FLYWHEEL: JURNAL TEKNIK MESIN UNTIRTA

Homepagejurnal: http://jurnal.untirta.ac.id/index.php/jwl

Spraying Agricultural Crops Based on Internet of Things (IoT)

Shofiatul Ula[1*], Sidik Susilo[1], Erny Listijorini[1], Raka Irawan[1], Aceng Sambas[2], Aldis Tia Assidiq[2]

[1] Universitas Sultan Ageng Tirtayasa, Jl. Jenderal Sudirman Km. 3, 42435, Kota Cilegon, Indonesia.
[2] Universitas Muhammadiyah Tasikmalaya, Jl. Tamansari Km 2,5, 46196, Kota Tasikmalaya, Indonesia.

*Corresponding author: *shofi@untirta.ac.id*

ARTICLE INFO

Received 31/10/2021
Revision 8/11/2021
accepted 12/12/2021
Available online 12/12/2021

ABSTRACT

Indonesia's Agriculture is a strategic sector in increasing economic growth. One of the efforts to increase agricultural production in Indonesia is through technology. Watering is an essential component in improving the quality of farming products. Developing farming models can improve the efficiency and effectiveness of watering in farmland management. The monitoring and watering system using IOT has many benefits, including time efficiency, work effectiveness, remote operation, simplicity, and better watering accuracy. In this study, Smart Farming System was used in watering arrangements in the chili plantation area. Data on the sensor is used to analyze the effectiveness of water spraying against soil moisture value. The Smart Farming Device was placed in a coastal area with a hot climate in the chili garden. The experiment was conducted 9 hours from 08.00 – 17.00 WIB (West Indonesian Time). The Device works in a modular manner controlled remotely by the internet network, which works by energy converted from the sunlight. The use of types of sensors and the sensors placed on the farmland will determine the accuracy of the information received by farmers. We found that the spraying water method does not raise the soil moisture from the sensors parameter. We also found that the temperature parameter is not correlated with the sunlight intensity. So we need to add a wind speed sensor to determine the effect of wind blow on the environmental parameters. We concluded that the watering method through soil surface seems more promising in increasing the soil moisture value rather than the water spraying system via air.

Keywords: *Smart Farming, Internet of Things (IoT), Control System, Watering, farmland.*

1. INTRODUCTION

Agriculture in Indonesia is a strategic sector in increasing economic growth [1]. Agricultural commodities are essential in increasing foreign exchange earnings through trade between countries [2]. One of the efforts to increase agricultural production in Indonesia is through technology. There is no exception for traditional farmers who are scattered throughout the country. The use of the internet can support the availability of appropriate agricultural information, which is very helpful for farmers in making decisions in land management [3].

The development of internet networks on cellular phone-based in Indonesia has touched the rural communities. They have started to use the internet as a source of information and communication media [4]. This situation is an opportunity to accelerate the transfer of technology for the traditional farmers in processing farmland [5]. Therefore, the farmer can use the internet network to monitor and control their agricultural land [6].

Watering are essential components in improving the quality of agricultural products. Plant fertility can be maintained, nutritional needs for plants can be regulated. So that the harvest obtained can meet the expected target. Traditionally, watering and fertilizing are done based on their knowledge from generation to generation. So that the measurements and references used tend to be inaccurate, and it is not easy to know their validity. The farmland management results are inconsistent and measurable [7].

Smart farming models can be developed to improve the efficiency and effectiveness of agricultural management land. Especially in planting, fertilizing, watering, and harvesting [8]. Adding sensors can improve accuracy and validity in identifying environmental parameters and land conditions. The data from the sensor is then processed and sent to the farmers via the internet of things (IOT) [9]. The presented information can be accessed by farmers in real-time wherever they are [10]. The data collected from these sensors use as a reference in irrigating and fertilizing crops on farmland [11,12].

Internet of things is software embedded on an internet platform, and its working system utilizes the internet network infrastructure [13,14]. Various devices, computing systems, and users are interlinked via cable or wireless internet. This interconnected network enables accessible collection and data exchange [15].

The monitoring and watering regulation system using IOT has many benefits, including time efficiency, work effectiveness, remote operation, simplicity, and better irrigation accuracy [16].

In this study, Smart Farming System was used to water arrangements in the chili plantation area. Data on the sensor is used to analyze the effectiveness of water spraying against soil moisture value. A smart farming system worked independently by utilizing the Internet of Things (IoT) application to determine the effectiveness of spraying water on crops on agricultural land. The sunlight utilizes to convert into electrical energy as its energy source.

2. METHODOLOGY

2.1. Smart Farming Device

This Smart Farming Device (Figure 1) is a series of instruments placed on agricultural land. This tool works in a modular manner controlled remotely using the internet. The electrical power supply is taken from batteries charged using electrical energy converted from sunlight. So that this tool can be placed on agricultural land far from residential areas that do not have electricity supply (off-grid field).

Figure 1. *Smart Farming Device*

Figure 2. Installation of Smart Farming Devices works in off-grid area.

In this study, the Smart Farming Device was placed in the chili garden area owned by residents in the Bonakarta area, Masigit Village, Cilegon City. This area is located in a coastal area with a hot climate. The trial was conducted for 9 hours from 08.00 – 17.00 WIB (West Indonesian Time).

The electricity of Smart Farming Device supply from sunlight conversion needs to be continuously monitored and controlled. To ensure that electricity obtained is sufficient to supply the operational needs of the equipment (Figure 2). This device always connects to the internet via a cellular-based network covering that area. Data monitoring and executing commands transceiving using IoT effectively.

Figure 3. Arduino Uno unit

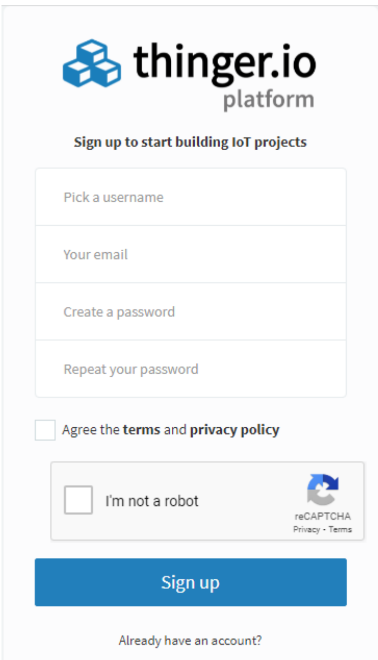

Figure 4. Platform Thinger.Io

In addition to the power source section, the Smart Farming Device also has several sections. GSM Modules, working together as a liaison between the Smart Farming Device and the internet. RTC (Real Time Clock) circuit, which is to run the time and calendar functions in real-time. Soil Moisture Sensor, which functions to identify soil moisture conditions. Voltage sensor, which determines the amount of electrical energy available. DHT11, which works to identify the humidity and air temperature conditions. LDR sensor, which functions as a solar sensor intensity. Relay Module, which functions as a switch to regulate the irrigation system and cooling system of the Smart Farming Device. Solar panels work to harvest sunlight and turn it into electrical energy stored in batteries. Solar charge controller, which functions as a regulator of the electric charging system to the battery. Water pump, which works to distribute water in the watering system. Sprayer, which works to spray water on the farmland.

Spraying water on chili plants is carried out three times a day, at 08.00, 12.00, and 17.00. spraying is carried out for more than 5 minutes. The height of the sprayer used is 65 cm. The regular soil moisture is 60-80% [17].

2.2 Internet of things (IOT) platform

This Smart Farming Device operates using a 16 bit Arduino Uno (Figure 3). This device is programmed by ArduinoIDE software. The program contains commands that must be executed to read and translate the data provided by the sensor. Then those data The device connected with IoT to send information to farmers, Or execute the farmer's orders received from IoT.

The IoT platform used in this research is Thinger.io, an open-source IoT platform. The platform has an opening display, as shown in Figure 4. The internet platform functions as a liaison software between the Smart Farming Device and farmers to present the monitoring results and control the spraying water to the crops.

2.3. Workflow Diagram

The Smart Farming Device works following the flow chart shown in Figure 5. the device Collects and processes data from farmland simultaneously by sending and presenting information on the IoT Platform.

2.4 Data logging

The data displayed from the Smart Farming Device consists of electricity voltage, soil moisture, sunlight intensity, and ambient temperature. Furthermore, each data monitoring is arranged based on the time, as shown in Figure 6.

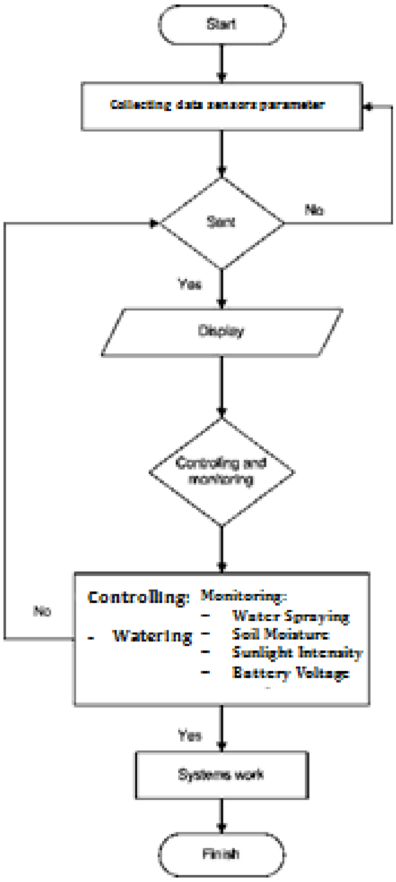

Figure 5. Working diagram.

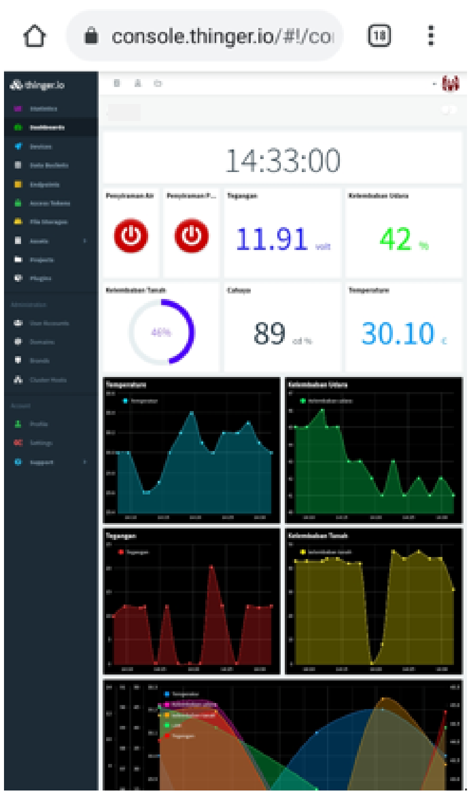

Figure 6. The screen display of Thinger.Io is connected to the smart farming device.

3. RESULTS AND DISCUSSION

Results are presented in three subsections: the electrical supplier, monitoring sensors, and controlling device. We used these data to analyze whether water spraying into the air effectively increases the value of soil moisture.

3.1 Electrical Supply System

Organizing modular devices with small electrical consumption [3]. The smart farming device monitoring systems employ sensors placed on the farmland and device box. Information from sensor nodes is transferred to the IoT using the cellular-based internet network. Thus the smart farming device can still work in the absence of sunlight. It can help alleviate supply energy from the battery.

Solar panels convert sunlight into electric energy. The voltage value shows the amount of electricity stored in the battery. The harvesting of sunlight energy is very dependent on receiving the sunlight intensity [10]. Figure 7 shows the battery voltage of the smart farming device. Simultaneously, electric energy is also used to operate these smart farming devices.

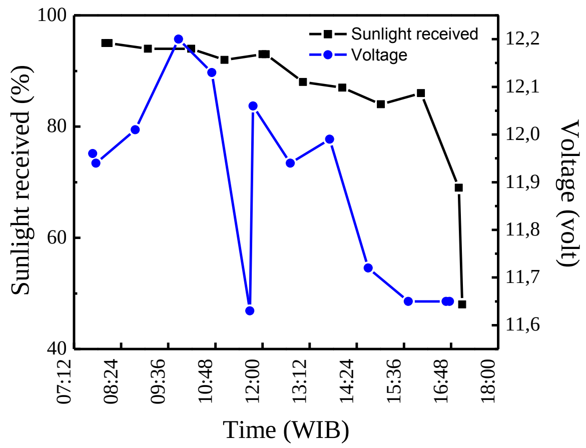

Figure 7. Sunlight received vs voltage in energy harvesting process.

Battery charging is limited to 12.5 Volts for maximum voltage and 10.5 Volts for minimum voltage. The solar charger controller shuts off the charging process when the battery voltage reaches the highest value. Furthermore, when the battery voltage reaches its lowest value, the supply load is cut off. Thus the battery life can be longer [13,18,19].

Chili plants require sun exposure between 10–12 hours per day [17]. The graph shows sunlight intensity at intervals 08.00 – 16.00 WIB (8 hours) was shining perfectly. The sun is unobstructed by clouds or other obstructions. Kondisi ideal untuk tanaman cabe. With this condition, The battery charging process also goes appropriately.

The decreasing voltage value from 12.13 Volts at 11.02 WIB to 11.63 Volts at 12.00 WIB tends to be caused by the operation of the water spraying device to water the plants. Moreover, the voltage decrease between 13.00 WIB to 16.00 WIB shows the incorrect position direction of the solar panel installing plane. It makes sunlight's absorption ineffective when the sun has passed from the culmination position.

Solar intensity data that is not in sync with the electrical voltage obtained also indicates that the placement of the light sensor is not entirely correct. For this reason, the placement of the sensor must be in the same direction as the solar panel plane.

3.2. Sensor Monitoring

Uneven tillage can cause the quality of chili products obtained to be not uniform [20]. So that the use of monitoring aids, such as sensors, needs to be done so that the land processing process becomes evenly distributed.

Figure 8 shows the environmental parameters of the farm field. It appears the soil moisture value is not affected by the value of the ambient temperature and the value of the intensity of sunlight that is read by other sensors. Water spraying carried out at 08.00 WIB did not increase soil moisture conditions. Likewise, when spraying water at 17.00 WIB, the increasing value of the soil moisture sensor parameter seems likely to be influenced by the earth's position towards the sun [21,22].

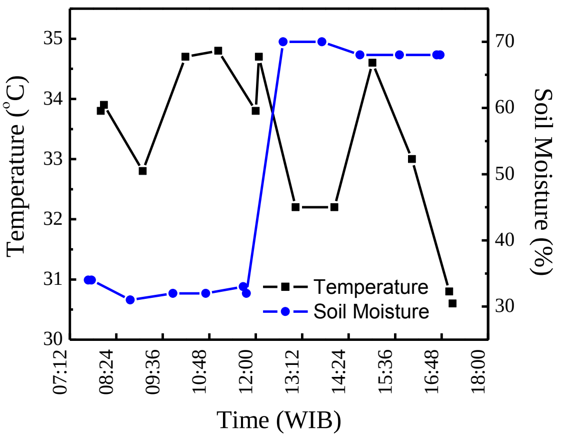

Figure 8. Environmental parameters

Allegations due to the clouds or rain can be refuted by referring to the solar intensity value at the time in Figure 7. The temperature values that fell at 09.05 WIB, 12.00 WIB, 13.00-14.00 WIB were thought to be due to the influence of the wind blow crossing the farmland. Furthermore, The value of the temperature that drops at 16.00-17.00 WIB tends to be influenced by solar positioning that will set. Therefore, a wind speed sensor needs to be added to the device to determine the effect of wind blow on the environmental parameters on farmland.

The data sensor shows that spraying water through the air for the farmland does not increase soil moisture value. Other methods, such as irrigation systems, are Needed to irrigate the farmland through the soil surface.

4. CONCLUSION

Watering is an essential component in improving the quality of agricultural products. Smart Farming Devices are beneficial for farmers in monitoring and controlling their farms. Internet of Things (IoT) connects the Devices installed on the farm with the farmers via a cellular-based internet network wherever they are. Information about soil moisture conditions, air temperature, sunlight, and the power supply adequacy for these devices can be accessed anytime and anywhere in real-time through internet access. Those data were used to analyze whether water spraying into the air effectively increases soil moisture value.

We found that the spraying water method does not raise the soil moisture from the sensors parameter. We also found that the temperature parameter is not correlated with the sunlight intensity. So we need to add a wind speed sensor to determine the effect of wind blow on the environmental parameters. We concluded that the watering method through the soil surface seems more promising to increase the soil moisture value than the water spraying system via air.

ACKNOWLEDGMENTS

This research was funded by Universitas Sultan Ageng Tirtayasa scheme *Penelitian Dosen Pemula*, contract no. B/177/UN.43.3/PT.01.03/2021.

REFERENCES

1. Kharismawati KHD, Karjati PD. Pengaruh Luas Lahan dan Jumlah Tenaga Kerja Terhadap Produksi Padi di 10 Kabupaten Jawa Timur Tahun 2014-2018. J Econ. 2021;03(1):50–66.

2. Direktorat Jenderal Perkebunan. Laporan Tahunan Direktorat Jenderal Perkebunan Tahun 2014 [Internet]. Jakarta; 2014. Available from: http://sakip.pertanian.go.id/admin/tahunan/LAPORAN_TAHUNAN_2014.pdf

3. Datta A, Prasad B, Kamepalli S, S SS, Kunisetti S. An efficient

mechanism using IoT and wireless communication for smart farming. In: Materials Today: Proceedings [Internet]. Elsevier Ltd; 2021. Available from: https://doi.org/10.1016/j.matpr.2021.07.363

4. Kusumadinata AA. PENGGUNAAN INTERNET DI KALANGAN PETANI SAYUR DALAM MEMPEROLEH INFORMASI PERTANIAN DI KABUPATEN CIANJUR. Indones J Agric Econ (IJAE). 2016;7(1):13–24.
5. Marescotti ME, Demartini E, Filippini R, Gaviglio A. Smart farming in mountain areas : Investigating livestock farmers ' technophobia and technophilia and their perception of innovation. J Rural Stud [Internet]. 2021;86:463–72. Available from: https://doi.org/10.1016/j.jrurstud.2021.07.015
6. Handika IDS, Sulistiawati A. PENGGUNAAN DAN PEMANFAATAN INTERNET UNTUK PERTANIAN DAN PERANANNYA TERHADAP TINGKAT PENDAPATAN PETANI. J Sains Komun dan Pengemb Masy. 2021;05(02):233–55.
7. Finahari N, Budi KP, Putra TD. Potensi Sprayer Otomatis sebagai Solusi Masalah Penyiraman Tanaman untuk Petani Cabe. JATI EMAS (Jurnal Apl Tek dan Pengabdi Masyarakat). 2019;3(1):19.
8. Moysiadis V, Sarigiannidis P, Vitsas V, Khelifi A. Smart Farming in Europe. Comput Sci Rev. 2021;39:100345.
9. Said E, Belal AA, Abd-elmabod SK, El-shirbeny MA, Gad A. Smart farming for improving agricultural management. Egypt J Remote Sens Sp Sci [Internet]. 2021;(xxxx). Available from: https://doi.org/10.1016/j.ejrs.2021.08.007
10. van der Burg S, Bogaardt MJ, Wolfert S. Ethics of smart farming: Current questions and directions for responsible innovation towards the future. NJAS - Wageningen J Life Sci. 2019;90-91(January):100289.
11. Islam N, Rashid MM, Pasandideh F, Ray B, Moore S, Kadel R. A review of applications and communication technologies for internet of things (Iot) and unmanned aerial vehicle (uav) based sustainable smart farming. Sustain. 2021;13(4):1–20.
12. Mahbub M. A smart farming concept based on smart emb e dde d electronics , internet of things and wireless sensor network. Internet of Things [Internet]. 2020;9:100161. Available from: https://doi.org/10.1016/j.iot.2020.100161
13. Saravanan D, Lingeshwaran T. Monitoring Of Solar Panel Based On IOT. In: International Conference on System, Computation, Automation and Networking (ICSCAN) 2019 IEEE. IEEE; 2019. p. 1–5.
14. Pivoto D, Dabdab P, Talamini E, Spanhol CP, Francisco V, Corte D, et al. Scientific development of smart farming technologies and their application in Brazil. Inf Process Agric [Internet]. 2018;5(1):21–32. Available from: https://doi.org/10.1016/j.inpa.2017.12.002
15. Wojdała M. The Internet of Things in carriage of goods by road - application , The Internet of Things in carriage of goods by road - application , opportunities , problems. Procedia Comput Sci [Internet]. 2021;192:3235–42. Available from: https://doi.org/10.1016/j.procs.2021.09.096
16. Chatzopoulos A, Papoutsidakis M, Sofianos G, Piromalis D. An Automated Plant Pot Controlled via the Internet based on Arduino Applications. Int J Comput Appl. 2019;178(25):26–30.
17. Ali M. Budidaya Tanaman Cabai Rawit. 2017;(17542110009).
18. Karthik S, Mahalakshmi M, Mahitha R, Meena S. IoT Based Solar Panel Fault Monitoring and Control. Int J Inf Comput Sci. 2019;6(3):238–43.
19. Padma S, Ilavarasi PU. Monitoring of Solar Energy using IOT. Indian J Emerg Electron Comput Commun. 2017;4(1):596–601.
20. Ajak A, Taolin RICO. Pengaruh Olah Tanah dan Jenis Pupuk Kandang terhadap Pertumbuhan dan Hasil Cabe Rawit Varietas Bara (Capsicum frutescens L.). Savana Cendana. 2016;1(03):98–101.
21. Yang J, Li Z, Zhai P, Zhao Y, Gao X. The influence of soil moisture and solar altitude on surface spectral albedo in arid area The in fl uence of soil moisture and solar altitude on surface spectral albedo in arid area. Environtal Res Lett. 2020;15:035010.
22. Karyati, Putri RO, Syafrudin M. SUHU DAN KELEMBABAN TANAH PADA LAHAN REVEGETASI PASCA TAMBANG DI PT ADIMITRA BARATAMA NUSANTARA , PROVINSI KALIMANTAN TIMUR. J AGRIFOR. 2018;XVII(2011):103–14.