

Water Quality Monitoring System and Automatic Filter System Based on the Internet of Things

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Abstract—PDAM's peak usage of clean water means that water supply to customers often stops due to insufficient distribution of discharge and pressure. To overcome the problem of insufficient water flow, the community provides a water storage tank consisting of a ground water tank and an over head water tank. PDAM water received by the public through distribution pipes has the potential to be contaminated due to the entry of pollutants from repair activities and pipe leaks. These pollutants will accumulate in the tank, causing the water quality to decline and no longer comply with the established quality standards. To prevent accumulation of pollutants in the tank, before using it, the water should be filtered first. An automatic filtration system with monitoring of turbidity and water levels is a technology that can make people's work easier and the quality of the water used is in accordance with drinking water quality standards. Data obtained from turbidity and water level sensors can also be monitored via the IoT platform. The test results of the turbidity and water level sensors have a low error so that the designed tool can be used to monitor turbidity, water level and automatic filter systems. Sending data so that it can be displayed on IoT platforms such as Blynk has also been successfully created. From 10 attempts, the Water Level Sensor gave an average error of 0.78%.

Keywords—Internet of things, turbidity, water level, filtration, automatic

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I. INTRODUCTION

Water is one of the basic human needs which has an important role in the body's metabolic processes. Water consumed by humans must meet quality standards so that it is not dangerous to health [1]. In Indonesia, drinking water quality standards are regulated by Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2023 concerning Implementing Regulations of Government Regulation Number 66 of 2014 concerning Environmental Health [2].

Communities, especially those in urban areas, obtain clean water from PDAM (Regional Drinking Water Company) which is channeled through distribution pipes to residents' homes. The water that reaches these houses has a high chance of being contaminated with pollutants originating from rust from old metal pipes, mud that enters during repairs to the distribution pipe network and pipe leaks which result in the entry of dirty water or sewer water into the distribution network [3].

Apart from water quality not meeting quality standards, the water flow reaching customers also fluctuates, especially during peak usage hours, which can result in the supply of clean water stopping in certain areas. As a solution, many

people use holding tanks. From the service pipe, water enters the ground water tank and is then pumped to the over head water tank. Water stored in tanks usually accumulates contaminants in it such as particles and microorganisms which can reduce the quality of the water [4]. The characteristics of water that does not meet quality standards are an unpleasant odor, an unpleasant taste and visible turbidity due to the presence of sediment [5]. The public is strongly advised to carry out regular checks. However, this will become a boring routine activity and is rarely done by the community so that the water consumed no longer meets quality standards.

Turbidity is a condition where the transparency of a liquid is reduced due to the presence of dissolved substances. Based on SNI 06-6989.25-2005 concerning water and waste-Part 25, turbidity is tested with a nephelometer using the principle of the light intensity of the test sample being absorbed and refracted, compared to the light intensity of the standard suspension. In developing turbidity sensors, this method is often used [6].

To remove contaminants in water, you can pass the water through a filter tube containing filter media such as active sand, silica sand and activated carbon. Filter media that has been used for a long time will experience blockages which

will affect the quality of the filtering results. To clean it, wash and replace the filter media [7]. Many automatic water filter systems have been developed nowadays so that they are easy and do not require user intervention [19].

The current trend of monitoring water quality is carried out continuously and in real time, using more than one sensor, an automatic control system and a wireless data collection mechanism [8]. For example, water sensors and ultrasonic sensors transmit data using a wireless gateway into the consumer network. Meanwhile, the ATmega 328P controller board is used to send data to the cloud server [9]. The data storage server will manage all water quality monitoring data, collect data, analyze and submit data to a web-based dashboard. This system allows water storage tank owners to access water quality conditions and levels via the internet [10]

Another example of monitoring water quality can also use ZigBee 802.15.4 which consists of several sensors and wireless communication networks, a 74HC14 inverter and mobile communications (GSM) [11],[15],[16]. The system can use water level sensors, turbidity sensors, temperature sensors, pH sensors and dissolved oxygen sensors [12],[20]. This system is more complicated in terms of microcontroller input and output communication because the algorithms and analysis are carried out to monitor water quality as a whole, such as water level, temperature and water pH. The information storage system obtained in the database can be accessed via a web-based monitoring service using GSM [13]. GSM technology has the advantage of being able to send data without an internet connection.

It is important to consider the cost and complexity of the water quality control and monitoring system architecture [14]. In this research, what was created was a water quality monitoring system, especially the turbidity of the water in the tank, which was equipped with an automatic filter system as seen in Figure 1 and Figure 2.

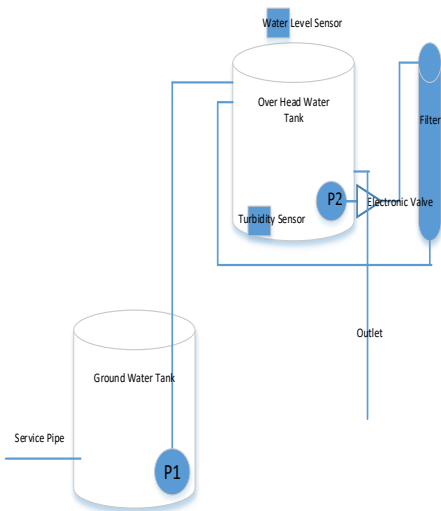


Fig 1. Monitoring and Filter System

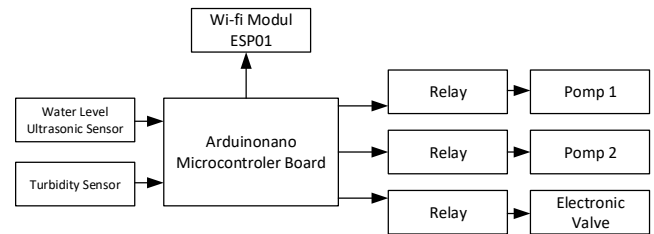


Fig 2. Electronic Controller Block Diagram

In this system, water can be seen being pumped from the bottom tank to the top tank. If the water in the over head water tank decreases, the water is automatically pumped to the over head water tank. In the over head water tank there is a turbidity sensor. If the turbidity of the water in the tank has passed the quality standards, then the water is pumped into the filter tube. The filtered water is returned to the over head water tank. All sensor data is processed by the microcontroller on the Arduino Nano board. After processing, a decision is obtained to activate the pump which was explained previously. Sensor data can be sent via the ESP01 wifi module.

The pump used to move water from the ground water tank to the over head water tank uses a submersible pump which has a voltage of 220 volts with a flow rate of 75 liters/minute (P1). In the filtration process, a submersible pump (P2) is used to pump water out of the tank. This pump is a pump that can be placed in water and has a voltage of 12 volts with a flow rate of 1.3 liters/hour. The gateway created in this system uses ESP01 as a microcontroller link to the cloud server. The cloud server used is the Blynk IoT platform. Blynk is an IoT platform that can control electronic devices remotely using IOS and Android applications, provides a dashboard that can create graphs, store and display sensor data and provides libraries for Arduino, ESP826, Raspberry pi, SparkFun and others [17].

II. THE MATERIAL AND METHOD

The flowchart of the monitoring and control system algorithm for the water filtration process can be seen in Figure 3. From Figure 3, it can be seen that the turbidity and water level sensors read the data. If the turbidity level is < 3 NTU, then pump 2 is on and if not, then pump 2 is off. Furthermore, if the water level read by the sensor is > 150 cm, then pump 1 is on. If the water level is < 5 cm, then pump 1 stops. Next, the data is sent to the cloud server.

If the water in the tank is read by the sensor > 3 NTU, the pump will work by pumping water out of the tank into the filter tube. While the filtration process is in progress, the turbidity sensor can continuously update the turbidity value of the filtered water in the tank. The system will stop if the sensor reads a turbidity level < 3 NTU, which indicates the filtration process has been completed.

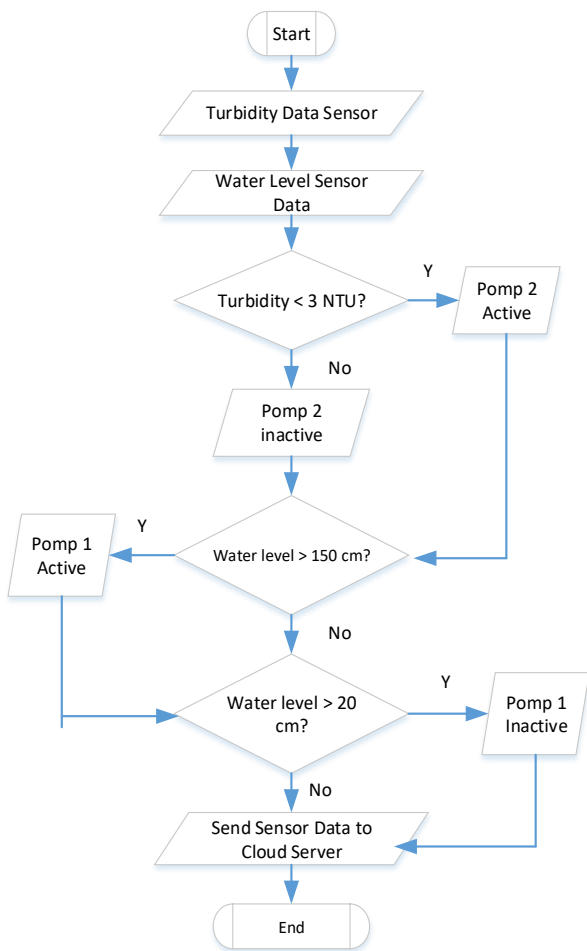


Fig 3. Flowchart of web based monitoring automated water filtration system

III. RESULT AND DISCUSSION

The results of the turbidity sensor experiment can be seen in Table 1 and it can be seen that in experiment 1 it can be seen that the higher the turbidity, the smaller the voltage produced [18]. The trend of the data that comes out can be seen in Figure 4, resulting in the following linear equation:

$$Y = -0.0366x + 5.0203$$

Table 1. Experiment Result

No Experiment	Turbidity NTU	Output (Volt)
1	1.55	4.96
2	1.76	4.96
3	2.30	4.94
4	3.26	4.90
5	4.65	4.85
6	15.45	4.45
7	20.34	4.28
8	32.20	3.84
9	35.30	3.73
10	44.21	3.40

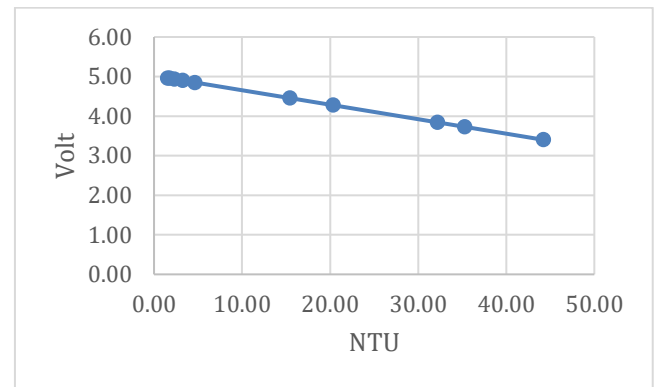


Fig 2. Measurement Results Graph

The experimental results for the water level sensor can be seen in Table 2 and Figure 5. Based on Table 2 and Figure 5, it can be seen that the error rate for the water level read by the sensor is in the range of 0.06% to 1.52%. The resulting equation from the graph formed is:

$$y = 0.9933x + 0.0658$$

Table 2. Water Level Sensor Test Results

No Experiment	Real Water Level (cm)	Water level read by sensor (cm)	Error (%)
1	3	3.05	1.52
2	6	6.03	0.43
3	9	9.01	0.06
4	12	11.99	0.12
5	15	14.97	0.23
6	18	17.95	0.30
7	21	20.93	0.36
8	24	23.91	0.40
9	27	26.88	0.43
10	30	29.86	0.45

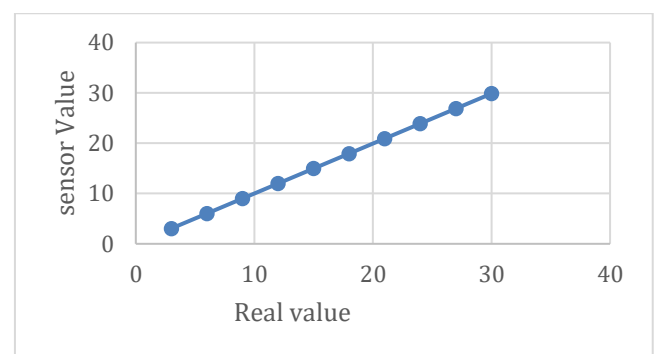


Fig 5. Water Level Sensor Experiment Results

The resulting data from sensor measurements is sent to the Blynk IoT platform server using the HTTP request format. Turbidity sensor data goes to datastream V0 while water level sensor data goes to datastream V1 on the Blynk platform. All data is displayed on the dashboard with chart and gauge widgets as shown in Figure 6.

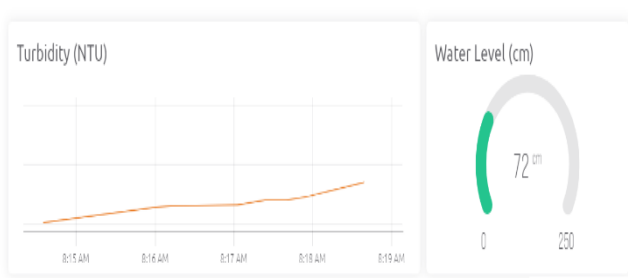


Fig 6. Appearance of the Blynk Application

IV. CONCLUSION

Turbidity sensors, water level sensors and pump automation systems that have been designed can be used for web-based monitoring and control systems. The data sent can be viewed on the Blynk IoT platform without experiencing any problems. From 10 attempts, the Water Level Sensor gave an average error of 0.78%.

REFERENCES

- [1] J.D. Miller, C.L. Workman, S.V. Pancang, G.Sneegas, E.A. Adams, S.L. Young, A.L. Thomson, "Water Security and Nutrition: Current Knowledge and Research Opportunities," *Advances in Nutrition*, Vol. 12, Issue 4, pp 2525-2539, November 2021.
- [2] Peraturan Menteri Kesehatan Republik Indonesia Nomor 2 Tahun 2023 Tentang Peraturan pelaksanaan peraturan Pemerintah Nomor 66 Tahun 2014 Tentang Kesehatan Lingkungan.
- [3] C.M. Fontanazza, V. Nataro, V. Puleo, P.Nicolosi, G. Freni, "Contaminant Intrusion Through Leaks In Water Distribution System: Experimental Analysis," in *Proc Engineering*, CCWI, 119, 2015, pp 426-433.
- [4] I. Slavik, K.R.F. de Oliveira, P.Cheung, W. Uhl, "Water Quality Aspects Related to Domestic Drinking Water Storage Tanks and Consideration in Current Standards And Guidelines Throughout The world – A Review," *Journal of Water and Health* 18(4), 2020, pp 439-463.
- [5] M.B. Addsie, Evaluating Drinking Water Quality Using Water Quality Parameters And Esthetic Attributes, *Air, Soil and water Research*, 15(3), 2022, pp 1-8.
- [6] SNI 06-6989.25-2005 tentang air dan limbah-Bagian 25.
- [7] A. Cescon, J.Q. Jiang, "Filtration Process and Alternative Filter Media Material in Water Treatment," *Water*, MDPI, 12, 3377, 2020, pp 1-20.
- [8] M. Miller, A. Kisiel, D.C. Lech, I. Durluk, T. Miller, "IoT in Water Quality Monitoring-Are We Really Here?," *Sensors*, MDPI, Vol.23, Issue 2, 2023, pp 1-12.
- [9] B.A. Jerom, R. Manimegalai, "An IoT Based Smart Water Quality Monitoring System using Cloud", 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), no. 7, 24-25 February, Vellore India, 2020.
- [10] Maneesha V. Ramesh, K. V. Nibi, Anupama Kurup, Renjith Mohan, A. Aiswarya, A. Arsha, P. R. Sarang, "Water Quality Monitoring and Waste Management using IoT", 2017 IEEE Global Humanitarian Technology Conference (GHTC), no. 7, 19-22 October, San Jose CA USA, 2017.
- [11] T. Perumal, M.N. Sulaiman, C.Y. Leong, "Internet of Things (IoT) Enabled Water Monitoring System," *Electronics (GCCE)*, IEEE 4th Global Conference on 2015, Oct 27, pp 86-87.
- [12] N.R. Moparthy; Ch. Mukesh; P.V. Sagar, "Water Quality Monitoring System Using IOT", 2018 Fourth International Conference on Advances in Electrical Electronics Information Communication and Bio-Informatics (AEEICB), no. 5, 27-28 February, Chennai India, 2018.
- [13] Ajith Jerom B, R. Manimegalai, R. Manimegalai, "An IoT Based Smart Water Quality Monitoring System using Cloud", 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), no. 7, 24-25 February, Vellore India, 2020.
- [14] S. Noorjannah Ibrahim, A.L. Asnawi, N.A. Malik, N.F.Mohd. Azmin, A.Z. Jusoh, F.N.Mohd Isa, "Filtration System: IoT Application in Water Management," *IJECE*, Vol.8, No.4, August 2018, pp 2503 -2511.
- [15] C. Feng, J. Yuan, Y. Sun, J. You, "Design of Water Quality Monitoring System", 2020 International Conference on Artificial Intelligence and Computer Engineering (ICAICE), no. 4, 23-25 October, Beijing China, 2020.
- [16] I.F. Almojela, S. M. Gonzales, K. Gutierrez, A.S. Santos, F.A. Malabanan, J.N.T. Tabin, C.B. Escarez, "WatAr: An Arduino-based Drinking Water Quality Monitoring System using Wireless Sensor Network and GSM Module", 2020 IEEE REGION 10 CONFERENCE (TENCON), no. 6, 16-19 November, Osaka Japan, 2020.
- [17] M.J. Lakshmi, C.S. Sameen, D.Maneesha, G.Dharani, K.F. Mubeena, "Smart Home Using Blynk App Based On IOT, *International Journal Of Creative Research Thoughts (IJCRT)*, Vol.10, Issue 5, May 2022, pp 341-345.
- [18] S.N. Ibrahim, A.L. Asnawi, N.A. Malik, N.F.M. Asmin, A.Z. Jusoh, F.N.M. Isa," Web Based water Turbidity Monitoring And Automated Filtration System: IoT Application in Water Managemen," *IJECE*, Vol.8, No.4, August 2018, pp.2503-2511.
- [19] I.M. Khalil, H.N. Abdulrazzak," Monitoring of water Purification Process Based on IoT," *IOSR-JECE*, Vol.14, Issue 2, Ser.1, Mar-Apr 2019, pp 56-62.
- [20] Md.M. Rahman, C. Bapery, M.J. Hossain, Z. Hassan, G.M.J. Hossain, Md.M. Islam," Internet of Things Based Water Quality Monitoring System," *IJMCER*, Vol.2, Issue 4, 2020, pp 168-180.