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Implementation Of Hydroponic Device Control System Via Website

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ABSTRACT

Hydroponics is a method of farming without using soil, usually carried out in a glass room using water as a medium containing nutrient. The hydroponic farming method is considered suitable for use in densely populated areas with limited agricultural land. The flow of water that carries nutrients for plants must be regulated as well as possible to support optimal plant growth. The focus of this research is to design a water flow control system that carries nutrients automatically and can be monitored and controlled remotely using the internet. Water conditions are read by sensors and processed by the ESP8266 microcontroller. Monitoring results are displayed via LCD and via website. Control of the nutrient-carrying water pump is also done via the website. With this system, hydroponic farmers can monitor and control the water and nutrient flow system remotely.

Keyword : hydroponics; monitoring; control; remote; website

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1. INTRODUCTION

Hydroponics is a method of farming without using soil media (Siregar et al., 2021), but by using nutritious mineral solutions or other materials containing nutrients such as coconut fiber, mineral fiber, sand, broken bricks, sawdust, and others as a substitute for soil media (Tharo & Hamdani, 2020). Hydroponics is agricultural cultivation without using soil media, so it is only carried out using water as a substitute for soil (Reftyawati et al., 2024). Various hydroponic models can be applied to land (soil) for example in urban areas. The main thing that must be considered to ensure maximum growth of hydroponic plants is the availability and distribution of plant nutrients properly. Nutrients for hydroponic plants are distributed through the flow of water from the system. Regulation of the flow of nutritious water can be done automatically, by applying various control system engineering. One example is a fuzzy logic-based control system carried out by Muhamad Asrori and M. Harist Murdan. The use of fuzzy logic as a method for determining nutrient output is very reliable for monitoring nutrients continuously without being limited by time. This method has a high level of accuracy in determining the nutrients needed by plants, thus ensuring that nutrients are at the optimal normal point for plant growth. Thus, the use of this system can help hydroponic plant supervisors to monitor plant nutrition more effectively and efficiently, to ensure optimal plant growth and quality harvest results (Tharo et al., 2019). In this case, fuzzy logic can be an innovative and effective solution in optimizing the growth of hydroponic plants. (Asrori & Murdani, 2023). Istiqomah, et al., have also conducted research and built a nutrient monitoring and control system using a smartphone application. The way this system works is when the sensor detects the acidity level (pH) and Nutrients according to the specified limits, the pump will release a pH and Nutrient solution with the provisions of pH 5-8 and Nutrients 1000-1400 ppm. The system is installed with a microcontroller connected to an ethernet shield which will then send data on the condition of the solution to the Android smartphone application in real time. (Istiqomah et al., 2020). In general, the electrical device of the automatic hydroponic control system consists of an electronic circuit, with components (devices) including pH or acidity level sensors, TDS (density) sensors, in this case nutrients, water temperature sensors, ambient air temperature and humidity sensors, monitoring systems, in the form of LCDs, relay modules that drive electric motors (pumps), and microcontroller components, for example ESP32 (Wadly & Fitriani, 2023; Wibowo et al., 2017). One example of a block diagram of a hydroponic monitoring and control system is shown in the following figure:

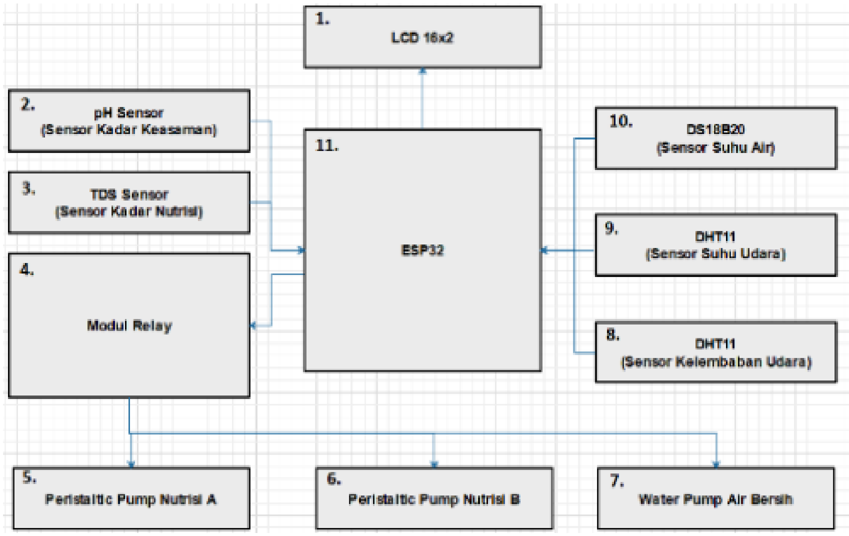


Fig. 1: block diagram of the hydroponic control system (Endryanto & Khomariah, 2022).

In a more complex monitoring and control system, a remote system can be applied. One of the remote systems that continues to be developed is the Internet of Things (IoT) based monitoring and control system . The Internet of Things (IoT) is a concept that refers to the use of smart devices and systems that are connected to utilize data collected by sensors and actuators in machines and other physical objects. IoT works by utilizing a programming argument with each argument command producing an interaction between fellow machines that are automatically connected without human intervention and at any distance. (Setiawan et al., 2019)The IoT hydroponic system consists of the main components, namely the Arduino microcontroller and the ESP8266 Wifi Module for system logic control and internet connection in data communication for sensor monitoring. (Bandung, 2021). One example of an IoT-based hydroponic control system is shown in the following figure:

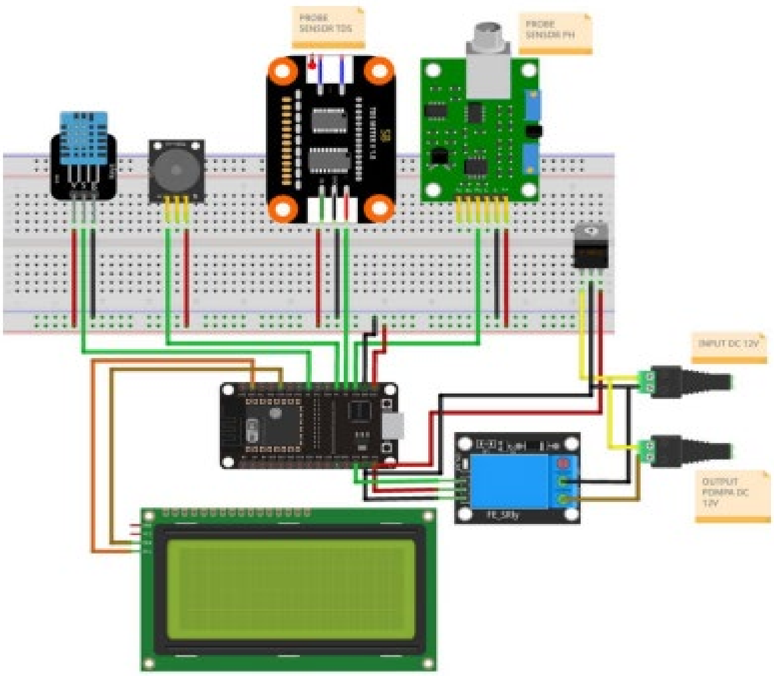


Fig 2. Example of IoT hydroponic control assembly. (Erlangga et al., 2023)

In this study, the development of a monitoring and control system for hydroponic devices that previously existed was carried out. The development of a website-based monitoring and control system for hydroponic devices is considered capable of ensuring more optimal maintenance and maximum growth of hydroponic plants until harvest time. Especially for hydroponic systems with relatively large sizes.

2. RESEARCH METHOD

A. *Use case diagram*

Use Case Diagrams are used to explain the interactions of the system created with the aim of making it easier for users to understand the functionality of the system .
The use case diagram used is as shown in the following image:

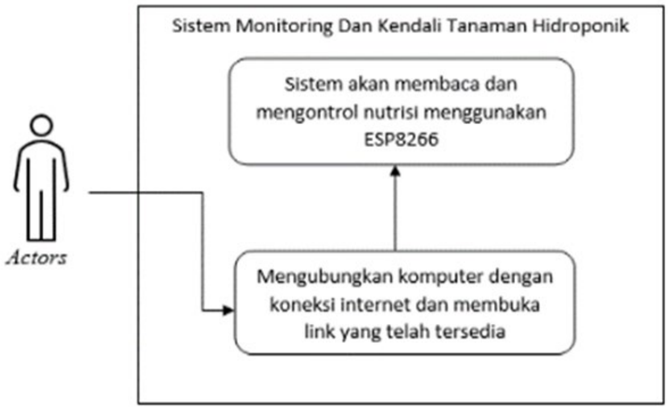


Fig 3. Use case diagram

B. *Hardware design*

The design of the control system device is presented in the following figure:

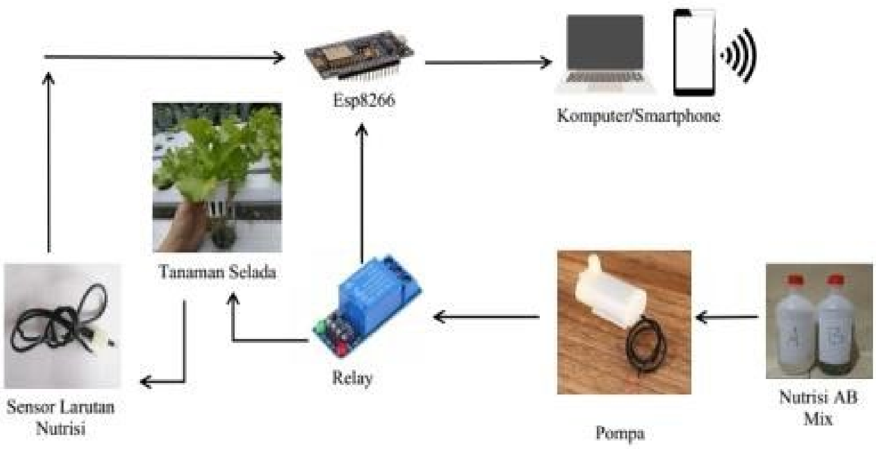


Fig 4. Design of control system and relationships between devices

The role of each device in the circuit is as follows:

1. The relay is used as a *delay timer* or switch to turn the nutrient fluid pump on and off so that the nutrient fluid can flow as needed.
2. Nutrient solution sensor to check nutrient capacity in PPM units.
3. The ESP8266 module acts as a WiFi module as well as the main controller or connector for hydroponic control devices to the internet and a computer or smartphone.
4. Pumps are used to mix nutrients and deliver nutrients to hydroponic plants.
5. Computers/Smartphones are used to monitor and control hydroponic plant systems.

C. Interface design (user interface)

The design of the display on the computer screen (*user interface*) is shown in Figure 4 below:

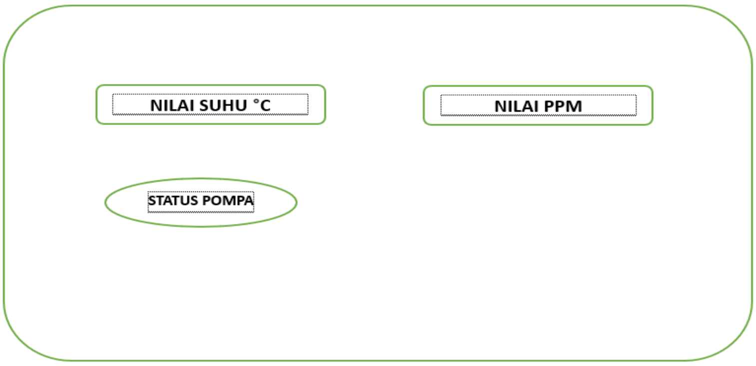


Figure 5. *User interface design*

1. Temperature value, to display temperature value from ds18b20 sensor
2. PPM Value, to Display ppm value of df-robot TDS sensor
3. Pump status, to set the status of the nutrient fluid pump on or off.

D. Software Development

The software creation is divided into two parts, namely the ESP 8266 microcontroller software, and the Internet of Things software. The ESP8266 board is programmed using the C programming language with the Arduino application as its compiler. The program from the compiler has a .ino extension and is then uploaded to the ESP8266 via a USB cable. The Internet Of Things software plays a role in displaying programming results information through the Arduino application and then displayed on the website page.

3. RESULTS AND DISCUSSION

The test results can be described as follows:

A. Home Menu On Website

The home menu on the website is an interface that displays the number of dissolved solids in PPM units and Temperature Values, equipped with a pump status display indicator in the off or on state. To use its function, users need to access the website link provided and can be accessed remotely if there is internet. The display in Figure 6 below is a screenshot of the home menu layout on the website.

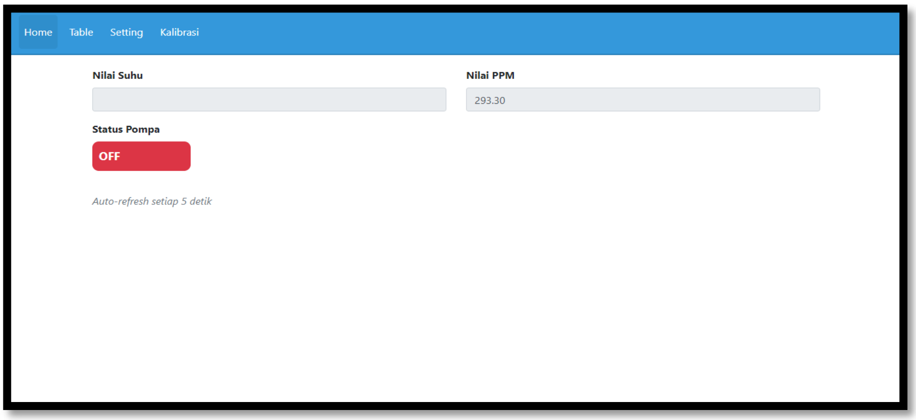
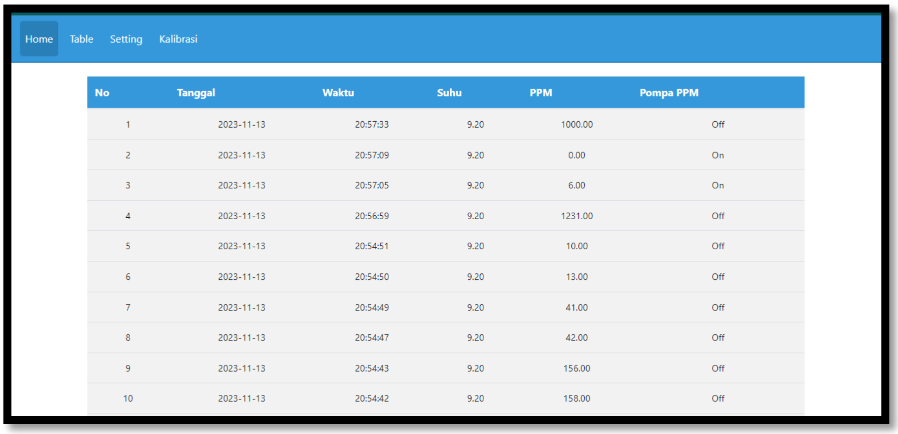


Figure 6. Home Menu

B. *Menu Table On Website*

The table menu contains information that displays the status of the date, time , ppm value, temperature and pump status every 10 minutes. The display in Figure 7 is a screenshot of the Table menu arrangement on the website.



No	Tanggal	Waktu	Suhu	PPM	Pompa PPM
1	2023-11-13	20:57:33	9.20	1000.00	Off
2	2023-11-13	20:57:09	9.20	0.00	On
3	2023-11-13	20:57:05	9.20	6.00	On
4	2023-11-13	20:56:59	9.20	1231.00	Off
5	2023-11-13	20:54:51	9.20	10.00	Off
6	2023-11-13	20:54:50	9.20	13.00	Off
7	2023-11-13	20:54:49	9.20	41.00	Off
8	2023-11-13	20:54:47	9.20	42.00	Off
9	2023-11-13	20:54:43	9.20	156.00	Off
10	2023-11-13	20:54:42	9.20	158.00	Off

Figure 7. Table Menu

C. *Settings menu on the website*

In the settings menu we can set the minimum ppm value and the maximum ppm value manually, and we can also set the ppm pump on or off. Figure 8 below is a screenshot of the settings menu on the website

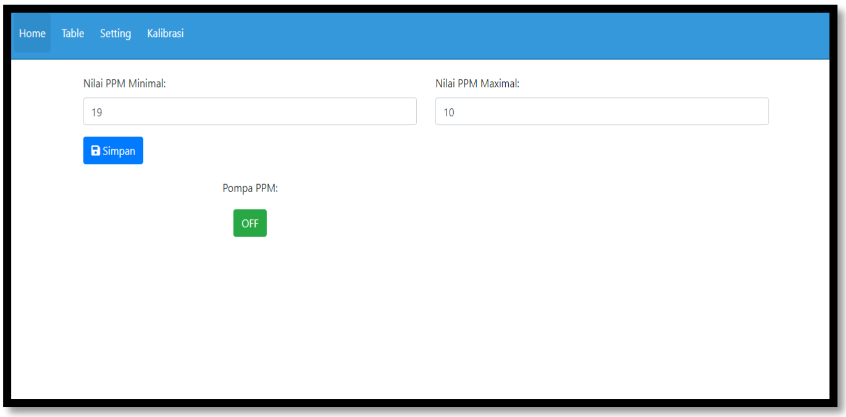


Figure 8. Settings Menu

D. Calibration Menu On Website

In the calibration menu we can calibrate the ppm value if the ppm value detected by the sensor does not match the conditions in the field or a sensor error occurs. The display in Figure 9 is a screenshot of the calibration menu display layout.

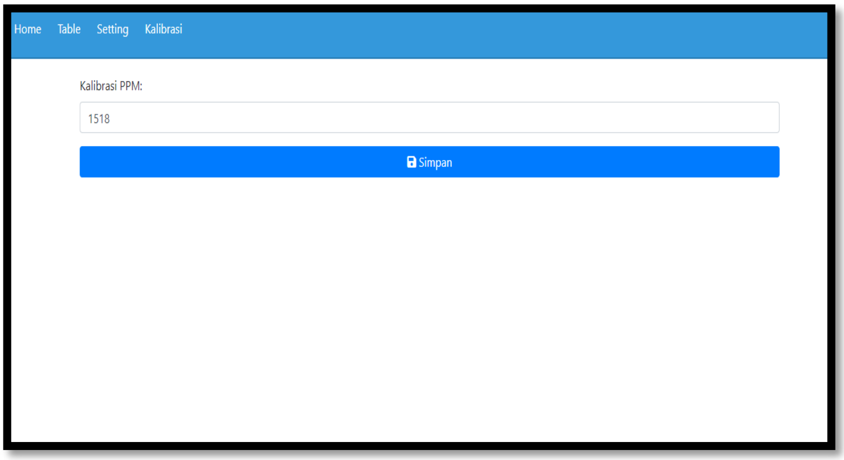


Figure 9. Calibration Menu

E. System hardware testing

System testing is carried out to ensure that the designed system will operate in accordance with the analysis and design that has been done previously. The main purpose of testing is to verify system performance and assess whether the system is functioning properly or not. In this case, the system will control the nutrient solution mixed with water using the ESP8266 module, which produces output in the form of a comparison value between the TDS EC Meter sensor and the TDS Meter. At this testing stage, the substance is the evaluation of the TDS EC Meter sensor, relay, and ESP8266 WiFi connection. Test data will be input into the table. the next step is to find the error value, the results obtained will be expressed in percentage error value as follows:

$$\%error = \frac{Nilai\ Sensor - Nilai\ Acuan}{Nilai\ Acuan} \times 100\ \%$$

$$\%error = \frac{\sum error}{\sum uji\ coba} \times 100\% \quad (2)$$

F. TDS EC Meter Sensor Testing

TDS EC Meter sensor is the main sensor used to measure the concentration of dissolved solids in hydroponic nutrient solutions. TDS, which stands for Total Dissolved Solids, reflects the amount of solids dissolved in the solution. Meanwhile, EC, which stands for Electrical Conductivity, indicates the level of electrical conductivity. The operation of this sensor involves values generated through the programming process on the Arduino software. The trial was conducted to determine whether the sensor can effectively detect the solid content in the liquid nutrient solution, and the test results are in the table below.

Table 1. Results Testing Output Sensor TDS E.C. Meter with TDS Meter

Lots Testing	O'clock	Sensor Value TDS EC Meter	Sensor Value TDS Meter	Difference Measurement	Error (%)
1	13:00	824	812	12	1.48
2	14:00	829	807	22	2.73
3	15:00	830	809	21	2.60
4	16:00	833	802	31	3.87
5	17:00	837	787	50	6.37
6	18:00	825	779	46	5.91
7	19:00	826	771	55	7.12

Average Error %	4.29

The information in table 1 above displays test data from the Tds Ec Meter and Tds Meter sensors. Sensor evaluation using the Tds Ec Meter sensor uses the calculation of the percentage of error and the average value of the error, which is presented in the following equation:

$$\%error = \frac{Nilai\ Sensor - Nilai\ Acuan}{Nilai\ Acuan} \times 100\ \%$$

Based on the formula above, the following calculations can be made:
TDS Ec Meter Sensor Value = 824
TDS Meter Sensor Value = 812
% error =((824-812)/812) x 100 %
= 1.48 %

G. *Pump Testing*

This nutrient fluid pump function test aims to check whether the relay coil and relay contacts operate as planned or not. The test is carried out by entering a command to activate the relay, so that it can be assessed whether the relay is functioning or not. The value limit set for measuring the ppm/tds meter value is if the setting given at the minimum ppm value is lower than the specified limit, then the relay will be activated (on). However, if the value has reached the maximum ppm value that has been set, then the relay will be turned off (off)

Table 2. Water Pump Test Results

No	Relay	Relay Condition	Pump Condition	Information
1	Relay 1	HIGH	ON	in accordance
		LOW	OFF	in accordance

H. *Power supply and stepdown testing*

Testing the power supply and stepdown circuit is shown in table 3 below:

Table 3 Power *Supply* and *Stepdown* Test Results

Tool Name	Testing	Standard V-out (Volt)	V-out read (Volt)	Difference voltage)
Power Supply 12V/5A	Without burden	12	12.36	0.36
	With a load	12	12.36	0.36
Step Down 5V/3A	Without burden	5	4.99	0.01
	with load	5	4.99	0.01

The data in table 3 shows that the power supply and step down are in normal condition for use.

4. CONCLUSION

From the results of the research and testing carried out, it can be concluded that All parts or components of the internet-based hydroponic system nutrient plant controller can function properly according to plan. **The error** rate of TDS EC Meter compared to TDS Meter obtained an average value of 4.29%. Monitoring and control of the device can be seen on the website that has been hosted https://tanampintar.000webhostapp.com/

REFERENCES

Asrori, M., & Murdani, M. H. (2023). Sistem Pemberian Nutrisi Pada Tanaman Hidroponik Menggunakan Metode Fuzzy Berbasis Arduino. *Journal of System Engineering and Technological Innovation (JISTI)*, *2*(01), 91–99. https://doi.org/10.38156/jisti.v2i01.37

Bandung, U. L. (2021). *Jurnal Sosial dan Teknologi (SOSTECH) Otomatisasi Monitoring Metode Budidaya Sistem e-ISSN 2774-5155 Hidroponik dengan Internet of Things (IoT) Berbasis p-ISSN 2774-5147 Android MQTT dan Tenaga Surya*. *1*(8), 785–800.

Endryanto, A. A., & Khomariah, N. E. (2022). Kontrol Dan Monitoring Tanaman Hidroponik Sistem Nutrient Film Technique Berbasis Iot. *Konvergensi*, *18*(1), 25–32. https://doi.org/10.30996/konv.v18i1.4494

Erlangga, A. P. M., Dinatha, K. S. K., Nainggolan, F. E., & Prayogi, S. (2023). Prototipe Otomatisasi dan Pemantauan Sistem Hidroponik Berbasis IoT dengan Pemanfaatan Solar Panel Sebagai Sumber Energi. *G-Tech: Jurnal Teknologi Terapan*, *7*(4), 1367–1377. https://doi.org/10.33379/gtech.v7i4.3143

Istiqomah, F., Regitasari, Y. Y., Roshita, A. N., & Susila, J. (2020). Rancang Bangun Sistem Kontrol Otomatis Dan Monitoring pH Larutan Nutrisi Kebun Sayur Hidroponik Berbasis Android. *El Sains : Jurnal Elektro*, *2*(1). https://doi.org/10.30996/elsains.v2i1.3673

Reftyawati, D., Rahman, M. A., & Alisha, A. D. (2024). Hidroponik Sebagai Alternatif Tanaman Unggulan Dalam Meningkatkan Produktivitas Pertanian. *Jurnal Pengabdian Sosial*, *1*(4), 234–240. https://doi.org/10.59837/91m9b349

Setiawan, Y., Tanudjaja, H., & Octaviani, S. (2019). Penggunaan Internet of Things (IoT) untuk Pemantauan dan Pengendalian Sistem Hidroponik. *TESLA: Jurnal Teknik Elektro*, *20*(2), 175. https://doi.org/10.24912/tesla.v20i2.2994

Siregar, M., Zamriyetti, Wahyuni, S., & Rahmaniar. (2021). Pelatihan Sistem Tanam Hidroponik Kepada Para IBu Jalasenastri FASHARKAN Belawan. *Jurnal Abdimas Hawari, Jurnal Pengabdian Kepada Masyarakat*, *1*(1), 9–17.

Tharo, Z., & Hamdani, H. (2020). Analisis biaya pembangkit listrik tenaga surya (PLTS) atap skala rumah tangga. *Journal of Electrical and System Control Engineering*, *3*(2), 65–71.

Tharo, Z., Hamdani, H., & Andriana, M. (2019). Pembangkit listrik hybrid tenaga surya dan angin sebagai sumber alternatif menghadapi krisis energi fosil di sumatera. *Prosiding Seminar Nasional Teknik UISU (SEMNASTEK)*, *2*(1), 141–144.

Wadly, F., & Fitriani, W. (2023). PERANCANGAN SISTEM RADIUS PADA MIKROTIK ROUTEROS DI PT. PUAN BALEO RAHMADSYAH. *Jurnal Nasional Teknologi Komputer*, *3*(1), 27–35.

Wibowo, P., Lubis, S. A., & Hamdani, Z. T. (2017). Smart home security system design sensor based on pir and microcontroller. *International Journal of Global Sustainability*, *1*(1), 67–73.