JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

DESIGN OF AN INTERNET OF THINGS-BASED WATER LEVEL MONITORING SYSTEM

Naufal Fakhrie Rienandie[1*], Resa Pramudita[1]
[1]Industrial Automation and Robotics Engineering Education, Universitas Pendidikan Indonesia
email: *naufalfahkrie@upi.edu[1]

Abstract: Conventional water reservoir filling systems often cause inefficiencies due to delays in monitoring or failure of the float system which results in overflowing water from the reservoir. this research aims to develop an ESP32-based water level monitoring and control system by utilising IoT technology and ultrasonic sensors, this system can facilitate users in monitoring water levels and automating pump control. this research uses the experimental method, starting from system design to system testing and analysis, as well as testing which includes sensor accuracy, system response, and communication stability with the IoT server. based on the results obtained. The test results show that the system has an average accuracy rate of 98.4% with an average response time of 1.8 seconds. based on the results obtained, this system shows a positive accuracy value and response time in its application.

Keywords: blynk; internet of things; monitoring; water level

Abstrak: Sistem pengisian tandon air secara konvensional sering kali menimbulkan ketidakefisienan karena keterlambatan dalam pemantauan atau kegagalan sistem pelampung yang mengakibatkan meluapnya air dari tandon. penelitian ini bertujuan untuk mengembangkan sistem monitoring dan kontrol ketinggian air berbasis ESP32 dengan memanfaatkan teknologi IoT dan sensor ultrasonik, sistem ini dapat memudahkan pengguna dalam memonitoring ketinggian air dan mengotomatisasi kontrol pompa. Penelitian ini menggunakan metode eksperimen, mulai dari perancangan sistem hingga pengujian dan analisis sistem, serta pengujian yang meliputi akurasi sensor, respon sistem, dan kestabilan komunikasi dengan server IoT. Hasil pengujian menunjukkan bahwa sistem memiliki tingkat akurasi rata-rata sebesar 98,4% dengan waktu respon rata-rata 1,8 detik. berdasarkan hasil yang diperoleh, sistem ini menunjukkan nilai akurasi dan waktu respon yang positif dalam pengaplikasiannya.

Kata kunci: blynk; internet of things; pemantauan; tingkat air

INTRODUCTION

Water is an indispensable element for the sustenance of all life on Earth. The utilization of water in Indonesia and globally is proportional, encompassing both domestic and industrial applications. Humans employ water for diverse household purposes, including drinking, bathing, and washing[1], [2].

Clean water is a source of necessity for human life which is usually taken from water sources such as wells. water sources such as wells, need tools to drain the water such as water pumps [3].

As is widely recognized, the wa-

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

ter pump is a tool employed for the purpose of extracting water from sources such as wells and conveying it to water reservoirs to satisfy daily requirements [4]. The process of reservoir filling is a daily necessity, but it typically necessitates close observation of the system. Historically, reservoir filling systems have been implemented through the use of floats that follow the water level. These floats, when the water level is full, lift and close the incoming water flow. However, there have been numerous instances of defective floats that have resulted in water wastage [5].

Furthermore, conventional monitoring systems frequently necessitate substantial manual oversight, which can result in delays in detecting alterations in water levels or even failure to promptly identify issues [6].

A significant challenge confronting users is the inability to effectively monitor water levels in reservoirs. This deficiency can lead to water loss and disruption to water dependent activities. Moveover, it hinders users ability to manage water use in an effective and efficient manner [7].

A considerable number of individuals continue to rely on traditional methods for determining the water level, rather than utilizing contemporary technologies that facilitate real-time monitoring. This affects the ignorance of knowing when exactly the water has reached a certain height limit [8].

The advent of the Internet of Things (IoT) has profoundly impacted various sectors, including the field of water level monitoring. The integration of advanced IoT technology, such as the ESP32, Sensors, and Cloud IoT, has enabled the automation of this process, facilitating real-time monitoring [9]. By utilising this technology, users can monitor the water level inside the reservoir in real-time, so that they can quickly take action if changes occur. The water level data can be displayed in the form of graphs or numbers on various platforms using Blynk. So that users can easily monitor and manage water usage in their homes [10] .

Therefore, this research designs an IoT device using a wireless network based on a water level detection sensor that works automatically by reading the water level using an ultrasonic sensor that is applied to measure the water level. The data obtained is then communicated via the Internet and will be received by a cloud-based application, namely blynk. [11].

This research was conducted to address these issues, with the objective of resolving the identified problems. The developed tool will prioritize the integration of the accuracy and responsiveness of the ESP32 module with the HC-SR04 ultrasonic sensor, as incorporated into the water level monitoring and control system. The integration of these two components is expected to enhance the efficiency of water usage by reducing waste and facilitating enhanced monitoring and control of the reservoir through the utilization of Internet of Things (IoT) technology [12].

METHODS

The research method used in this study is an experimental method illustrated in Figure 1 below. it shows a visual representation of the methodological framework, which explains the sequential steps and processes carried out in the study.

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

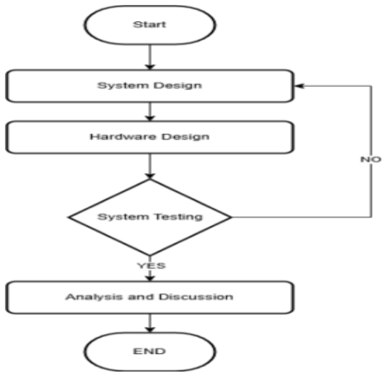


Figure 1 Research Flow

The system architecture of this prototype consists of several main components that interact with each other as shown in Figure 2. The sensor used is an HC-SR04 Ultrasonic, and the data collected by the sensor will be sent to the microcontroller, which in this case is an ESP32. This microcontroller is responsible for collecting data from the sensors and sending it to the IoT Server, which in this case is Blynk. The IoT Server functions as a data management and monitoring center, providing a user interface accessible via a dedicated application. This interface enables users to view water level data transmitted from the sensors and to control or interact with the system as required. The architecture of the prototype system facilitates environmental condition monitoring and enables remote system monitoring and control through the provided application.

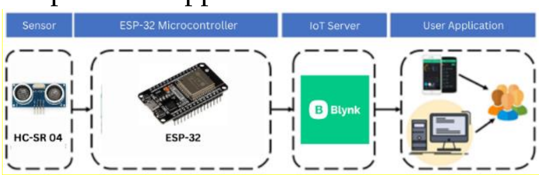


Figure 2 IoT-based water level monitoring system architecture

System Design

The system architecture consists of both hardware and software components. The block diagram illustrating the proposed system is depicted in Figure 2. The diagram is structured into three main stages: input, processing, and output. The input section contains an HC-SR04 ultrasonic sensor, which functions as a water level detector. These sensors utilize ultrasonic waves to detect the distance or presence of objects, operating on a principle analogous to that of sonar or radar.

These sensors transmit waves to an object, then measure the reflection time to determine the distance or presence of the object. These sensors are widely employed in various fields, including automotive, industrial, and robot navigation, as well as distance measurement. They are composed of ultrasonic transducers, which generate sound waves with a frequency exceeding 20 kHz [13]. These sensors offer several advantages, including high sensitivity, good resolution, and the capacity to function in a variety of conditions. However, they are also susceptible to interference from nearby objects as well as changes in temperature or humidity. These sensors find application in a variety of systems, including those responsible for accurate monitoring, navigation, and object detection.

The process section contains an ESP32 Microcontroller, an ESP32-based development module designed to facilitate the prototyping of IoT projects. The ESP32 is popular in IoT development due to its high performance and wireless connectivity features, such as Wi-Fi and Bluetooth [14]. The ESP32 development board is equipped with various components, including a USB-to-serial converter, a PCB with integrated circuits, pin-headers for additional connections, and a reset button. This module finds extensive application in IoT projects, encompassing device control, environmental monitoring, and smart applications that leverage wireless connectivity.

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

This research employs the Hypertext Transfer Protocol (HTTP) communication protocol, which is a network protocol at the application layer utilised in distributed, collaborative, and hypermedia-based information systems [15]. The conceptual framework of HTTP is illustrated in Figure 3. HTTP operates through a request-response mechanism, wherein the client (user) initiates a request to the server, which subsequently responds according to the request received.

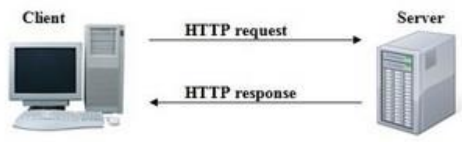


Figure 3 HTTP Concept

The output section contains a relay that functions as a connector with the actuator utilized, which may be a motor or a water pump. This relay operates as an automatic switch, determined by the state of the water level in the reservoir.

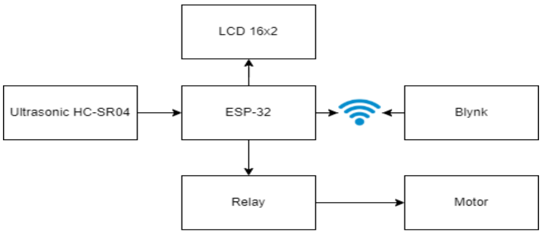


Figure 4 Diagram Block

Hardware Design

In the hardware design stage, the physical components required for the water level monitoring system are selected and prepared. This process involves the identification of the appropriate hardware for the system, including the ESP32 microcontroller, HCSR ultrasonic sensor, communication module, and other components. Subsequently, the physical design of the system is carried out, encompassing the layout and connections between the components. Reliability aspects are also taken into account in this design, to ensure that the system can be integrated easily and operate stably in a suitable environment.

System Testing

System testing is a critical component of ensuring the proper operation of all components and functionality of the IoT-based water level monitoring system. The initial step involves performing functional testing, wherein each feature and function of the system is meticulously examined to ascertain their proper functionality. This encompasses the evaluation of the HCSR ultrasonic sensor for water level measurement, the communication between the ESP32 microcontroller and other devices, and the system's response to control commands.

Subsequent to this, integration testing was conducted, wherein the entire system was tested under real operational conditions, including the interaction between the different components and the system's response to varying environmental conditions. During the tests, the data generated is monitored and analyzed to verify the accuracy and reliability of the system. Once all testing is complete, the results are evaluated to identify areas that require improvement or adjustment, so that the system can operate optimally in the desired environment.

Analysis and Discussion

In the analysis and discussion stage, the results of the system testing are evaluated in depth to identify the performance and effectiveness of the developed IoT-based water level monitoring system, attached below is the equation for calculating the error value of the measurement results. The data collected during testing is analyzed to evaluate the accuracy of

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

the water level measurement, the system's response to control commands, and the stability and reliability of the system under various environmental conditions. The results of this analysis are then discussed to identify the strengths and weaknesses of the system, as well as the potential for further improvement. The formula for calculating the error is as follows:

$$Error = \frac{\text{reference distance} - \text{sensor distance}}{\text{reference distance}} \times 100\% \quad (1)$$

RESULT AND DISCUSSION

Research on prototype monitoring and control systems for water levels in IoT-based tanks necessitates comprehensive testing. The objective of this testing is to ascertain the functionality of the system, as well as to identify and rectify any errors that may have occurred during the development process. The testing procedure is meticulously designed to analyse and refine the system, ensuring its effectiveness and reliability. The testing process encompasses several components, including the ultrasonic sensor, the water pump, the communication with the IoT server, and the overall system. The ensuing comprehensive prototype design outcomes are delineated in Figure 6 below.

Figure 5 IoT-based Water Level Monitoring System Prototype

Sensor and Communication Testing

The HCSR-04 Ultrasonic Sensor was subjected to a series of tests in order to evaluate its accuracy in detecting the water level in the tank. This was achieved by comparing the sensor readings with manual measurements up to 30 cm, the test is shown in Figure 7. This assessment ensured consistent performance under various conditions, the results of which are shown in Tables 1 and 2. In addition, the system's communication with the IoT server was tested by analysing data transmission, connection stability and responsiveness under different network conditions.

Table 1 HCSR-04 Testing Results

Ref Distane (cm)	Sensor Value (cm)	Delay (s)	Error (%)
1	1	1	0
2	2	1	0
3	3,1	3	3,33
5	5	2	0
7,5	7,6	2	1,33
10	9,99	2	0,1
15	15,2	1	1,33
20	20	3	0
24,1	24,1	2	0
30	30	2	0

Table 1 IoT Communication Test Results

Type of Test	Test Result
Connection to the Server	Success
Connection Stability	Stable
Server Responsiveness	Average Delay 1,9s
Performance Evaluation	Average Error 0,61%

Overall System Testing

The objective of this study was to assess the effectiveness and functionality

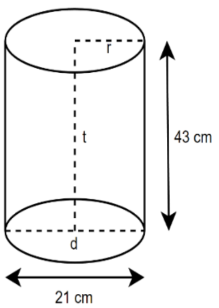
JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

of a prototype IoT-based water level monitoring and control system. The experimental process involved the integration of system components, including ultrasonic sensors, water pumps, communication control with the IoT server, and other automation features. These components were integrated to operate in a synergistic manner according to predefined specifications. The testing process also encompassed the simulation of real-world situations and different usage scenarios.

This approach was adopted to identify potential issues or deficiencies in the system design or implementation. The outcomes of these assessments will furnish a comprehensive depiction of the reliability and feasibility of the system in effectively and efficiently monitoring and controlling the water level in the tank. Prior to conducting the test, it is imperative to ascertain the volume of the tube. This is of paramount importance as the volume of the tube exerts a significant influence on the water level measured by the ultrasonic sensor.

Consequently, precise volume calculation is essential for the proper calibration of the system. Subsequent to this, the system can be subjected to a process of testing to evaluate its performance and functionality.

$$V_{\text{Tabung}} = \pi \text{ x } r^2 \text{ x } t \quad (2)$$



Description:

P = Length
L = Width
T = Height

From the equation, we can calculate the volume of the tube as follows:

$$V_{\text{Tube}} = 3{,}14 \text{ x } 10{,}5^2 \text{ x } 43$$
$$V_{\text{Tube}} = 14.886 \approx 15.000 \text{ cm}^2$$

The gallon canister has a capacity of ±15 liters of water, indicating that within this range, the tube exhibits a high degree of water retention. The error value in measuring the volume of water is obtained through the previously established equation, which is used to compare the volume or height that should be in the tube with the value measured by the sensor. The error value thus obtained facilitates the evaluation of the sensor's capacity to provide accurate measurements, as well as the identification of potential areas for enhancement in the developed water level monitoring system.

In addition to the preceding experiments, the researcher also examined the precision of the sensor in quantifying the volume of water. This procedure entailed a comparison of the volume ascertained by the sensor with the volume calculated on the basis of the dimensions of the tank. This approach was adopted to assess the reliability of the sensor in providing accurate data regarding the actual volume of water in the tank.

As illustrated in Table 3, the outcomes of water volume tests on tubes were employed to assess the performance of the system. Each test is designated by its sequence number, and the reference volume of water in the tube is documented, along with the volume ascertained by the sensor. The percentage error between the volume measured by the sensor and the reference volume is also documented for each test. The results of these tests facilitate a comprehensive evaluation of the performance of the sensor and the system in detecting the volume of water in the tube. This evaluation is crucial for identifying and enhancing areas that necessitate refinement to augment the accuracy and efficiency of the Internet of Things-based water level monitoring system under development.

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. XI No 2, Maret 2025, hlm. 265 – 272 ISSN 2550-0201 (Online)
DOI: http://dx.doi.org/10.33330/jurteksi.v11i2.3713
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

Table 2 Test Results for Water Height in Tubes and Water Volume in Tubes

Reference (cm)	Sensor Value (cm)	Delay (s)	*Error* (%)	Reference (liter)	Measured Volume (liter)	Delay (s)	*Error* (%)
1	1,2	1	20	346,2	342,7	2	1,011
2,5	2,6	1	4	692,4	726,3	2	4,896
5	5	2	0	1038,6	1038,6	1	0
7,5	7,35	1	2	1384,7	1419,4	1	2,506
10	9,99	1	0,1	1730,9	1661,7	2	3,998
12,5	12,6	1	0.8	6231,3	6231,3	1	0
15	15	2	0	7269,9	7259,9	1	0,138
20	20	2	0	8308,44	8325,7	3	0,208
25	24,2	3	0	9347	9347	3	0
30	30	2	0	10385,5	10731,7	3	3,333

CONCLUSION

This research successfully developed an IoT-based water level monitoring and control system that integrates ESP32 and HC-SR04 ultrasonic sensors to improve water usage efficiency. The system successfully performs real-time monitoring through the Blynk application as well as water pump automation based on the water level in the reservoir. Test results show that the system has a high accuracy of 98.4% with an average response time of 1.8 seconds, proving its reliability and effectiveness in optimising water usage and reducing the risk of wastage due to inaccurate manual or conventional systems. Thus, this system can be an efficient and practical solution for water management in both domestic and industrial environments.

BIBLIOGRAPHY

[1] M. Kumar B, K. Kumar K, P. Sasikala, B. Sampath, B. Gopi, and S. Sundaram, "Sustainable Green Energy Generation From Waste Water," 2024, pp. 440–463. doi: 10.4018/979-8-3693-11868.ch024.

[2] J. A. P Pettarani, I. Politeknik Bosowa, and J. Kapasa Raya No, "Automatic Water Level Controlling And Monitoring System Using Iot Application," *International Journal of Artificial Intelligence Research*, no. Vol.7, No 2, Dec. 2023,

[3] R. Jisha, G. Vignesh, and D. Deekshit, "IOT based Water Level Monitoring and Implementation on both Agriculture and Domestic Areas," in *2019 2nd International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT)*, IEEE, Jul. 2019, pp. 1119–1123. doi: 10.1109/ICICT46008.2019.8993272.

[4] M. S. Vadivu, M. P. Reddy, K. Rane, N. Kumar, A. Karthikayen, and N. Behare, "An IoT-Based System for Managing and Monitoring Smart Irrigation through Mobile Integration," *Journal of Machine and Computing*, vol. 3, no. 3, pp. 196205, Jul. 2023, doi: 10.53759/7669/jmc202303018.

[5] P. Mahale, S. Panse, P. Rajule, V. P. Samaj's Karmaveer, and B. Ganpatrao, "Iot Based Water Level Monitoring System," *www.irjmets.com @International Research Journal of Modernization in Engineering*, 2262,

[6] Z. Wu, Y. Huang, K. Huang, K. Yan, and H. Chen, "A Review of Non-Contact Water Level Measurement Based on Computer Vision and Radar Technology," *Water (Basel)*, vol. 15, no. 18, p. 3233, Sep. 2023, doi: 10.3390/w15183233.

[7] S. Srinivas Vellela, B. Venkatesh Babu, D. Mahendra, Y. Bharat, and A. Info, "IoT-Based Tank Water Monitoring Systems: Enhancing Efficiency and Sustainability," *International Journal for Modern Trends in Science and Technology*, vol. 2024, no. 02, pp. 291–298, doi: 10.46501/IJMTST1002037.

[8] M. Faisal, Z. M. Ramadhani, S. A. M. Hidayat, A. Basrida, and T. F. Fazrin, "Prototype of Water Level and Rainfall Detection System as Flood Warning Based On Blynk Iot Application," *International Transactions on Education Technology (ITEE)*, vol. 1, no. 1, pp. 1–10, 2023.

[9] P. R. Mahardika, F. A. Lani, and R. Suwartika, "Perancangan Sistem Control Tandon Air Menggunakan Sensor HC-SR04 Berbasis Internet of Things," *JIPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika)*, vol. 7, no. 1, pp. 1–9, Feb. 2022, doi: 10.29100/jipi.v7i1.2147.

[10] M. Hendriawan, H. Haryono, and T. Budiman, "Development Of Water Level Monitoring Applications In Smart Home Systems Using Flutter," *Journal of Information System, Informatics and Computing*, vol. 7, no. 2, p. 213, Dec. 2023, doi: 10.52362/jisicom.v7i2.1197.

[11] S. Sulaimn Ambu Saidi, K. Hamed ALabri, I. AL Salim Azwani, S. Azan Ali AL-Shaibani, and A. Muthu, "Arduino Based Smart Phone Liquid Level Monitoring System Using Ultrasonic Sensor," *International Journal of Engineering Research and Applications www.ijera.com*, vol. 11, pp. 41–45, 2021, doi: 10.9790/9622-1108024145.

[12] W. Czekała, "Water, Wastewater and Waste Management for Sustainable Development," *Water (Basel)*, vol. 16, no. 17, p. 2468, Aug. 2024, doi: 10.3390/w16172468.

[13] A. K. Sahoo and S. K. Udgata, "A Novel ANN-Based Adaptive Ultrasonic Measurement System for Accurate Water Level Monitoring," *IEEE Trans Instrum Meas*, vol. 69, no. 6, pp. 3359–3369, Jun. 2020, doi: 10.1109/TIM.2019.2939932.

[14] S. N. Mohd Zain *et al.*, "Development of a Wireless Monitoring System to Monitor River Water Levels in Real Time," *International Journal of Integrated Engineering*, vol. 15, no. 03, Jul. 2023, doi: 10.30880/ijie.2023.15.03.026.