Volume 11. No 3, September 2024
e-ISSN: 2527-9572 / ISSN: 2354-8924

# IoT-based Automatic Pesticide Sprayer Control System on Guava Trees

**Budi Cahyo Wibowo**
Program Studi Teknik Elektro
Fakultas Teknik
Universitas Muria Kudus
budi.cahyo@umk.ac.id

**Noor Yulita Dwi Setyaningsih**
Program Studi Teknik Elektro
Fakultas Teknik
Universitas Muria Kudus
noor.yulita@umk.ac.id

**Riyan Setiawan**
Program Studi Teknik Elektro
Fakultas Teknik
Universitas Muria Kudus
riyan123925@gmail.com

***Abstract*** **– The development of the use of agricultural technology is currently very rapid to meet the increasing basic human needs, according to water guava farmers in Penanggungan village who said that in the last year there has been an increase in water guava fruit orders by consumers. Therefore, we need a tool to help farmers in terms of cultivating water guava fruit. In this case the use of technology used in the application of automatic pesticide sprayers on water apple trees based on IoT, previously spraying was carried out by farmers manually so that with this automatic pesticide sprayer it can help farmers work in guava cultivation. This monitoring system utilizes Internet of Things technology. This study uses component input outputs, including NodeMCU ESP8266, RTC sensors, relays, LCDs. The software used for system monitoring uses Blynk software. The results of the study obtained success reaching 100% with automatic spraying successfully functioning, when the time was 16.00 WIB the pump would automatically start spraying pesticides and when the time showed 16.01 the pump would stop spraying. Notifications can be sent to the Blynk app.**

***Keywords: Blynk; Internet of Things; Monitoring; Automatic pesticide sprayer.***

Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License

## I. INTRODUCTION

The application of agricultural technology, both in preharvest and post-harvest activities, is decisive in achieving food sufficiency in both quantity and production quality. The application of agricultural technology, both in preharvest and post-harvest activities, is decisive in achieving food sufficiency in both quantity and production quality. Agricultural technology has played a role in increasing the efficiency and productivity of food commodity farming in developed or developing countries including Indonesia[1]. Water guava is a fruit plant belonging to the genus Syzygium and family Myrtaceae. Water guava trees have a height of 5-10 m with a short, branched trunk and irregular leaf crown[2][3].

In the process of cultivating guava fruit should be taken with sufficient care, starting from regular watering of water and fertilizer application. While in eradicating pests, treatment must be given in the form of spraying pesticides on trees. Literally, pesticide means pest killer (*Pest*: pests and *cide*: kill). Chemical compounds are widely used in agriculture, among others, as plant fertilizers and pesticides [4].

The results of interviews with farmers cultivating water guava fruit in Penanggungan Village, it is known that until now in general, guava pest control is carried out by farmers manually. So many farmers complain about spraying pests because it is not efficient in time and energy, seeing farmers who are still manual in spraying pesticides, automation of pesticide spraying systems on water guava fruit trees is needed.

Related research on automatic pesticide spraying systems was developed by Gusrio Tendra in 2020. This study discusses the use of the GSM module SIM800L as a telephone notification feature on *Smartphones* used for automatic pesticide sprinkler systems. The study used RTC DS1307 as a detection of pesticide watering time, but this study has not used the IoT concept as remote monitoring and there is no feature to detect pesticide supplies [5].

With the above problems, one solution that can be applied is by making an automatic pesticide spraying system on water guava fruit trees. This system utilizes IoT technology, and this automatic pesticide sprayer is monitored using a *smartphone* that has the *Blynk application* installed. With this system, it is hoped that it can help the work of farmers and can make crop yields better than before.

## II. BASIC OF THEORY

According to Monitoring is something related to the activity cycle which includes collecting, reviewing, reporting and acting on a process that is being carried out so that it can make corrections and evaluations for further improvement of the activity[6]. Monitoring is generally done for a specific purpose, with monitoring will provide information about the status and trends that measurements and evaluations are completed repeatedly over time[7].

*Internet of things* or commonly referred to as IoT is an advanced technology that has a concept that aims to expand and develop the benefits of internet connectivity that is connected continuously connecting objects around so that daily activities become easier and more efficient which greatly helps all human work. The importance of the internet of things can be seen by being increasingly applied in various lives today. According to the RFID identification method (*Radio Frequency Identification*), the term IoT belongs to a method of communication, although IoT can also include other sensor technologies, wireless technologies or QR codes (*Quick Response*)[8].

The Blynk app is an IoT platform that's easy to learn but feature rich. Blynk supports various devices such as Arduino, Raspberry Pi and the like. Blynk is also the server to support the project Internet of Things that works on iOS and Android. Blynk consists of three main components, namely: Blynk Library, Blynk Cloud Server, and Blynk Apps.Blynk Library is used to aid code development. Blynk Apps create interfaces to various I/O components that support sending and receiving data and presenting data according to selected components. Data can be presented in the form of visual numbers or graphs. Blynk Cloud Server is a service backend cloud-based responsible for managing communication between Blynk Appswith hardware environment[9].

NodeMCU ESP-8266 also has a very small board, which is 4.83cm long and 2.54cm wide. NodeMCU ESP-8266 offers convenience for developing internet-based devices because it is equipped with a wireless communication module (WiFi). NodeMCU ESP-8266 can be considered as the Arduino board of ESP8266. The program ESP8266 is a bit of a hassle as it requires some wire techniques as well as the addition of a USB module to the serial to download the program. However, the NodeMCU ESP-8266 has unified ESP8266 into a minimalist board with various features such as a microcontroller that has access to WiFi as well as a USB communication chip to serial. So to program it only needs a USB data cable [10]. Figure 1. The physical form of NodeMCU ESP8266.

Figure 1. NodeMCU ESP8266

Real Time Clock DS1307 is one type of IC (Integrated Circuit) that works as a timer, DS1307 can store hours, minutes, seconds, dates, months, and years. Due to its ease of use and small shape, IC (Integrated Circuit) This is a good solution if you face problems about timers [11]. Figure 2. The physical form of RTC DS1302.


Figure 2. Modul RTC DS1302

Relay is a type of switch that is controlled by electric current and is an electromechanical component consisting of two main parts, namely electromagnet and mechanical consisting of a group of switch contacts. The working principle of the relay uses electromagnetic force to drive the switch contacts, so that by using a low electric current, the relay can flow an electric current that has a higher voltage. The difference between a relay and a switch lies in the way the contactor operates on the switch. On the switch, the movement of the contactor for the on and off position is done manually without electric current, while the relay requires an electric current to work[12].

*Liquid Crystal Display* (LCD) is a device used to display the results of output in an electronic circuit. This LCD has several features such as equipped with 16 characters and 2 lines or commonly called a 16x2 LCD, has 192 characters, can be used through 4-bit and 8-bit modes, and can also be used *back light*[13]. LCD can act as a producer of text display on a screen interface, able to display characters in the form of letters, numbers, and certain symbols[14].

A water pump is a device used to divert fluids or fluids from one location to another through a pipeline system. The working principle of the water pump occurs during operation where a pressure difference is created between the pressure side and the suction side. This pressure difference is generated by the mechanism contained in the impeller wheel which causes the suction side to remain stationary. The pressure difference causes the liquid to be sucked so that it can be moved from one tank to another [15].

Figure 3. 12DCV Water Pump

Battery or battery *Lead acid* is a type of electrical cell that undergoes an electrochemical process that can be reversed with a high degree of efficiency. This reversible electrochemical process refers to the ability of a battery to convert a chemical reaction into electrical energy (the discharge process), and vice versa, convert electrical energy into chemical energy upon recharge by passing an electric current in opposite polarity within the cell.[16].

Figure 4. Accumulator Battery

Research by Rahmad Hidayat, Muhaimin, and Aidi Finawan. 2019. Design *Prototype Drone* pesticide sprayers for rice farming Automatically: In this study *Drones* move using 6 propellers (*Propeller*) with a 10x4.7-inch size mounted on a 980KV brushless motor. Drones at the time of watering pesticide liquid perform *take off* Use the automatic flight mode set via *Universal Ground Control software* [17].

Research by Agung Wiksandiyo, Yamto, and Bloko Budi Rijadi. 2021. Development *Internet Of Things* (IoT) for Automatic Pesticide Spraying Applications: The way this system works is by using 3 different pesticide tubes and *user* can choose the type of pesticide to be sprayed on plants through *Smartphones*, NodeMCU that has been connected with 4 relays for 3 pesticide tube solenoids and 1 water pump, if the pesticide has been selected then the solenoid will automatically open and the water pump will spray pesticides [15].

Research by Budi Cahyo Wibowo, Imam Abdul Rozaq, and Tredi Pratama. 2023. Implementation of IoT-Based Temperature and Humidity Monitoring and Control in Oyster Mushroom Cultivation Room. In this study, the author created a temperature and humidity control monitoring system to maintain temperature and humidity stability in oyster mushroom cultivation by watering and heating the room temperature of the beetle automatically. In this system, the author uses a NodeMCU microcontroller ESP8266 and a DHT22 sensor as temperature and humidity monitoring, then to monitor the author using *website* which can be accessed via *Smartphones* [18].

## III. METHOD

In this research, research and development (Research and Development / R &D) methods will be used.

### A. Research Flow Stages

At this stage of the research flow has several steps including problem identification, hardware and software design, tool creation and tool testing. In testing the tool, if it is felt that the tool has not worked or functioned properly, an evaluation will be carried out from the previous step, when the tool is working and functioning properly, it will proceed to the next step, namely data retrieval and data analysis.

### B. Identification of Problem

At the stage of identifying this problem, it begins with the step of finding literacy materials and collecting supporting data, namely by conducting field observations by interviewing guava fruit farmers to obtain the needed information which is then adjusted to the description of the literature research is also carried out to evaluate the results of each study and identify weaknesses, which are then analyzed to obtain the information needed and developed in the research.

### C. Hardware Design

At the hardware design stage, this is done to find out the components needed in the design of an automatic pesticide automizer system on IoT-based guava fruit trees so that the implementation can run as planned.

System block diagram is a step used to display system blocks connected by lines to show the function of each component in a system. From the block diagram it is known that the system of this tool consists of inputs and several outputs. The block diagram of the pesticide sprinkler system is presented in Figure 5. It can be seen in Figure 5 that the system starts with a battery voltage source connected to the 5 VDC step-

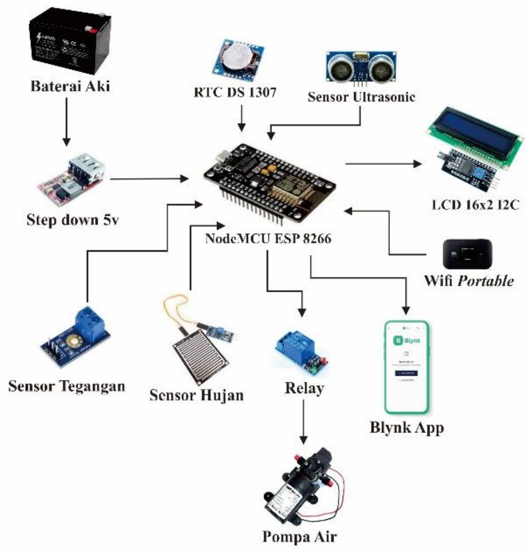


Figure 5. Diagram Block Automatic Spraying Pesticide System

down module and connected to the main system, NodeMCU is a microcontroller as the main controller. This microcontroller will later receive input and then provide output to LCD, *Relay*, and *Smartphone* (Blynk). The input in this system is in the form of RTC *(Real Time Clock*) DS1307 sensor which functions as a time detector and HC SR04 sensor as a water level detector in pesticide supply containers. Furthermore, there is a voltage sensor that will detect the battery voltage so that the condition of the battery will be monitored, then there is a rain sensor which if it detects pesticides when spraying will send information to be displayed in the android application.

### D. Software Design

At this stage, *software* design is done so that the system is made more organized and in accordance with what is planned. This research will use Arduino IDE software and the Blynk application. The program is created using Arduino IDE software, then continues *to upload* the program to NodeMCU ESP8266, then for Blynk to be used as system monitoring and notifications on *smartphones*. The program algorithm used in this automatic pesticide sprinkler system is shown in Figure 6.

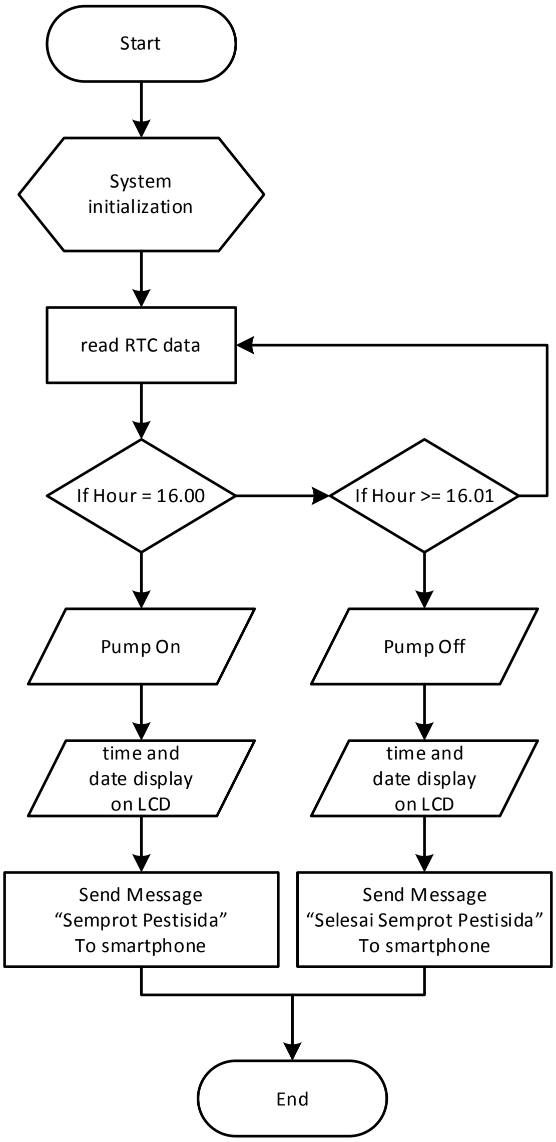


Figure 6. Flowchart Automatic pesticide sprinkler system

Figure 3 describes the process of automatic pesticide spraying, starting with the access to the DS1307 RTC module, when the clock strikes 16.00 then the pump will start, and spraying starts then there will be a notification sent to the *smartphone*. When the clock strikes 16.01 then the pump will turn off and spraying will stop, then there will be a notification on the *smartphone* about the notification of finishing spraying pesticides.

E. Android Software Design

Software used to monitor and control the water guava fruit tree sprinkler system is an android-based application so that it can be monitored and controlled using a smartphone. The display of the application used as shown in figure 7.

Figure 7 shows the results of the android software design consisting of a manual on/off button, pesticide availability indicator, battery availability indicator, and pesticide spraying equalization detection led and notification feature on a smartphone.


Figure 7. Android Software Design

F. System Design

At the system design stage, it starts with designing drawings according to the plan to make an automatic pesticide spraying system on IoT-based guava fruit trees. After the design of the drawing is complete, then proceed with preparing the tools and components to be used.

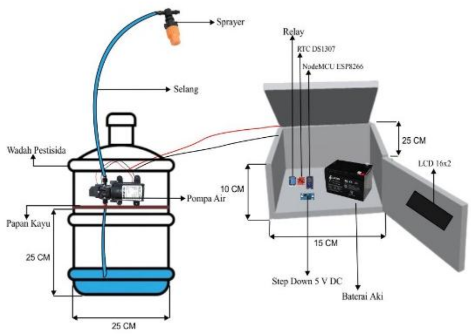


Figure 8. Sprayer System Design

Figure 8 is the result of the system design design. While in Figure 9 is an illustration of the implementation of pesticide sprinklers on water guava fruit trees, box panels and pesticide containers are placed under the tree and then for the sprayer and rain sensor placed on the guava water fruit tree.

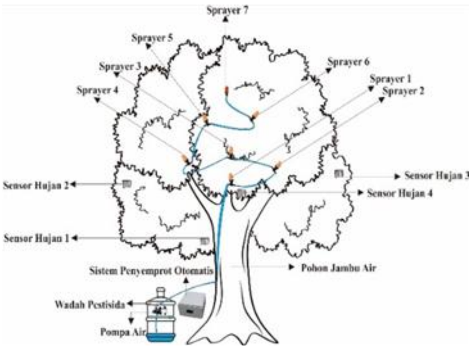


Figure 9. System Implementation on Water Guava Trees

## IV. RESULTS AND DISCUSSION

This automatic pesticide spraying system on water guava trees is designed to facilitate farmers in the process of caring for water guava trees. The nextr the stages of the process of designing and making tools, the next stage is to test the system made. The system testing is carried out to find out the extent of the performance of the tools made.

### A. Automatic pesticide sprayer testing

The purpose of this test is to determine the performance of the system built. The system works based on setting the clock on the RTC module. Pesticides will be sprayed at 4:00 p.m. and finished at 4:01 p.m. When spraying takes place, the system will send a notification to the smartphone that has installed the guava tree sprinkler application. Similarly, when the spraying process is complete, it is carried out. Table 1 is the test results of pesticide spraying systems based on timing.

Table 1 shows that when the clock shows 16.00 WIB, the pump will automatically turn on and the system sends a notification with the text "Spraying Pesticides" to the smartphone. When the clock shows 16.01 WIB, the pump automatically turns off and the system sends a notification with the text "Finished Spraying Pesticides". When the schedule shows outside the automatic spraying schedule, the pump turns off.

Table 1. Automatic Pesticide Sprayer Testing

| Experiment | Clock | Pump Condition | Blynk Notification Text | Status |
|---|---|---|---|---|
| Experiment 1 | 28/6/2023 At 16:00 | ON | Spraying Pesticides | Succeed |
| | 28/6/2023 At 16:01 | OFF | Finished Spraying Pesticides | Succeed |
| Experiment 2 | 29/6/2023 At 16:00 | ON | Spraying Pesticides | Succeed |
| | 29/6/2023 At 16:01 | OFF | Finished Spraying Pesticides | Succeed |
| Experiment 3 | 30/6/2023 At 16:00 | ON | Spraying Pesticides | Succeed |
| | 30/6/2023 At 16:01 | OFF | Finished Spraying Pesticides | Succeed |
| Experiment 4 | 13/7/2023 At 1:31 p.m. | OFF | - | Succeed |
| | 13/7/2023 At 10:16 p.m. | OFF | - | Succeed |

### B. Pump Response Time Delay Testing

This test aims to find out how much delay time the pump needs to respond to the actual schedule.

Table 2 shows the results of pump response *time delay* testing, testing was carried out 4 times with the average result of pump response *delay* reaching 0.75 seconds. *The delay* with the fastest time occurred on the second try with a delay result of *0* seconds while the *delay* with the longest result occurred on the fourth try with a delay result of 2 seconds. In this test, the system used 4G network mode. With these results, the pump can still function properly and in accordance with the planning stage.

Table 2. Pump Response Time Delay Testing

| Experiment | Clock Conditions | Pump Condition | Pump Response Time | *Delay* |
|---|---|---|---|---|
| Experiment 1 | 22/7/2023 16:00:00 | ON | 22/7/2023 16:00:01 | 1 Second |
| | 22/7/2023 16:01:00 | OFF | 22/7/2023 16:01:01 | 1 Second |
| Experiment 2 | 23/7/2023 16:00:00 | ON | 23/7/2023 16:00:00 | 0 Second |
| | 23/7/2023 16:01:00 | OFF | 23/7/2023 16:01:00 | 0 Second |
| Experiment 3 | 25/7/2023 16:00:00 | ON | 25/7/2023 16:00:00 | 0 Second |
| | 25/7/2023 16:01:00 | OFF | 25/7/2023 16:01:00 | 0 Second |
| Experiment 4 | 26/7/2023 16:00:00 | ON | 26/7/2023 16:00:02 | 2 Second |
| | 26/7/2023 16:01:00 | OFF | 26/7/2023 16:01:02 | 2 Second |

### C. Testing Notification Time Delay on Smartphone

This test aims to determine *the delay in the notification time sent to the* smartphone when the automatic pesticide sprayer is active. The test was carried out by calculating the delay time from the automatic spraying schedule until the notification can be sent to the *smartphone.* The test was conducted with four experiments with notifications sent by NodeMCU to the android application displayed on the *smartphone* and on the android application. When the clock strikes 16.00 WIB, the automatic spraying system will turn on and send a notification with the text "Spraying Pesticides" to *the smartphone*. Meanwhile, when the clock shows 16.01 WIB, the rotter automatically turns off and sends a notification with the text "Finished Spraying Pesticides". The following are the results of *the automatic* pesticide sprayer notification delay test on *smartphones* in Table 3.

Table 3 shows that notifications can be sent to *smartphones* through the Blynk application with an average *delay* of 2.12 seconds.

Table 3. Testing Notification Time Delay on Smartphones

| Experiment | Clock Conditions | Pump Condition | Notification Time on *Smartphone* | *Delay (second)* |
|---|---|---|---|---|
| Experiment 1 | 22/7/2023 16:00:00 | ON | 22/7/2023 16:00:02 | 2 |
| | 22/7/2023 16:01:00 | OFF | 22/7/2023 16:01:02 | 2 |
| Experiment 2 | 23/7/2023 16:00:00 | ON | 23/7/2023 16:00:00 | 0 |
| | 23/7/2023 16:01:00 | OFF | 23/7/2023 16:01:01 | 1 |
| Experiment 3 | 25/7/2023 16:00:00 | ON | 25/7/2023 16:00:02 | 2 |
| | 25/7/2023 16:01:00 | OFF | 25/7/2023 16:01:01 | 1 |
| Experiment 4 | 26/7/2023 16:00:00 | ON | 26/7/2023 16:00:03 | 3 |
| | 26/7/2023 16:01:00 | OFF | 26/7/2023 16:01:06 | 6 |

## V. Conclusion

From the results of designing, manufacturing, and testing the tool, it can be concluded that the automatic pesticide spraying system is able to work well, when the time shows 16.00 WIB the automatic pump turns on and notifications are sent to the smartphone android application. And when the time shows 16.01 WIB the pump automatically turns off and a notification is sent to the application, when the time shows outside working hours the pump is automatically off. Testing the pump response delay obtained an average delay of 0.75 seconds and for *the notification time delay* an average of 2.12 seconds.

## Reference


[1] L. M. Munadi, "KEMAJUAN TEKNOLOGI PERTANIAN DAN PERADABAN MANUSIA SERTA IMPLIKASINYA BAGI KESEJAHTERAAN PETANI DAN NELAYAN INDONESIA," pp. 1–12, 2020.

[2] Y. G. D. Anggraheni, E. B. M. Adi, H. Wibowo, and E. S. Mulyaningsih, "ANALISIS KERAGAMAN JAMBU AIR (Syzygium sp.) KOLEKSI KEBUN PLASMA NUTFAH CIBINONG BERDASARKAN MORFOLOGI DAN RAPD (Diversity Analysis of Syzygium sp. from Cibinong Germplasm Garden Based on Morphology and RAPD)," *Biopropal Ind.*, vol. 10, no. 2, p. 95, 2019, doi: 10.36974/jbi.v10i2.5248.

[3] S. Wahyuni, "Sosialisasi Pemanfaatan Jambu Air Menjadi Nata De Syzigium," *Din. J. Pengabdi. Kpd. Masy.*, vol. 4, no. 1, pp. 209–213, 2020, doi: 10.31849/dinamisia.v4i1.3285.

[4] G. N. Fajriani, F. R. Fadhilla, and R. R. Hutagaol, "Hubungan Intensitas Penyemprotan Pestisida Dengan Kadar Kolinesterase Dalam Darah Petani Di Desa Pasirhalang Kabupaten Bandung Barat," *Meditory*, vol. 7, no. 2, pp. 66–76, 2019.

[5] G. Tendra, "SISTEM PENYIRAMAN PESTISIDA OTOMATIS MENGGUNAKAN ARDUINO UNO DAN GSM SHEILD SIM 800L," vol. 12, no. 2, pp. 13–19, 2020.

[6] A. Wijaya and M. Rivai, "Monitoring dan Kontrol Sistem irigasi Berbasis IoT Menggunakan Banana PI," *J. Tek. ITS*, vol. 7, no. 2, 2018.

[7] Fauzan, "KOTAK PENERIMA PAKET BERBASIS IoT MENGGUNAKAN MODUL ESP32-CAM," *Institutional Repos. UIN Syarif Hidayatullah Jakarta*, pp. 1–66, 2020.

[8] A. Selay *et al.*, "INTERNET OF THINGS," *Karimah Tauhid*, vol. 1, no. 2963–590X, pp. 860–868, 2022.

[9] T. Juwariyah, L. Krisnawati, and S. Sulsasminingsih, "Sistem Monitoring Terpadu Smart Bins Berbasis IoT Menggunakan Aplikasi Blynk," *JIRE (Jurnal Inf. Rekayasa Elektron.*, vol. 3, no. 2, pp. 94–95, 2020.

[10] R. A. Murdiyantoro, A. Izzinnahadi, and E. U. Armin, "Sistem Pemantauan Kondisi Air Hidroponik Berbasis Internet of Things Menggunakan NodeMCU ESP8266," *J. Telecommun. Electron. Control Eng.*, vol. 3, no. 2, pp. 54–61, 2021, doi: 10.20895/jtece.v3i2.258.

[11] F. Muliawati, "RANCANG BANGUN PROTOTIPE SISTEM PEMBERIAN PAKAN IKAN BERBASIS RTC DS1307," *J. Tek. S*, vol. 4, no. 1, pp. 25–33, 2017.

[12] A. Wiksandiyo, Yamto, and B. B. Rijadi, "PENGEMBANGAN INTERNET OF THINGS (IoT) UNTUK APLIKASI PENYEMPROTAN PESTISIDA OTOMATIS," pp. 1–8, 2021.

[13] R. F. Murad, G. Almasir, C. R. Harahap, and L. Ratu, "Pendeteksi Gas Amonia Untuk Pembesaran Anak Ayam Pada Box Kandang Menggunakan MQ-135," *J. Ilm. Mhs. Kendali dan List*, vol. 3, no. 1, pp. 120–130, 2022.

[14] D. Mahendra, "Uji Sensitivitas Sensor Tcs230 Berbasis Arduino Uno Sebagai Alat Pendeteksi Warna Bagi Penderita Buta Warna," *Inov. Fis. Indones*, vol. 10, no. 1, pp. 43–51, 2021.

[15] A. Wiksandiyo, Yamto, and B. B. Rijadi, "PENGEMBANGAN INTERNET OF THINGS (IoT) UNTUK APLIKASI PENYEMPROTAN PESTISIDA OTOMATIS," pp. 1–8, 2021.

[16] F. A. Nugroho, K. B. Adam, and Angga Rusdinar, "SISTEM PENGISIAN BATERAI AKI PADA AUTOMATED GUIDED VEHICLE MENGGUNAKAN SOLAR PANEL," vol. 7, no. 3, pp. 81–90.

[17] R. Hidayat and A. Finawan, "RANCANG BANGUN PROTOTYPE DRONE PENYEMPROT," vol. 3, no. 2, pp. 86–94, 2019.

[18] B. C. Wibowo, I. A. Rozaq, and T. P. Pratama, "Implementation Of Monitoring and Control Temperature and Humidity Based on IoT in The Oyster Mushroom Cultivation Room," *PROtek J. Ilm. Tek. Elektro*, vol. 10, no. 2, pp. 85–92, 2023, doi: 10.33387/protk.v10i2.4863.