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Performance of Data Transmission using LoRa Module in Smart Plantation Watering Systems

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ABSTRACT

Indonesia has a very large plantation area and is the main sector to support the community's economy. Generally, not all of the harvests obtained are good, so farmers experience losses. This condition is influenced by several factors such as plant needs that are not being met, which is why the Smart Watering System for Plantation (SWAP) is presented. SWAP is an automatic plant watering tool designed for the plantation sector by implementing a data transmission system using LoRa (Long Range) and NodeMCU ESP 8266 as a microprocessor. This research aims to determine and test data transmission performance using LoRa (Long Range). The aspects tested were testing the data transmission configuration using LoRa and delay testing in the plantation 1 and plantation 2 areas. The results shows that the plantation 2 has a better performance in terms of delay with 280,97 ms than plantation 1 that needs 322,53 ms to transmit the data

Introduction

Plantations are the main sector that supports the economy of the Indonesian people. The development of the plantation system in the Indonesian region is an important role for the community because it can contribute to the foreign economy to increase the country's finances (S. Y. Tyasmoro & Saitama, 2021). Many plants in the plantation are not harvested plants have good quality, so the harvest must be sorted again to get a harvest that is suitable for sale. This condition is influenced by several factors during the plant growth phase, one of which is the lack of water supply. Generally, farmers in Indonesia apply the manual watering method. This method is considered less effective because the water discharge used cannot be controlled accurately so it can cause a mismatch in the water needs used for each plant. Another cause is that sometimes farmers are often late in watering the plants.

The development of agricultural technology has now entered the 4.0 revolution era known as Smart Farming (Putri, Suroso, & Nasron, 2019). The agricultural revolution consists of artificial intelligence, the Internet of Things, human-machine interface, and communication technology in agriculture. Digitalization of the agricultural system is expected to produce good quality crop products to increase farmers' income. To answer the problems that often occur, therefore, the solution offered is to make a Smart Watering System for Plantation (SWAP) smart device. The SWAP device was made to help farmers in carrying out watering and maintenance of plants remotely. With the presence of SWAP devices that can control plant conditions remotely, it can reduce farmers' worries when they are away for long periods (Pambudi, Andryana, & Gunaryati, 2020). The studies about the IoT-based smart which has been done shows the good performance of the systems in terms of crop productivity (Rezk, Hemdan, & et al., 2021), energy consumptions (Dhruva, Prasad, & et al., 2023), pest detection accuracy (Saranya, Deisy, & et al., 2023), (El-Ghamry, Darwish, & et al., 2023), and profitability of large scale farm (Li, Nanseki, & et al., 2023).

Smart Watering System for Plantation (SWAP) is an automatic watering control system based on the Internet of Things (IoT). To support the performance of the SWAP system, it is equipped with a NodeMCU ESP 8266 microcontroller. The microcontroller will use soil temperature and humidity data to control the plant watering system. The data is received and processed by the microcontroller and then sent to the Android device using an internet connection (Hidayat & Amrullah, 2022). This system enables farmers and plant owners to remotely control and monitor watering, making it more convenient for them (Azzaky & Widiantoro, 2020).

METHODS

A. System Block Diagram

The overall system includes hardware and data transmission as shown in the following diagram

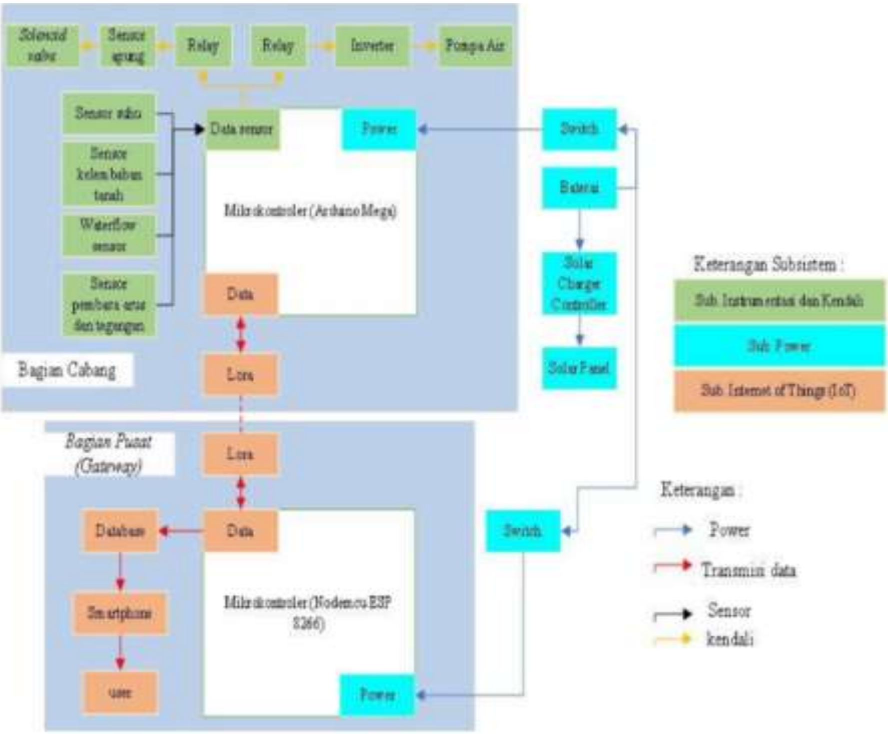

Figure 1. System Block Diagram

The center (gateway) uses a star topology network and a Nodemcu ESP 8266 microcontroller, while the branch is controlled by an ArduinoMega microcontroller. The communication link between the center and the branch uses the LoRa (Long Range) RFM 95 W module. The gateway functions as a forwarder for receiving monitoring data from sensor readings located at the user's branch through data uploads using the Wireless Fidelity (WiFi) network. The microcontroller functions as a control center and control of the sensor data readings used. Furthermore, the explanation of the Smart Watering System for Plantation (SWAP) provides several features, the first of which is the automatic watering and manual watering features. The automatic watering system obtains data from soil moisture sensor readings which, if below the set indicator, the automatic water pump will be active until the moisture sensor reading reaches the set indicator limit. For the manual watering feature can be done based on the user's wishes. Activation of the water pump is supported by a 500 W PSW inverter which has a power peak of up to 1000 W. Monitoring features are equipped using soil moisture sensors, temperature sensors, air humidity, and waterflow sensors. Additional features of the SWAP system are in the form of a TFT LCD that functions the same as a smartphone application, namely control and monitoring if the system is disturbed.

The LoRa (Long Range) communication network system is shown in the following figure.

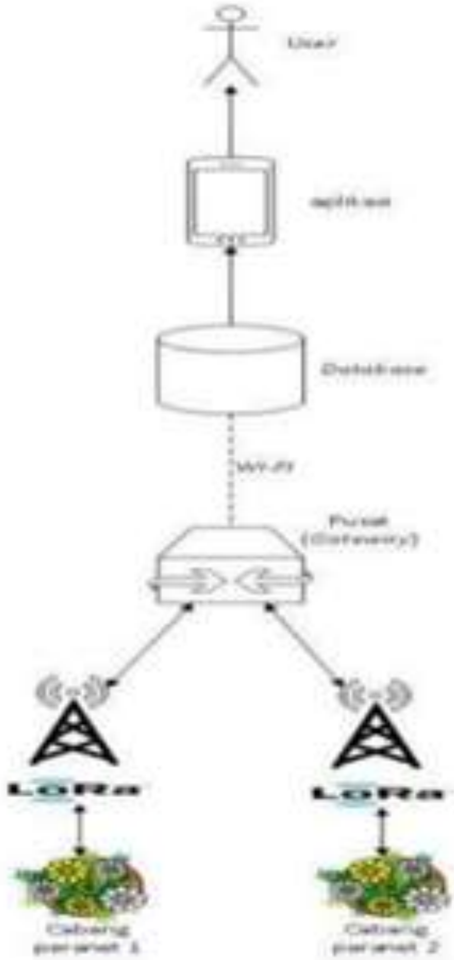

Figure 2. LoRa (Long Range) Architecture

The SWAP (Smart Watering System for Plantation) data transmission system uses a NodeMCU ESP 8266 microcontroller and a LoRa (Long Range) module connected to a gateway. LoRa is used in the garden 1 and garden 2 areas which are then connected to the gateway which is 200 meters from the garden. The SWAP communication network uses a star topology consisting of 3 devices. The use of star topology was chosen because if one branch experiences interference, it will not disrupt the data transmission network in other gardens. Monitoring is done by reading sensor data sent through the gateway, then the control system will send commands to the branch.

B. Hardware Components

The following, several components are used in the Smart Watering System for Plantation.

- Digital Output Relative Humadity and Temperature Sensor (DHT22)

  DHT 22 is a digital temperature and relative humidity sensor. The DHT 22 sensor has a power of 3.3 - 5 VDC and can measure temperatures of -400C – 800C and humidity of 0% - 100%. Temperature measurement accuracy can reach 0.50C and humidity 2% - 5% (Puspasari, Satya, Oktiawati, Fahrurrozi, & Prisyanti).

- Capasitive Soil Sensor (v1.2)

  Capacitive soil sensors possess capacitive properties that can impede corrosion of the sensor material and can be integrated into the planting media (Suryatini, Maimunah, & Fachri, 2018).

- Water Flow Sensor (YF-S201)

  Water flow sensor is used to monitor the flow of water discharge. YF-S201 can detect water flow of 50 liters/minute (3,000 liters/hour) (Agung & Rahardjo, 2017). The YF-S201 specification has a pressure of 1.75 Mpa and a voltage of 5 - 18 VDC.

- Solenoid Valve

  Solenoid valve functions to close and open the flow of water between the two chambers. The solenoid used has the Normally Closed (NC) type (Arifin, Baqaruzi, & Zoro, 2021). The specifications of the solenoid used have 12 VDC power and pressure 0,02 – 0,8 Mpa.

- Relay 5V

  Relay is a switch that consists of 2 main parts, namely electromagnet (coil) and mechanical (set of switches). The working principle of the relay uses electromagnetics to move the switch so that with a small electric current it can conduct electricity with a higher voltage (Risanty & Arianto, 2017). The relay used has a VCC size of 5 V and an output of 28-30 DC/10 A.

- Arduino Due

  Arduino due has 54 digital input/output pins, 12 analog inputs, 4 UARTs, 84 MHz clock, USB OTG connection, 2 DACs, 2 TWIs, SPI header, JTAG header, reset button and delete button. Arduino software consists of a standard programming language and boot loader that is executed in the microcontroller (Puspitasari, et al., 2019).

- NodeMCU ESP 8266

  NodeMCU ESP 8266 is a module that integrates TCP/IP protocol and can provide microcontroller access to WiFi networks. Each ESP 8266 module is programmed using AT command set firmware that can connect to Arduino to connect to WiFi with the ability as a WiFi Shield (Samsugi, Ardiansyah, & Kastutara, 2018).

- LoRa RFM 95W

  The RFM 95W transceiver module features a LoRa (Long Range) modem that provides ultra-long range spread spectrum communication and is resistant to high interference and minimizes current consumption. This module provides significant advantages that are a solution to conventional communications based on distance, interference resistance, and energy consumption (Wahyudi, et al., 2022). The LoRa RFM 95W specification has a frequency band of 868/915 MHz, a spreading factor of 6-12, a bandwidth of 125-500 kHz, and an effective bitrate of 293-37,5 kbps.

C. Monitoring Application

Users can monitor and control using the SWAP application. The following is the design of the SWAP application.

Figure 3. Garden Watering Design

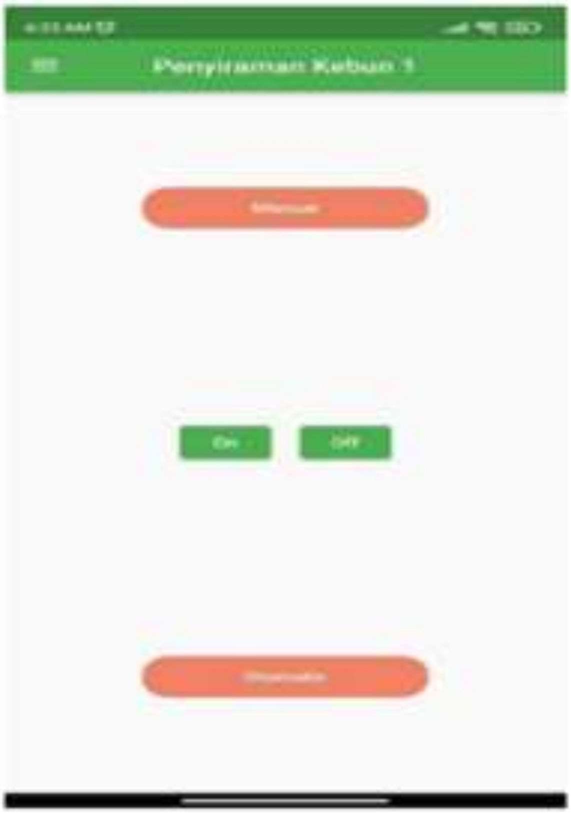

Figure 4. Garden Watering Options

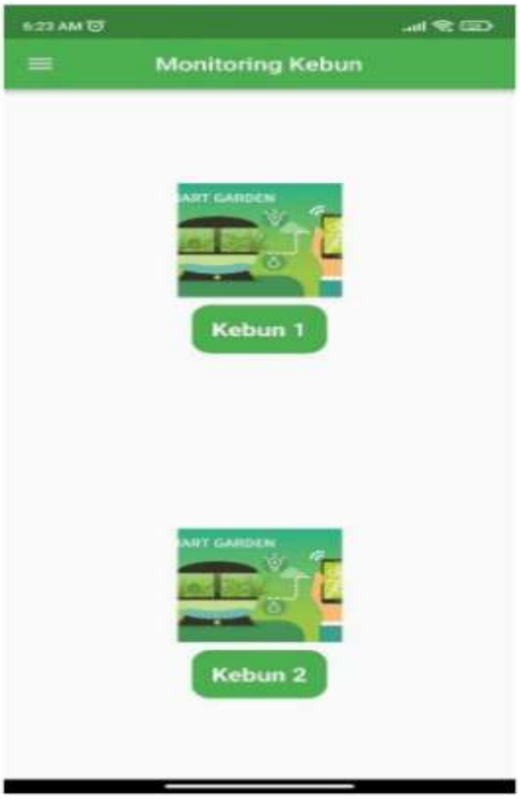

Figure 5. Garden Monitoring

Figure 6. Garden Monitoring 1

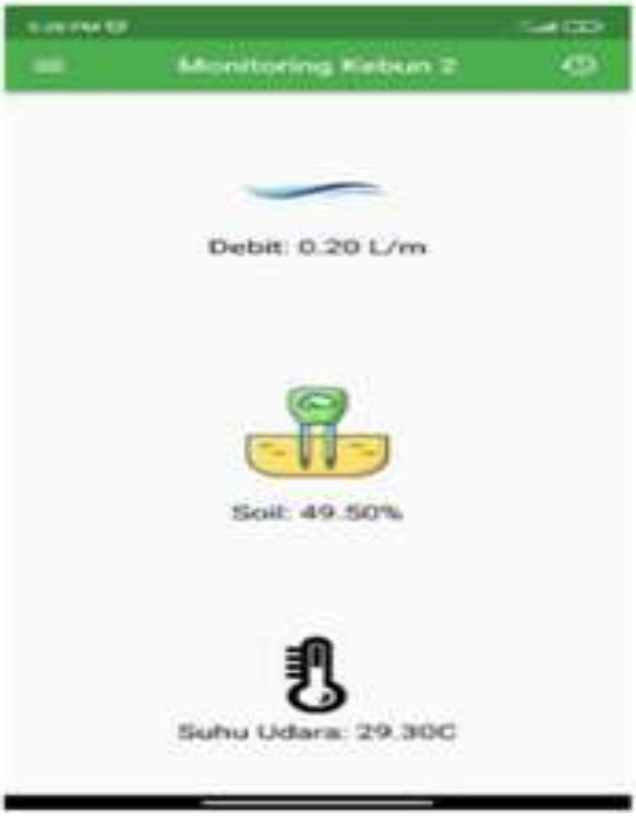

Figure 7. Garden Monitoring 2

Figure 8. Account Registration

RESULTS AND DISCUSSION

A. Tool Implementation

The microprocessor circuit on the branch section can be seen in the following figure.

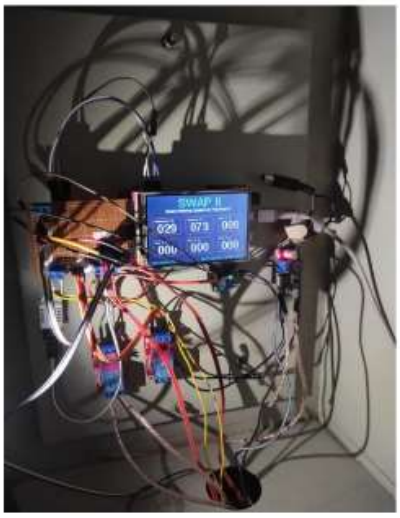

Figure 9. Branch Microcontroller Circuit

The central microprocessor circuit can be seen in the following figure.

Figure 10. Rangkaian Mikroprosesor Pusat

The overall system of the Smart Watering System for Plantation (SWAP) tool starts by connecting the microprocessor with a 12V and 100Ah voltage power source. The sensor is connected to the Arduino Due and the received data is transmitted to the LoRa module, which then sends it to the central LoRa module. The data collected by the central LoRa is transmitted wirelessly to the NodeMCU 8266. Once the data is stored in the NodeMCU, it is then sent to a database. Users can access this data via the SWAP application.

B. Data Transmission System Testing

- Data Communication System Testing Using LoRa (Long Range).

  The process of receiving data is sent using LoRa (Long Range) connected to the NodeMCU ESP 8266 which has been designed with source code and the data is displayed in a serial monitor.

In the tests carried out, the LoRa branch is connected to the Arduino Due which is also connected to the DHT22, capacitive soil, INA 219, and water flow sensors. The LoRa gateway is connected to the NodeMCU ESP 8266 and connected to WiFi. The testing process involves providing input to the sensor, which sends its readings through the LoRa network to the Arduino Due for data reception. The LoRa branch will also send sensor data to the LoRa center. Data from the LoRa center will be sent to the NodeMCU ESP 8266 microcontroller. The data received by ESP 8266 is analog data which is converted into digital data using the source code in the Arduino software. All sensor data will be sent to the database and can be accessed by users.

Delay Testing on Data Delivery The following is test data on delay in garden 1 and garden 2.

Table 1. Delay Time Classification Garden 1

Field Work	**Delay (ms)**	**Index**	**Description**
Garden 1	319	3	Medium
	307	3	Medium
	305	3	Medium
	300	3	Medium
	324	3	Medium
	265	3	Medium
	325	3	Medium
	335	3	Medium
	289	3	Medium
	302	3	Medium
	328	3	Medium
	307	3	Medium
	319	3	Medium
	63	5	Best
	325	3	Medium
	338	3	Medium
	315	3	Medium
	331	3	Medium
	349	3	Medium
	349	3	Medium
	314	3	Medium
	337	3	Medium
Average	322,53	3	Medium
Greatest Value	349	3	Medium

Table 2. Delay Time Classification Garden 2

Field Work	Delay (ms)	Index	Description
Garden 2	235	4	High
	343	3	Medium
	349	3	Medium
	327	3	Medium
	349	3	Medium
	44	5	Best
	355	2	Low
	326	3	Medium
	324	3	Medium
	328	3	Medium
	238	4	High
	226	4	High
	328	3	Medium
	369	2	Low
	325	3	Medium
	362	2	Low
	337	3	Medium
	257	3	Medium
	40	5	Best
	17	5	Best
	314	3	Medium
	337	3	Medium
Average	280,97	3	Medium
The largest delay value	369	2	Low

Delay testing is carried out to observe the delay time in the process of sending data obtained from measurements of temperature, soil moisture, and water discharge. Delay measurements in garden area 1 are in the quite good category. The average delay obtained is categorized as medium with a Received Signal Strength Indicator (RSSI) > -80 dBm, which is in the range of 80 dBm to -110 dBm. The signal is said to be good if it has an RSSI ≤ -70 dBm.

The delayed test on plantation 2 is in the quite good category because it has an average delay value of 280,97 ms and an RSSI value ranging from -72 dBm to -110 dBm. This happens because the LoRa module used is placed in a closed room so the signal strength is better. This condition is also influenced by the LoRa material and the LoRa antenna which is made of brass.

Observations from the results of the comparison of delay data in plantation 1 amounted to 322,53 ms and plantation 2 amounted to 280,97 ms, it can be concluded that plantation 2 has better signal quality than plantation 1. This difference condition is influenced by the box panel material used. In garden 1 the box panel material is used from metal, while the box panel in garden 2 uses plywood. This affects the frequency of the LoRa signal, causing large delays in data transmission.

CONCLUSION

Based on the research results obtained to determine the data transmission performance using LoRa, it can be concluded that LoRa (Long Range) can be used as a data transmission medium that can be connected to a microcontroller such as the NodeMCU ESP 8266. Data from sensor readings can be used for automatic watering control via the application. The data transmission process is affected by delay. The delay value is influenced by the location and quality of the LoRa materials in order to obtain good signal quality.

REFERENCES

El-Ghamry, A., Darwish, A., & et al. (2023). An optimized CNN-based intrusion detection system for reducing risks in smart farming. Internet of Things.

Agung, I. G., & Rahardjo, P. (2017). Rancang Bangun Sistem Pembacaan Jumlah Konsumsi Air Pelanggan PDAM Berbasis Mikrokontroler ATMEGA328 Dilengkapi SMS. Majalah Ilmiah Teknologi Elektro, 16(1), 31-40.

Arifin, I., Baqaruzi, S., & Zoro, R. (2021). Analisis Sistem Kendali Dua Posisi pada Solenoid Valve untuk Produk Biogas Control and Monitoring (Common-Bigot) From Animal Waste. Journal of Vocational Mechanical Engineering, 16(32), 47-57.

Azzaky, N., & Widiantoro, A. (2020). Alat Penyiram Otomatis Berbasis Arduino Menggunakan Internet of Things (IoT). Jurnal Eltrik, 8(3), 87.

Dhruva, A. D., Prasad, B., & et al. (2023). An efficient mechanism using IoT and wireless communication for smart farming. Materials Today: Proceedings, (pp. 3691-3696).

Erwanto, D., K., D. A., & Sugiarto, T. (2020). Sistem Pemantauan Arus dan Tegangan Panel Surya Berbasis Internet of Things. Multitek Indonesia, 14(1), 1. doi:10.24269/mtkind.v14i1.2195

Hidayat, M. A., & Amrullah, A. Z. (2022). Sistem Kontrol dan Monitoring Tanaman Hidroponik Berbasis Internet of Things (IoT) Menggunakan NodeMCU ESP 8266. Jurnal SAINTEKOM, 12(1), 25.

Li, D., Nanseki, T., & et al. (2023). A review of smart agriculture and production practices in Japanese large-scale rice farming. Journal of the Science of Food and Agriculture, 1609-1620.

Pambudi, A. S., Andryana, S., & Gunaryati, A. (2020). Rancang Bangun Penyiraman Tanaman Pintar Menggunakan Smartphone dan Mikrokontroler Arduino Berbasis Internet of Things. Jurnal Media Informatika Budidarma, 4(2), 250.

Puspasari, F., Satya, T. P., Oktiawati, U. Y., Fahrurrozi, I., & Prisyanti, H. (n.d.). Analisis Akurasi Sistem Sensor DHT22 berbasis Arduino terhadap Thermohygrometer Standar. J. Fis. dan Apl, 16(1), 40. doi:10.12962/j24604682.v16i1.5776.

Puspitasari, F., Fahrurrozi, I., Satya, T. P., Setyawan, G., Fauzan, M. R., & Admoko, E. M. (2019). Sensor Ultrasonik HCSR04 Berbasis Arduino Due Untuk Sistem Monitoring Ketinggian. Jurnal Fisika dan Aplikasinya, 15(2), 36. doi:10.12962/j24604682.v15i2.4393

Putri, A. R., Suroso, & Nasron. (2019). Perancangan Alat Penyiram Tanaman Otomatis pada Miniatur Greenhouse Berbasis IOT. Prosiding SENIATI, 155.

Rezk, N., Hemdan, E., & et al. (2021). An efficient IoT based smart farming system using machine learning algorithms. Multimed Tools Appl , 773–797.

Risanty, R. D., & Arianto, L. (2017). Rancang Bangun Sistem Pengendalian Listrik Ruangan Dengan Menggunakan AtMega 328 dan SMS Gateway Sebagai Media Informasi. Jurnal Sistem Informasi, Teknologi Informasi dan Komputer, 7(2), 1-10.

S. Y. Tyasmoro, P. N., & Saitama, A. (2021). Teknologi Produksi Tanaman Perkebunan. Malang: UB Press.

Samsugi, S., Ardiansyah, & Kastutara, D. (2018). Internet of Things (IoT): Sistem Kendali Jarak Jauh Berbasis Arduino dan Modul WiFi ESP8266. Prosiding Seminar Nasional XII Rekayasa Teknologi Industri Informasi, 295-303.

Saranya, T., Deisy, C., & et al. (2023). A comparative study of deep learning and Internet of Things for Precision Agriculture. Engineering Applications of Artificial Intelligence.

Suryatini, F., Maimunah, & Fachri, I. F. (2018). Sistem Akuisisi Data Suhu dan Kelembaban Tanah pada Irigasi Tetes Otomatis Berbasis Internet of Things. Prosiding Seminar Nasional Sains dan Teknologi, 1-6. Retrieved from https://jurnal.umj.ac.id/index.php/semnastek/article/view/3479

Wahyudi, T., Marpaung, J., Tjahjamooniarsih, N., Yacoub, R. R., Pontia, F. T., & Imansyah, F. (2022). Pengujian Performansi Modul Radio Transceiver RFM95W Menggunakan Sistem Komunikasi Bergerak Dengan Beberapa Pola Secara Real Time pada Area Perairan/Sungai di Kota Pontianak. Journal of Electrical Engineering, Energy, and Information Technology, 10(1). doi:http://dx.doi.org/10.26418/j3eit.v10i1.52519