IPC

Indonesian Physics Communication

Department of Physics, Universitas Riau, Pekanbaru, Indonesia
p-ISSN 1412-2960 | e-ISSN 2579-521X

Vol. 21 | No. 2
July 2024

Web: https://kfi.ejournal.unri.ac.id
E-mail: kfi@ejournal.unri.ac.id

Application of solar panels in IoT-based bird pest control tools

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ABSTRACT

The use of solar panels in bird pest control equipment in the rice field zone is based on the internet of things (IoT), which aims to create bird pest control equipment for farmers. This control system is equipped with a PIR sensor whose role is to determine the presence of birds in the rice field zone. The distance range when a bird is found is 5 meters, and an ultrasonic speaker will be active when there is bird movement in the rice field. This speaker uses an ultrasonic wave frequency of 20 kHz. RTC testing is used as a timer to reset the number of invasions in 1 × 24-hour intervals at 00.00 WIB. Next, there is a test of sending (transmitter) and receiving (receiver) LoRa material information near ± 450 meters, information to be sent and placed on the dashboard things board.

Keywords: ESP32; internet of things; RTC DS3231; sensor PIR

Received 25-08-2023 | Revised 20-01-2023 | Accepted 07-06-2024 | Published 23-07-2024

INTRODUCTION

Indonesia is an agricultural country, one of Indonesia's crops is rice which is the staple food of Indonesian citizens. Rice or in Latin Oryza sativa is one of the most cultivated plants in today's civilization. In Indonesia itself, rice is the staple food every day for Indonesian citizens, therefore Indonesia is a country that is synonymous with rice as the main food of its population. In the process of planting rice, there are challenges that farmers will experience, one of which is bird pests. The increasing problem of bird pest attacks can cause serious damage to rice so farmers' rice harvests decrease. Bird pest attacks generally range from when the rice is 25 to 30 days old (the period when rice flowers develop). Various obstacles to rice cultivation give rise to shaky food security [1-3].

Bird pests are one of the main enemies of farmers who can harm plant production. The bird population continues to increase causing crop yields to decrease. On average, bird pests eat 5 – 10 g of rice. Attacks by groups of birds have disturbed farmers planting rice. Bird pest attacks include consuming rice grains during the ripening period of milk or rice with a planting period of 70 days. Due to bird invasions, rice production fell by 30% – 50%. Over the last 10 years, the development of Indonesian rice production has increased, and in 2045 the Ministry of Agriculture of the Republic of Indonesia designated Indonesia as the world's food basket, to ensure the stability of rice production in the years to come, making it necessary to estimate early the problems encountered in rice production. One of them is the difficulty of controlling rice-eating bird pests [4-6].

Solar panels are equipment that can convert solar energy into electrical energy or as it is often called photovoltaic. In PLTS, solar panels are the most important component and use WP units. Solar panels are not only environmentally friendly, but they also have advantages, one of which is saving on electricity bills [7-9]. With today's technological developments and problems, the author got the inspiration to create another alternative, namely producing equipment to control pests. One of them is by using solar panels as a voltage source for bird pest control equipment in the rice field zone based on the internet of things (IoT) using an ESP32 microcontroller based on the IoT. PIR sensors to detect pest movements and ESP32 are used for monitoring. So it can help farmers

to be more efficient in monitoring using IoT in rice fields. IoT is a concept to expand the benefits of continuously connected internet connectivity to monitor pests on rice plants.

LITERATURE REVIEW

Pests are the causes of destruction in plants which can be seen using the five senses, namely the eyes. In the rice field area, there are many pests, one of which is a group of small birds that eat seeds or are often called sparrows. Farmers generally make equipment to control bird pests by using strands of rope provided with objects that make a sound when the rope is pulled. This causes the birds to be startled and fly away from the rice so they can't eat. The sparrow or bond (Latin: genus Lonchura) is a small bird and also a seed eater, this species is widespread in tropical areas including Indonesia. This bird generally inhabits areas of grass, rice fields, grasslands, bushes, and forest edges [10-12].

Solar panels are a device system that converts light and sunlight energy into electrical energy through a photovoltaic impact process also called photovoltaic cells (PV for short). The electrical voltage produced from a solar cell system is very small, around 0.6V without load or 0.45V with load. To obtain a large enough electrical voltage as desired, several solar cells can be arranged in a series circuit. Solar cells are made from semiconductor materials, namely silicon, which functions as an insulator at low temperatures and as a conductor when there is power and heat. In simple terms, the working principle of the solar panel system is that when sunlight hits the solar panel, the valence electrons in the solar cell material will experience movement from N to P, so that at the output stop pole of the solar panel it will create an electric current. The amount of electrical energy depends on the number of solar cells combined in the solar panel and the number of serious rays of solar radiation that hit the solar panel [13-15].

IoT is access to electronic features via the internet. Access to this feature occurs due to human contact with the feature or by using a network to share information, share access, and also think about the security involved in access. This IoT was first reported by Kevin Aston in 1999. The Internet of Things is used in a collection of features that are connected to other features on the internet network. This feature consists of Things whose job is to record information in an area or object. The results of the recording are in the form of information, after which they are forwarded or sent to an application located on the internet. The information obtained is then processed further to show the data stored behind a set of information. IoT can be developed using universal electronic devices such as Arduino for more specific needs and IoT can also be developed as an integrated application with the Android operating system [16-19].

RESEARCH METHODS

The research method used is a qualitative method starting from initialization and initial values which regulate input-output parameters and so on while also setting initial values. Followed by reading the input, in this case, the PIR sensor which reads or detects the movement of objects, namely birds in the rice field area. In this system, the sensor reads in several directions such as north, east, south, and west. If the PIR sensor hits an object, the speaker will automatically sound and the program will calculate and compare the number of attacks according to each direction or concerning certain limits. This research was designed based on the block diagram shown in the following image.

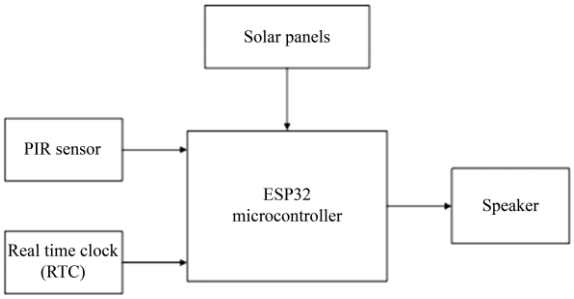

Figure 1. Block diagram.

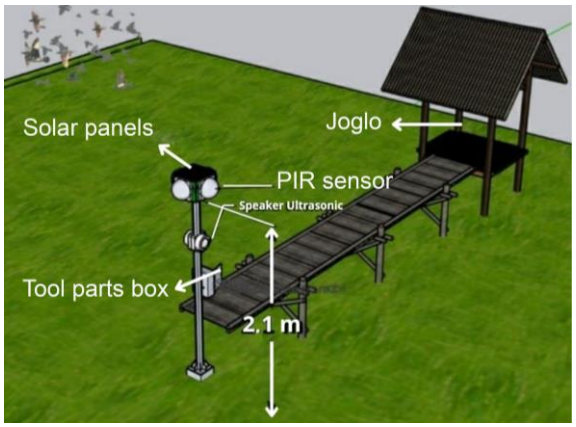

Figure 2. Tool design.

In this design, a telemetry data set is created to reset data on the status of the north, east, south, and west PIR sensors. The counter reset every 24 hours will be zeroed via the website or server using the LoRa module which functions as a radio frequency. Next, the telemetry data set will send data to the gateway and the gateway will receive data from the node which then parses the data. After the telemetry data is converted to another format, the telemetry data will be sent to the thingsboard to be stored and the client PC will access or display the latest data. An illustration of the tool design can be seen in Figure 2.

The overall prototype design of the bird pest control tool consists of a 20wp solar panel, 4 PIR sensors, a speaker, and a box of tool components placed in the rice field area. Next is the prototype design of a bird pest control tool in the sensor section and the sensors used are 4 PIR sensors.

RESULTS AND DISCUSSION

Power Supply Testing (Solar Panels)

Testing solar panels is to ensure that the voltage produced is by the requirements of the equipment system that will be used. The output voltage required by the components in the device is around 5 V. We can see the results of testing the solar panel power supply voltage for each component in Table 1.

Table 1. Power supply testing.

Solar panel voltage (Battery Scc) (V)	Solar panel voltage (Battery multimeter) (V)	Battery output voltage (Stepdown) (V)	Deviation Vin (%)
13.60	13. 38	5.01	1.61
13.90	13. 85	5.01	0.35
13.10	13.00	5.01	0.76
14.00	13.91	5.01	0.64
14.20	14.00	5.01	1.40

PIR Sensor Testing

PIR sensor testing aims to find out whether an object emits infrared rays or not. This PIR sensor is used to identify bird movements in rice fields. An application that uses infrared rays connected to an ESP32 microcontroller to see bird movements can be seen in the following program. PIR sensor test results data can be seen in Table 2.

Table 2. PIR sensor testing table.

Test	Object distance (m)	Condition	Digital value
1	1	Detected	1
2	2	Detected	1
3	3	Detected	1
4	4	Detected	1
5	5	Not detected	0
6	6	Not detected	0
7	7	Not detected	0

DS3231 RTC Testing

The RTC DS3231 test aims to reset the number of bird attacks in rice fields where the attack data will be reset once every 24 hours automatically, namely at 00.00 WIB. Then the data is stored on the thingsboard dashboard. The RTC DS3231 test results data are shown in Table 3.

Table 3. DS3231 RTC test result.

DS3231 RTC	Actual Schedule	D (%)
Sunday, August 13 2023 09:59:55 WIB	Sunday, August 13 2023 10:00:00 WIB	8.33
Sunday, August 13 2023 12:59:55 WIB	Sunday, August 13 2023 13:00:00 WIB	8.33
Sunday, August 13 2023 15:59:55 WIB	Sunday, August 13 2023 16:00:00 WIB	8.33
Monday, August 14 2023 11:59:55 WIB	Monday, August 14 2023 12:00:00 WIB	8.33
Monday, August 14 2023 16:59:55 WIB	Monday, August 14 2023 17:00:00 WIB	8.33

SX1278 LoRa Module (Long Range) and Thingsboard

This research was carried out using LoRa which is supported by many factors, one of which is the advantages of LoRa which are difficult to find on other devices. The main advantage of LoRa is that LoRa is a low-cost device because the LoRa device includes the sensors needed during research, apart from requiring a low cost, LoRa is classified as a device with low power consumption because LoRa only requires around 13 mA-15 mA so a device can be used for a long period.

Apart from that, LoRa devices support research over long distances where LoRa devices can transmit data. In this research, the first 2 types of LoRa are used as transmitters, where the LoRa SX1278 module, PIR sensor, and speaker relay are connected to the ESP32. Meanwhile, the second functions as a receiver, where the RTC and LCD modules are connected to the ESP32 and then forwarded to the thingsboard dashboard. The IoT bird pest control design works by using solar panels as a voltage source, ESP32, PIR sensor, 16x2 LCD, RTC DS3231, ultrasonic speaker relay, and LoRa module.

PIR sensor which aims to identify bird movements in rice fields. The ultrasonic speaker relay aims to turn on or turn off the ultrasonic speaker if bird movements are detected or not detected by birds around the rice fields. This ultrasonic speaker uses ultrasonic wave frequencies. RTC is used to reset the number of bird attacks in the rice fields and the attack data will be reset every 1 × 24 hours at 00.00 WIB. The LoRa module has a working procedure when a tool in the rice field (transmitter) detects bird movements, the ultrasonic speaker will activate, then the detection data will be sent to a tool at home (receiver) which will then forward the data to the thingsboard dashboard so that the rice field owner can monitoring the number of attacks and movement/detection of birds in the rice fields. The maximum distance that the tool can send and receive is ± 450 m. Overall, IoT-based bird pest control tools in rice fields function well.

CONCLUSION

In this research, it can be concluded that the use of solar panels as a voltage source for controlling bird pests in rice fields is based on IoT which uses ESP32, PIR sensors, RTC,

ultrasonic speakers and LoRa modules. The way the system uses solar panels as a voltage source for controlling bird pests in rice fields based on the IoT is based on microcontroller commands through sensor detection and schedules. The PIR sensor aims to detect birds in rice fields with a range of ≤ 5m. Then the ultrasonic speaker will be active if there is bird movement in the rice field area. This speaker uses ultrasonic wave frequencies.

REFERENCES

1. Angriawan, B., Jatmiko, S. T. M. T. & Umar, S. T. (2015). *Pembasmi hama menggunakan gelombang ultrasonic dengan memanfaatkan panel surya (Solar cell)*. Doctoral dissertation, Universitas Muhammadiyah Surakarta.
2. Aroeboesman, F. N., Ichsan, M. H. H. & Primananda, R. (2019). Analisis kinerja LoRa SX1278 menggunakan topologi star berdasarkan jarak dan besar data pada WSN. *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer*, **3**(4), 3860–3865.
3. Moh Noor Al Azam, S. K. M. M. T. (2022). *Cara Cepat Belajar IoT: ESP32: Pengenalan Dan Instalasi Arduino IDE*. Radnet Digital Indonesia.
4. Hardiansyah, M. Y. (2020). Pengusir hama burung pemakan padi otomatis dalam menunjang stabilitas pangan nasional. *Jurnal ABDI (Sosial, Budaya dan Sains)*, **2**(1).
5. Hidayat, K., Hasani, M. C., Mardiyah, N. A. & Effendy, M. (2021). Strategi pengisian baterai pada sistem panel surya standalone berbasis kontrol PI multi-loop. *Jurnal Teknik Elektro*, **13**(1), 25–33.
6. Jakaria, D. A. & Fauzi, M. R. (2020). *Aplikasi smartphone dengan perintah suara untuk mengendalikan saklar listrik menggunakan Arduino*. *Jurnal Teknik Informatika (JUTEKIN)*, **8**(1).
7. Meliala, S., Putri, R., Saifuddin, S. & Sadli, M. (2020). Perancangan penggunan panel surya kapasitas 200 WP on grid system pada rumah tangga di pedesaan. *JET (Journal of Electrical Technology)*, **5**(3), 100–111.
8. Mehta, M. (2015). ESP8266: A Breakthrough in wireless sensor networks and internet of things. *International Journal of Electronics and Communication Engineering & Technology*, **6**(8), 7–11.
9. Modjo, A. S. (2012). *Rancang bangun alat pengendali hama burung pemakan bulir padi sawah (Oryza Sativa L.) sistem mekanik elektrik*. Teknologi Hasil Pertanian Universitas Negeri Gorontalo.
10. Muliadi, M., Imran, A., & Rasul, M. (2020). Pengembangan tempat sampah pintar menggunakan ESP32. *Jurnal Media Elektrik*, **17**(2), 73–79.
11. Nugroho, A. A. (2018). *Prototipe Sistem Pengusir Hama Burung Berbasis Computer Vision*. Universitas Sanata Dharma Yogyakarta.
12. Robby, A. N. & Firmansyah, A. (2022, December). Prototype Lampu otomatis Pencegah Hama Berbasis Panel Surya. *Prosiding Seminar Nasional Hi-Tech (Humanity, Health, Technology)*, **1**(1).
13. Roslinawati, E., Prihatini, W. & Haryoko, T. (2019). Variasi ciri morfometrik burung Bondol di Indonesia. *Zoo Indonesia*, **26**(2).
14. Nurtado, A. (2020). Simulasi bel sekolah otomatis berbasis Arduino Uno. *Jurnal Manajemen dan Teknik Informatika (JUMANTAKA)*, **3**(1).
15. Sumadikarta, I., No, J. A. P. I. & Lama, K. (2020). Perancangan smarthome berbasis Arduino Nodemcu Esp8266 (Studi kasus: Griya Setu Permai). *Jurnal Ilmiah Fakultas Teknik LIMIT'S*, **16**(1).
16. Suhaeb, S. (2017). *Mikrokontroler dan interface*. Makassar: UNM.
17. Sulaiman, A. A. (2018). *Sukses swasembada Indonesia menuju lumbung*

pangan dunia 2045. Jakarta: IAARD Press.
18. Toyib, R., Bustami, I., Abdullah, D. & Onsardi, O. (2019). Penggunaan sensor passive infrared receiver (PIR) untuk mendeteksi gerak berbasis short message service gateway. *Pseudocode*, **6**(2), 114–124.
19. Wilianto, W. & Kurniawan, A. (2018). Sejarah, cara kerja dan manfaat internet of things. *Matrix: Jurnal Manajemen Teknologi Dan Informatika*, **8**(2), 36–41.