark software are calculated as follows:

$$Delay = \frac{Time\ Spain}{Packet\ Capture} \quad (1)$$

$$Delay = \frac{189{,}795}{1018}$$

$$Delay = 186.4 \text{ ms}$$

From the calculation results it can be stated that the delay obtained in the system test is 186.4 ms with an index value of 3 which is good.

E. *Packet Loss test*

The results of the network quality parameter packet loss from the Wireshark software are calculated as follows:

$$Packet\ Loss = \frac{(\text{Packet send} - \text{packet received})}{\text{Packet send}} \times 100\% \quad (2)$$

$$= \frac{(1018 - 1006)}{1018}\ x\ 100\%$$

$$= 0{,}0117\ \%$$

From the calculation results it can be stated that the packet loss obtained in system testing is 0.0117% with an index value of 4 which is very good.

F. *Throughput test*

The results of the network quality throughput parameters from the Wireshark software are calculated as follows:

$$\text{Throughput} = \frac{\text{packet received}}{\text{Time}} \quad (3)$$

$$= \frac{176277\ \text{Byte}}{189{,}795\ \text{second}}$$

$$= 7428\ \text{Kbits/s}$$

From the calculation results, it can be stated that the throughput obtained in the system test is 7428 Kbits/s with an index value of 4 which is very good.

IV. CONCLUSIONS

Based on the results of the planning and system testing that has been done, it can be concluded that the system is designed using ESP32 as a microcontroller to process the data results from each sensor used, for the processed data results will be sent to a smartphone that is already connected to the network as water quality monitoring. Automatic draining in the system is divided into 2, namely as a control by draining volume of water at 05.00 PM on Monday to Saturday and as a total routine drain on Sunday at 05.00 PM with the highest pH of 7.9 and the lowest was 6.9. Furthermore, the results of the turbidity sensor data have a value of 0 NTU with the highest ADC of 3827. The quality of the network (QoS) used when carrying out the data transmission process, obtained an average delay of 186.4 ms, packet loss of 1.178% and throughput of 7428 Kb/s.

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