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Study on the design of the Remote Distance Recording Automation Tool for Regional Water Utility Companies (PDAM) Water Distribution Using WIFI

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Abstract

Based on the research study on the design of the Remote Distance Recording Automation Tool for PDAM Water Distribution Using WIFI, several conclusions can be drawn. The PDAM water usage recording device, which uses the Water Flow YF-S201 sensor on a microcontroller installed in the PDAM water distribution flow, can accurately read the volume of water flowing through the sensor. Experiments showed that the sensor achieved an average accuracy of 98.9% for water volumes ranging from 1.5 liters to 15 liters. This demonstrates the sensor's high precision in measuring water flow. To build the hardware and software circuit, the ESP8266 WiFi module was used on the atmega328 microcontroller. The data sent to the server via the WiFi network worked as expected as long as it was within the range of the access point. Testing was conducted with a maximum distance of 8 meters, as the WiFi access point device used in the experiment could only reach a maximum of 10 meters and operated at a frequency of 2.4 GHz. This shows that the system can function well within a certain range and supports efficient wireless data transfer.

Keywords: Atmega 328, ESP8266 Wifi module, sensor

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1. Introduction

Water is an essential need for every living creature, especially humans. Besides drinking, water also serves various other crucial purposes in daily human life, such as cooking, bathing, washing, and other domestic needs. The provision of clean water services is generally regulated and managed by the government through Regional Water Utility Companies (PDAM). The water supplied to residential homes typically originates from river water initially stored in reservoirs before being evenly distributed to the community. This process ensures the availability of safe and potable water for all residents, thereby safeguarding their health and enhancing their overall quality of life.

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Regional Water Utility Companies (PDAM) use water meters to measure the amount of clean water used by each household customer. These water meters are installed in every home, including residential, commercial, and industrial areas, serving as primary recording devices to calculate monthly water consumption by customers. The installation of water meters is standard for every house subscribing to PDAM services, the primary water provider, to meet the needs of the population. This system ensures that water usage can be accurately monitored, and customers can be billed according to the amount of water they use. With these water meters in place, PDAM can manage water resources efficiently, promote conservation practices, and ensure fair distribution of water across all communities served by PDAM.

The distribution of clean water by the Regional Water Utility Company (PDAM) is an essential service needed by the community, both in residential areas and industrial zones. To ensure the efficient and appropriate use of clean water in accordance with customer needs, a meticulous process of checking or monitoring water usage for each customer is required. Each recording or checking of water usage is done by PDAM officers visiting customer locations, whether residential or business premises, to note the amount of water usage shown on the water meters installed by PDAM. This process is carried out routinely to ensure the accuracy of water usage data, which will then be used as the basis for billing. However, this conventional method presents several challenges, such as requiring significant time and effort, especially if the number of customers to be checked is very large. Moreover, the possibility of manual recording errors can also affect the accuracy of the obtained data. To improve efficiency and accuracy in the water usage monitoring process [1], PDAM may consider utilizing technologies such as Automatic Meter Reading (AMR) systems or even Smart Metering Systems. With this technology, water usage data can be automatically transmitted from the water meters to the PDAM data center without manual intervention by the officers. The use of this technology will not only reduce the workload of field officers but also increase the speed and accuracy of recording water usage. Additionally, customers can monitor their own water usage in real time through applications or customer portals, allowing them to manage their daily water consumption more wisely. Thus, the implementation of technology in PDAM's water usage data collection system will bring significant benefits to both the company and customers, enhancing operational efficiency and providing better and more transparent services.

In the process of recording water usage data for customers, there are often difficulties due to the fact that data recording is still done manually. As a result, data recording of water usage often experiences delays and potential errors. PDAM officers must visit each customer location to read the water meter and record the data manually, which then needs to be further processed at the office. This process is not only time-consuming but also prone to human errors such as writing mistakes or inaccurate meter readings. Additionally, weather conditions and unfavorable field conditions can also hinder and slow down the data recording process. Delays in recording can impact the timeliness of bill delivery to customers, ultimately affecting the overall efficiency of PDAM services. Therefore, a more modern and efficient solution is needed to overcome these obstacles, such as the implementation of automatic recording technology that can speed up the recording process and reduce errors.

This research aims to create a monitoring system to measure the amount of clean water used by customers with the theme "Study of Remote Automation in Water Distribution Recording for Regional Water Utility Company (PDAM) Based on WiFi." The system will be designed using a flow water sensor operated with a microcontroller, which will then automatically send data via a WiFi network. The flow water sensor will measure the water flow used by each customer. Data from this

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sensor will be processed by an integrated microcontroller in the system. After the data is processed, the microcontroller will send the water usage information to the data center via a WiFi connection. Thus, any changes in water usage can be monitored in real time by PDAM without needing to send officers to read the meters manually. This automation system is expected to address various challenges that have been faced in the manual recording process, such as delays and recording errors. Moreover, with more accurate and real-time [2] monitoring, PDAM can respond more quickly to customer needs and manage water distribution more efficiently. Customers will also benefit from this system, as they can monitor their own water usage through an application or portal provided by PDAM. This will help them manage their daily water consumption more wisely and efficiently. Thus, this research focuses not only on developing advanced recording and monitoring technology but also on improving service quality and customer satisfaction. The implementation of this WiFi-based automatic monitoring system [3] is expected to bring significant changes to PDAM operations, making the water distribution process more transparent, efficient, and responsive to community needs.

2. Research Method

In this research, the research methods used are the experimental method and the literature review method. The experimental method is employed to test and develop the designed monitoring system. This method involves conducting various experiments to ensure that the flow water sensor, microcontroller, and WiFi connection function properly and meet the requirements. These tests will include simulations of customers' real-life water usage conditions, real-time data collection, and analysis of the system's accuracy and reliability in various situations. Additionally, the literature review method will also be applied to support this research. Through this method, various literature, scientific journals, and publications related to automatic recording technology, flow water sensors, microcontrollers, and WiFi networks will be thoroughly reviewed. The literature review aims to gain a comprehensive understanding of the latest developments in relevant technology and best practices that can be adopted in this research. By combining the results of the experimental method and the literature review, it is expected that this research will produce an innovative, effective monitoring system that can be widely implemented by PDAM. This dual approach ensures that the research is not only based on theory but also on tested practical applications. The results from both methods will be analyzed and synthesized to provide comprehensive and applicable recommendations for improving the water usage recording and monitoring system. [4] At PDAM. Thus, this research not only contributes to the improvement of PDAM's operational efficiency but also adds value to the community in managing and monitoring their water consumption more wisely.

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3. Results And Discussion

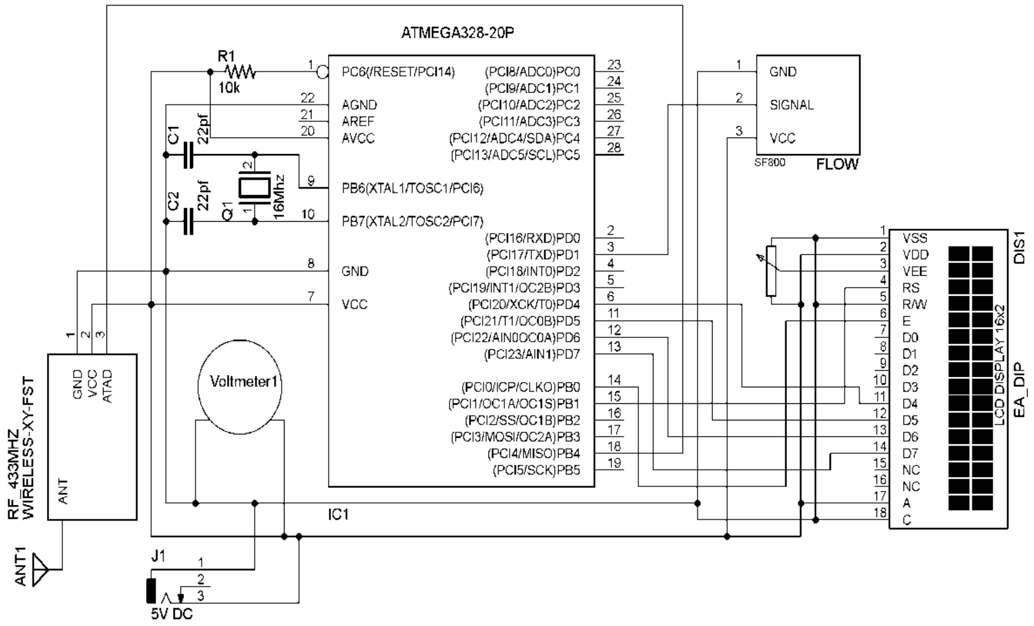

Figure 1. Overall system testing Part 1

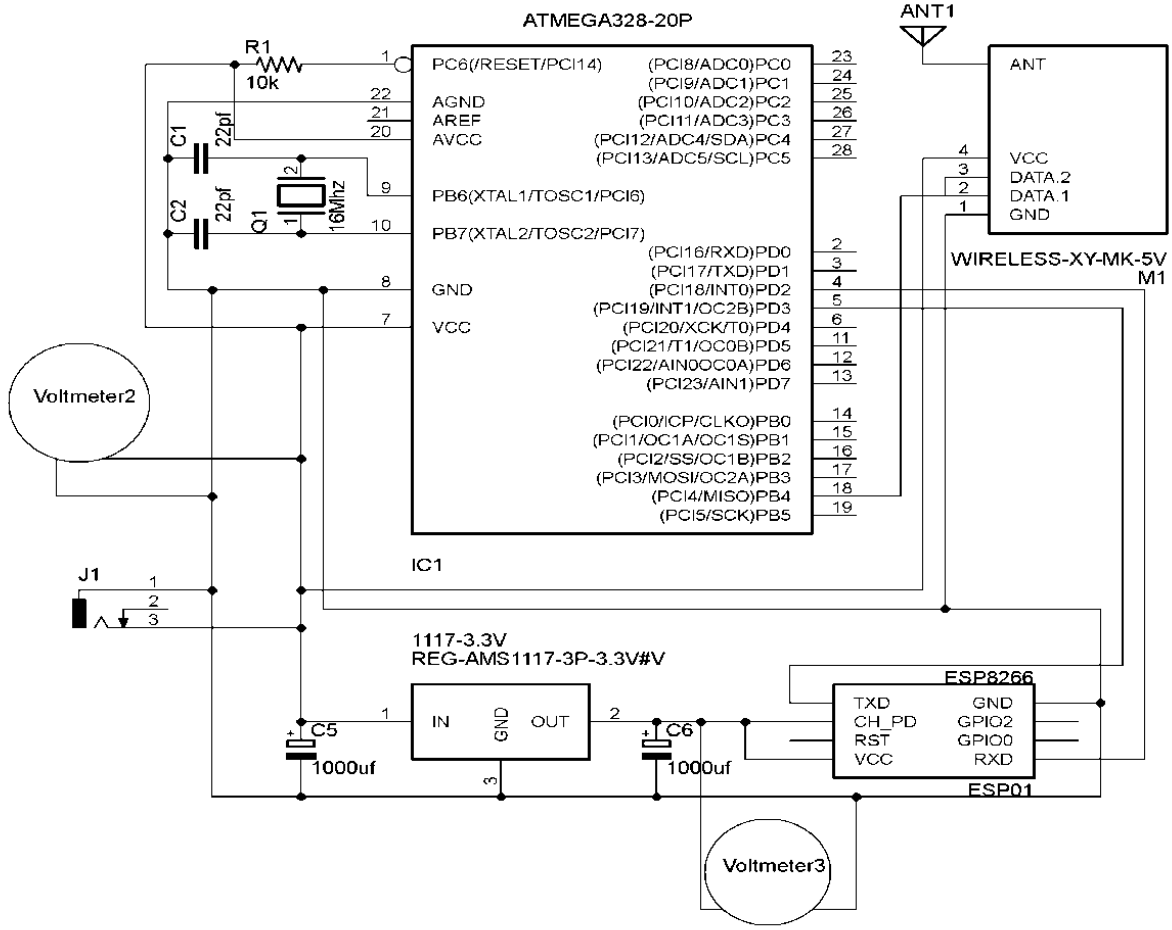

Figure 2. Overall system testing 2

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This comprehensive testing uses a battery in the circuit to operate all sensors. In this test, the circuit will operate the water flow sensor to measure the volume of water usage, which will be channeled through the water flow sensor installed in the water flow. Additionally, an LCD will be installed to display the volume of water used, allowing users to monitor their water usage directly. In designing this device, two Arduino units are used, communicating via RF modules to transfer data between the two Arduinos. This process allows data obtained from the water flow sensor on one Arduino to be sent to the other Arduino for further processing. After the data is received by the second Arduino, the microcontroller will process the data and send it via the WiFi ESP8266 module for storage or further analysis. With this system, water usage data can be monitored in real-time and stored digitally, facilitating data analysis and management. This testing aims to ensure that all components work properly and according to the design, as well as to identify and fix any potential issues that may arise during operation. The measurement results from this test are shown in Table 1, which includes various important parameters such as the volume of water used, sensor reading accuracy, and the difference between water volume reading and water flow sensor reading. Through this testing, it is expected that the designed monitoring system can provide accurate and reliable results under various usage conditions.

Table 1 Results Of Water Volume Reading Test

No	Water Volume (ml)	Water Flow Sensor Reading (ml)	Difference	Accuracy Percentage
1	1500	1534	34	97,8%
2	3000	3030	30	99%
3	4500	4547	47	98,9%
4	6000	6073	73	98’8%
5	7500	7597	97	98,7%
6	9000	9102	102	98’8%
7	10500	10604	104	99%
8	12000	12052	52	99,5%
9	13500	13612	112	99,2%
10	15000	15108	108	99,3%

After conducting the overall testing, the results data for each component listed in Table 2 were obtained. Here are the results from Table 2.

Table 2. Overall Testing Results

No	Test sections	Status
1	Water flow sensor testing	Running
2	LCD testing	Running

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3	WiFi module ESP8266 testing	Running
4	Overall testing	Running

The testing includes:

1. **Water flow sensor testing:** Shows "Running" status, indicating that the water flow sensor can accurately measure water flow.
2. **LCD testing:** Shows "Running" status, indicating that the LCD can correctly display the volume of water used.
3. **WiFi module ESP8266 testing:** Shows "Running" status, indicating that the ESP8266 WiFi module can effectively transmit data over the WiFi network.
4. **Overall testing:** Shows "Running" status, confirming that the entire system operates as expected during testing.

These testing results ensure that each component in the monitoring system has been thoroughly tested and functions well according to the expected specifications. This indicates that the system is ready for further implementation in real-world environments for efficient water usage monitoring and management.

From the results of the hardware circuit testing, it can be confirmed that all devices function properly. Testing on the microcontroller used to operate the LCD shows that this function operates well. Furthermore, testing on the YF-S201 water flow sensor indicates that it can accurately measure the amount of water flowing through it. Testing on the LCD display also shows that the screen can display information effectively. Testing on the RF 433 MHz module was also successful, as the device does not require long-distance communication. Therefore, testing was focused on verifying data transmission and reception. Lastly, testing on the WiFi ESP8266 module demonstrates that it functions well for transmitting data over WiFi networks. The results of these tests confirm that all components in the hardware circuit perform as expected and are ready for use in broader applications for monitoring water usage.

After conducting hardware testing and ensuring that all devices function properly, the next step is software testing and program implementation. The results of these tests indicate that the entered program is correct, as after execution, the display shows "done compile." This indicates that the program has been successfully compiled without syntax or logic errors and is ready for implementation in a broader monitoring system. Software testing is crucial to ensure that the program runs smoothly and meets the desired specifications. Thus, the combination of hardware and software testing ensures that the designed monitoring system is ready for operational use to effectively and efficiently monitor water usage.

After successfully conducting hardware and software testing, the next step is to perform overall system testing to evaluate the performance and potential shortcomings of the entire system. From this comprehensive testing, it can be confirmed that the YF-S201 water flow sensor accurately measures the amount of water flowing through it. The WiFi ESP8266 module has also proven capable of transmitting data effectively within the circuit. In this setup, the YF-S201 water flow sensor is responsible for measuring the flow rate or volume of water used, and the results are sent via the WiFi module for further processing. Additionally, information regarding water usage is displayed in real-time on the 16x2 LCD. The RF 433 MHz module has successfully transferred data between

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microcontrollers. The data displayed on the LCD is proven to be accurate and consistent with the data transferred by the RF 433 MHz module and the data transmitted via WiFi ESP8266. This overall testing provides confidence that the designed water monitoring system can operate effectively and reliably in managing and monitoring water usage.

To systematically calculate the device using linear regression, data from Table 3 is utilized to determine the volume read by the sensor based on water flow per minute. After computing various parameters such as X, Y, Xy, x^2, and y^2, as shown in Table 4, linear regression calculations are performed to determine the parameter b (slope) and the intercept value.

Table 3. Data for calculating systematic tools

No	Discharge per minute (ml)	Volume read by sensor (ml)
1	15000	15108
2	17000	18120
3	19000	19140
4	21000	21132
5	23000	23127
6	25000	25153
7	27000	27142
8	29000	29201
9	31000	31113
10	33000	33214
Sum	240000	242450

Table 4. Calculation using linear regression

No	X	Y	XY	x^2	y^2
1	15000	15108	226620000	225000000	228251664
2	17000	17120	308040000	289000000	328334400
3	19000	19140	363660000	361000000	366339600
4	21000	21132	443772000	441000000	446561424
5	23000	23127	531921000	529000000	534858129
6	25000	25153	628825000	625000000	632673409
7	27000	27142	732834000	729000000	736688164
8	29000	29201	846829000	841000000	852698401
9	31000	31113	964503000	961000000	968018769

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10	33000	33214	1096062000	1089000000	1103169796
Sum	240000	241450	6126066000	6090000000	6162353756

$b = \frac{n\sum XY - (\sum X)(\sum Y)}{n\sum X^2 - (\sum X)^2}$ (1)

$b = \frac{10(\ 61260660000) - (240000)(241450)}{10(6090000000) - 240000^2}$

$b = \frac{61260660000 - 58188000000}{60900000000 - 57600000000}$

$b = \frac{3312660000}{3300000000}$

$b = 1{,}01$

$a = \overline{Y} - b\overline{X}$ (2)

a = 24145-1,01.24000

a = 24145-24240

a = -95

With the formed regression equation, we can calculate the value of y if the value of x is known. For example, if x is the flow of water at 15000 ml per minute, then the value of y can be calculated as follows:

$a = \overline{Y} - b\overline{X}$

y= a +bx (3)

y= −95+1.01·15000

y = -95 + 1.01 15000

y= −95+15150

y = -95 + 15150

y= −95+15150

y= 15055

Thus, based on this mathematical calculation, if the device flows with water at a rate of 15000 ml per minute for one minute, the device will read a volume of 15055 ml. This result shows that the

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device has a slight deviation from the ideal value but is still within acceptable limits for measuring water volume.

4. Conclusion

Based on the research study on the design of the Remote Distance Recording Automation Tool for PDAM Water Distribution Using WIFI, several important points can be concluded. The PDAM water usage recording device using the Water Flow YF-S201 sensor on a microcontroller installed in the PDAM water distribution flow has been able to read the volume of water flowing with high accuracy. In the experiments conducted, this sensor showed an accuracy rate of 98.9% for water volumes from 1.5 liters to 15 liters. This indicates that the Water Flow YF-S201 sensor is very reliable in measuring water flow with high precision, making it suitable for use in the PDAM water distribution system. Additionally, to build the hardware and software circuits, the ESP8266 WiFi module was used on the atmega328 microcontroller. This module functions to send data from the sensor to the server via the WiFi network. Test results show that data sent through the WiFi network works well as long as it is within the access point's range. Testing was conducted with a maximum distance of 8 meters because the WiFi access point device used was only able to reach a maximum of 10 meters and operated at a frequency of 2.4 GHz. This demonstrates that the designed system can function well within a certain range and supports efficient wireless data transfer. In other words, this system allows real-time water usage data transmission to the central server, facilitating the monitoring and management of PDAM water distribution. However, for further improvements, the WiFi range factor and the possibility of developing broader network technology need to be considered to ensure this system can function more optimally in various environmental conditions.

References

[1] P. Thomson, "Remote monitoring of rural water systems: A pathway to improved performance and sustainability?," *Wiley Interdiscip. Rev. Water*, vol. 8, no. 2, p. e1502, 2021.

[2] E. Creaco, A. Campisano, N. Fontana, G. Marini, P. R. Page, and T. Walski, "Real-time control of water distribution networks: A state-of-the-art review," *Water Res.*, vol. 161, pp. 517–530, 2019.

[3] M. Irmansyah, E. Madona, N. Anggara, and others, "Design and Development of Water Distribution Monitoring System in Regional Drinking Water Companies (PDAM) Based On Internet Of Things," in *Journal of Physics: Conference Series*, 2021, vol. 2111, no. 1, p. 12024.

[4] S. Kara, I. E. Karadirek, A. Muhammetoglu, and H. Muhammetoglu, "Real-time monitoring and control in water distribution systems for improving operational efficiency," *Desalin. Water Treat.*, vol. 57, no. 25, pp. 11506–11519, 2016.

[5] Parvaze, S., Kumar, R., Khan, J.N. *et al.* Optimization of Water Distribution Systems Using Genetic Algorithms: A Review. *Arch Computat Methods Eng* **30**, 4209–4244 (2023). https://doi.org/10.1007/s11831-023-09944-7

[6] Mancosu N, Snyder R, Kyriakakis G, Spano D. Water scarcity and future challenges for food production. Water 7:975–992, 2015

[7] Liu, Z., Xu, J., Liu, M., Yin, Z., Liu, X., Yin, L., & Zheng, W. (2023) Remote sensing and

DOI: https://doi.org/10.71225/jstn.v1i3.44

geostatistics in urban water-resource monitoring: A review. Marine and Freshwater Research.

[8] Tanyimboh TT, Seyoum AG (2020) Design optimization of water distribution networks: a real-world case study with a penalty-free multi-objective genetic algorithm using pressure-driven simulation. Water SA.

[9] Sangroula U, Han K-H, Koo K-M, et al. (2022) Optimization of water distribution networks using genetic algorithm based SOP–WDN program. Water 14:851.

[10] Mala-Jetmarova H, Sultanova N, Savic D (2018) Lost in optimization of water distribution systems? A literature review of system design. Water 10:307.

[11] Jafari H, Nazif S, Rajaee T (2022) A multi-objective optimization method based on NSGA-III for water quality sensor placement with the aim of reducing potential contamination of important nodes. Water Supply 22:928–944. https://doi.org/10.2166/ws.2021.222

[12] Pandey S, Singh RP, Mahar PS (2020) Optimal pipe sizing and operation of multistage centrifugal pumps for water supply. J Pipeline Syst Eng Pract 11:4020007. https://doi.org/10.1061/(ASCE)PS.1949-1204.0000447

[13] Lansey KE, Mays LW (1989) Optimization model for water distribution system design. J Hydraul Eng 115:1401–1418. https://doi.org/10.1061/(ASCE)0733-9429(1989)115:10(1401)

[14] Nicklow J, Reed P, Savic D et al. (2010) State of the art for genetic algorithms and beyond in water resources planning and management. J Water Resour Plan Manag 136:412–432. https://doi.org/10.1061/(ASCE)WR.1943-5452.0000053

[15] Bi W, Dandy GC (2014) Optimization of water distribution systems using online retrained metamodels. J Water Resour Plan Manag 140:4014032. https://doi.org/10.1061/(ASCE)WR.1943-5452.0000419

[16] E. Kurniawan, M. Adnin Nanda Pratama, and E. Eddi, "Sound-Based Light Control System in The Ship's Room With Uno Arduino," *JSTN*, vol. 1, no. 1, pp. 1–6, Apr. 2024.

[17] H. Aji Bimansyah, S. Mulyanto Herlambang, and E. Eddi, "Design and Construction of Fire Detection Equipment on Electrical Panels Automatically Using IOT," *JSTN*, vol. 1, no. 1, pp. 7–12, Apr. 2024.

DOI: https://doi.org/10.71225/jstn.v1i3.44