

Design and Implementation of an Arduino-Based PIR Sensor System for Automated Bird Pest Control in Agricultural Areas

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ABSTRACT

Indonesia depends greatly on agriculture, especially rice farming, as one of the main sectors supporting the economy and community livelihoods. However, farmers often face serious problems during the planting season due to pest attacks, particularly sparrows that eat ripening rice grains before harvest. This condition can reduce crop productivity and cause major financial losses for farmers. Traditionally, farmers use simple bird-repelling methods by hanging used cans around the rice fields and connecting them with ropes. The ropes are pulled manually to create noise that scares birds away. Although widely used, this method is inefficient because it requires constant human involvement and does not always prevent birds from returning to the fields. As a result, significant crop losses may still occur, reaching around 642 kilograms during a seven-month planting period. To overcome this issue, this study proposes an automated bird repellent system based on an Arduino microcontroller and a Passive Infrared (PIR) sensor. The PIR sensor detects bird movement through infrared radiation. When movement is identified, the system automatically activates a buzzer that produces sound to drive birds away from the rice fields. This automated system helps farmers protect crops more effectively, reduce harvest losses, and improve agricultural productivity before harvest time.

Keyword : Bird Pests, Mikrokontroler Arduino, Sensor PIR, Buzzer, LCD I2C



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1. INTRODUCTION

Indonesia is known as an agricultural country because it has vast areas of fertile land that are suitable for rice farming. Many people in Indonesia rely on agriculture as their main source of income and livelihood. For this reason, the agricultural sector has an important role in supporting economic growth and national development. Agriculture is also considered one of the main foundations of the Indonesian economy. However, rice production in Indonesia still faces many challenges and has not been able to completely fulfill the increasing food demand of the growing population. One of the factors that reduces rice productivity is the attack of bird pests that feed on rice grains in the fields [1].

Improving efficiency in agricultural activities is very important because it can help farmers reduce production costs. Lower operational costs can increase farmers' income and improve the welfare of people living in rural areas. Besides supporting food availability, agriculture also contributes greatly to the national economy. In Indonesia, the development of the economy is strongly connected to the agricultural sector because this sector provides employment opportunities and contributes significantly to national income for a large part of the population [2].

Rice is the main staple food consumed by most Indonesians because it contains carbohydrates needed by the human body. Rice farming is therefore one of the most common agricultural activities in the country. Even though Indonesia has extensive agricultural land and rice is a major commodity, farmers still face many problems that affect both the quantity and quality of rice harvests. Agriculture is also a strategic sector because it influences economic growth and national stability. If agricultural production decreases, it can create problems not only in the economy but also in social and political conditions. Generally, rice plants need around 110 days from planting until harvest, making it possible for farmers to grow rice two or even three times a year [3].

One of the biggest problems experienced by rice farmers is bird attacks during the ripening stage of the rice plants. Birds eat the rice grains and reduce the amount of harvest that farmers can obtain. Sparrows, for instance, can consume around five grams of rice each day. When birds come in large groups, the damage to rice fields can become very serious. To overcome this problem, farmers usually use simple tools to scare birds away. However, most of these tools still work manually, meaning farmers need to spend extra time and energy operating them continuously [4].

Farmers also use traditional methods to protect their rice fields from bird pests. Some of them place scarecrows in the fields or install ropes across the rice paddies. These ropes are often connected to bells or empty cans that produce sounds when moved, with the aim of frightening birds away. Unfortunately, these methods are not very effective because they still require farmers to monitor and operate them manually. As a result, many farmers must stay in the fields to guard the crops directly. Usually, when the rice grains start turning yellow, farmers become more alert because birds often attack during the morning between 6:00 AM and 10:00 AM and again in the afternoon from 2:00 PM to 6:00 PM [5].

Based on these problems, an automated bird-repellent system is proposed to help farmers protect their rice fields more effectively. The system is designed using a microcontroller combined with a Passive Infrared (PIR) sensor to detect the movement of birds in the field. When motion is detected, the device can automatically activate a mechanism to scare birds away. With this automatic system, farmers no longer need to constantly monitor their fields manually, and the efficiency of protecting rice crops can be improved.

2. RESEARCH METHOD/MATERIAL AND METHOD/LETERATURE REVIEW (10 PT)

At this stage of the research, the authors conduct the study through several structured and sequential steps. The process starts with collecting relevant data and reviewing related literature to build a strong theoretical basis for the research. After that, the study continues with the system design process, followed by the development of hardware and the implementation of software. Once all system components have been completed, various tests are carried out to examine the performance and functionality of the system. In the final stage, the researchers prepare and compile the research report as official documentation of the entire research process [6].

A. Analysis of System Requirements

At this analysis stage, the researchers identify the hardware and software requirements needed to develop the proposed system. The hardware used in this research consists of several main components, including an Arduino Uno microcontroller, a PIR sensor, a buzzer, a servo motor, a relay module, jumper cables, a breadboard, and a battery that functions as the system's power source. In addition, the software used in this study is the Arduino Integrated Development Environment (Arduino IDE), which is utilized to create, compile, and upload the program code into the Arduino Uno microcontroller [7].

B. Research Method

The research methodology is a series of organized and systematic steps carried out by researchers to collect accurate data and determine suitable solutions to problems related to the object being studied. Through a structured research process, researchers are able to gain a deeper understanding of a phenomenon, identify existing issues, and develop solutions based on factual findings obtained during the study. In scientific research, methodology plays an important role because it serves as a guideline that directs every stage of the research process so that the results can be accounted for objectively and academically.

This study focuses on the application of technology in the agricultural sector, particularly in reducing bird pest disturbances in rice fields through the use of an Arduino Uno microcontroller integrated with a Passive Infrared (PIR) sensor. The development of this system aims to assist farmers in protecting rice crops more effectively and efficiently compared to conventional methods that are still widely used. In many rural farming areas, bird pests are one of the main factors causing crop losses because they attack rice plants during the grain-filling period. Therefore, the use of modern technology is expected to provide a practical and innovative solution to support agricultural productivity [8]. The proposed system combines both hardware and software components to create an automatic bird pest control device. The hardware consists of electronic components such as the Arduino Uno, PIR sensor, buzzer, servo motor, and supporting circuits that work together as an integrated system. Meanwhile, the

software component is responsible for controlling the operation of the device, processing sensor input data, and activating the output system when bird movement is detected. The integration between hardware and software is essential to ensure that the device can function properly and respond automatically in real-time conditions within the rice field environment.

In this research, a quantitative analytical method was employed. This approach was selected because it allows researchers to measure and analyze system performance based on numerical data obtained from testing and observation activities. The quantitative method also helps in evaluating the effectiveness of the developed system objectively, particularly in terms of sensor accuracy, response time, and the ability of the device to reduce bird pest disturbances in rice fields. By using measurable data, the research findings become more reliable and easier to interpret scientifically.

Several stages were carried out during the development of the system. The first stage involved conducting a literature review to gather theoretical references and previous studies related to Arduino-based agricultural technology, pest control systems, and sensor applications. This step was important to strengthen the theoretical foundation of the study and to identify research gaps that could be addressed through the proposed system. Information obtained from books, journals, articles, and previous research was used as supporting material in designing the system. The next stage involved requirements analysis, where researchers identified the hardware and software needed to develop the proposed device. This process included determining suitable electronic components, analyzing system functionality, and considering environmental conditions in rice fields that could affect device performance. Through this stage, researchers were able to prepare the necessary tools and materials to support the implementation process effectively. Field observation was also conducted to obtain direct information regarding the conditions of the rice fields and the behavior of bird pests in the study area. This activity allowed researchers to understand the actual problems faced by farmers and to determine the most appropriate placement and operation of the device. Observations in the field provided valuable insights into environmental factors such as weather conditions, field size, and pest activity patterns that could influence the effectiveness of the developed system.

After the observation process, the system design stage was carried out. During this stage, researchers designed the overall structure of the device, including the electronic circuit, sensor placement, and system workflow. The software program for the Arduino Uno was also developed at this stage using the Arduino IDE. The program was designed to process signals from the PIR sensor and activate output components automatically whenever motion was detected within the monitored area. The implementation stage involved assembling the hardware components and integrating them with the software program. Each component was tested individually before the complete system was assembled to ensure that all parts functioned correctly. After integration, the device was installed in the rice field area to evaluate its actual performance under real environmental conditions. The final stage of the research focused on system testing and evaluation. The developed device was tested several times to determine its effectiveness in detecting bird movement and producing responses that could scare pests away from the rice fields. Researchers also analyzed the stability, reliability, and responsiveness of the system during operation. The results obtained from these tests were then used to evaluate the strengths and limitations of the proposed device and to identify possible improvements for future development.

This research was conducted over approximately three months, beginning in March 2025 and ending in May 2025. The duration of the study included preparation, system development, implementation, testing, and evaluation activities. Conducting the research over several months provided researchers with sufficient time to observe system performance under varying environmental conditions and agricultural activities. The study took place in the rice field area of Pasirmalati Village, Dawuan District, Majalengka Regency, West Java Province. This location was selected because agriculture is the primary livelihood of the local community, and rice farming plays an essential role in supporting the economy of the area. Most residents depend heavily on farming activities as their main source of income, making agricultural productivity highly important for community welfare. Bird pest attacks are considered one of the common challenges faced by farmers in this region. Traditional methods used to scare birds away, such as manual monitoring or simple scarecrow installations, are often less effective and require continuous human supervision. Therefore, the implementation of an automated system based on microcontroller technology is expected to provide a more efficient and practical alternative solution for local farmers. Overall, this research not only contributes to the development of technology-based agricultural systems but also demonstrates how modern electronic

devices can be utilized to support farming activities in rural areas. By integrating sensor technology and automation into agricultural practices, the proposed system is expected to improve crop protection, reduce potential losses caused by pests, and assist farmers in managing their fields more efficiently in the future.

In this region, farmers still commonly use traditional methods to prevent bird pests from damaging rice crops. These conventional techniques are typically applied during the critical growth stages of rice plants, particularly when the grains begin to develop and turn yellow, indicating that the crops are approaching the harvesting period.

Furthermore, the study presents the results of quantitative data analysis collected over a seven-month period covering two harvesting seasons, from June to December 2025. The data indicate that farmers experience an average daily loss of approximately three kilograms of rice grains consumed by birds. This daily loss is then calculated based on the total number of days in each month to estimate the overall agricultural losses experienced by farmers during the observation period.

Table 1. Farmers' Losses Over a Seven-Month Period

Month (2025)	Number of Days	Loss per Day (3 kg)	Total Loss (kg)
June	30	30×3kg	90 kg
July	31	31×3kg	93 kg
August	31	31×3kg	93 kg
September	30	30×3kg	90 kg
October	31	31×3kg	93 kg
November	30	30×3kg	90 kg
December	31	31×3kg	93 kg
Total			642 kg

Based on the data presented in the table above, the losses experienced by farmers during two harvesting seasons can be clearly identified. The total loss incurred prior to the harvesting period over the seven-month observation timeframe reached approximately 642 kg of rice. When converted into monetary value, this loss is estimated to be around IDR 3,852,000. Considering the magnitude of these losses, this study proposes the development of an automated bird pest deterrent system utilizing a PIR sensor integrated with an Arduino-based microcontroller. The primary objective of this system is to minimize crop damage caused by bird pests and ultimately reduce the financial losses experienced by farmers.

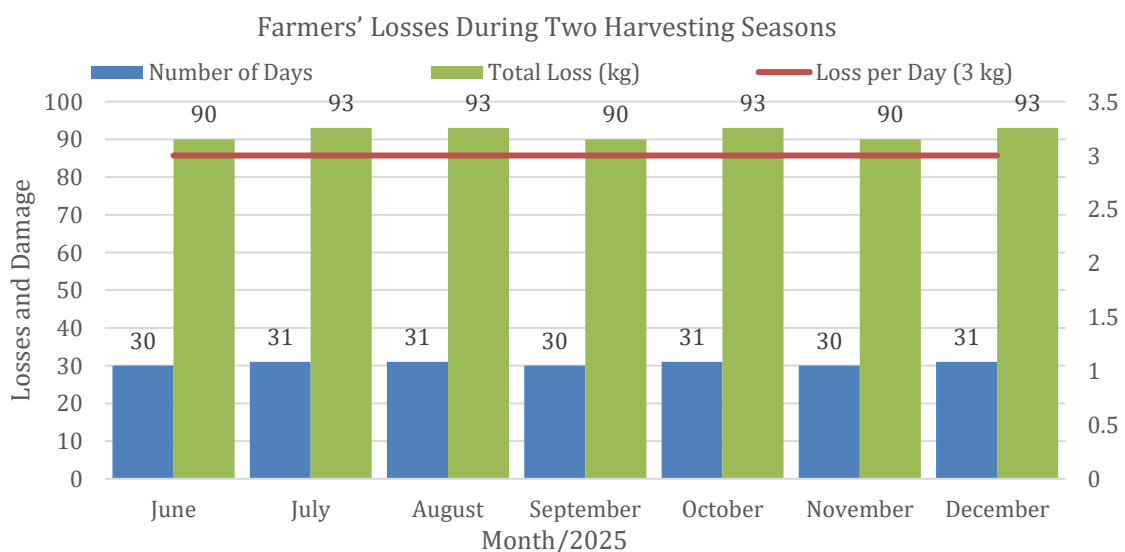


Fig 1. Graph of Farmers' Agricultural Losses

The graph above indicates that the level of crop damage and economic losses experienced by farmers due to bird pest attacks prior to the harvesting period remains relatively high. This condition leads to a decrease in rice production obtained by farmers. Consequently, the decline in agricultural output may affect the availability of staple food commodities and indirectly influence the purchasing power of the community in meeting their basic needs.

C. System Architecture Design

The system architecture is designed to describe how the device operates and to provide a clearer overview of the arrangement of each component used in the system. In this proposed design, a Passive Infrared (PIR) sensor is employed to identify movement caused by birds around the monitored area. When the sensor detects motion, it sends a signal to the Arduino, which acts as the primary controller. The Arduino then processes the received input and triggers the appropriate response mechanism based on the detected activity.

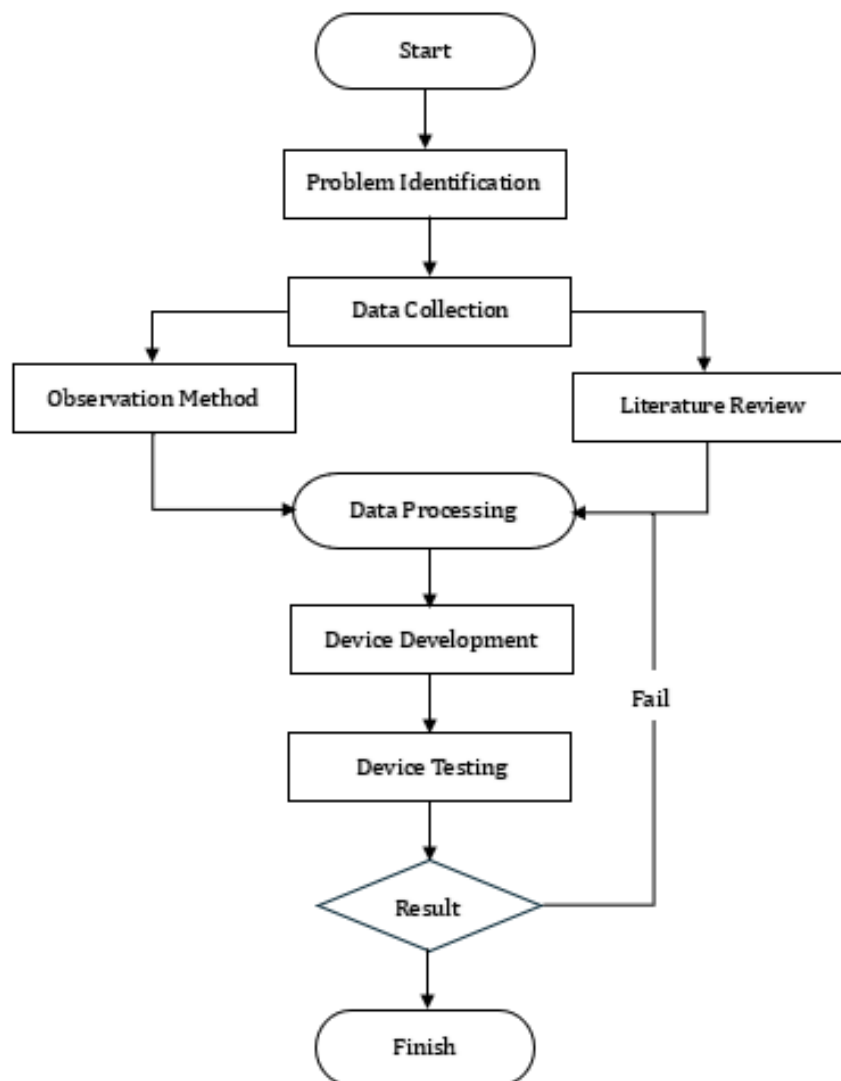


Fig 2. Research Flowchart

The research flowchart created by the authors is presented in the figure above. Each stage of the research process is explained in detail as follows:

1. Problem Identification: The research begins with identifying the primary issue faced in the field. In this study, the main problem concerns bird pests that often damage rice crops and cause considerable losses to farmers.

2. **Data Collection:** After the problem is identified, relevant data are gathered through observation and documentation. The collected information is then arranged and reviewed carefully to support the process of finding suitable solutions.
3. **Literature Review:** The researchers also conduct a literature study by reviewing scientific journals, books, and other related references. These sources are used to strengthen the theoretical basis and support the development of the research.
4. **Observation Method:** Direct observation is carried out to examine the existing conditions in the field. Through this method, the researchers are able to identify the strengths and weaknesses of the current tools or methods used to repel bird pests.
5. **Data Processing:** At this stage, all data obtained from the identification and collection processes are analyzed. The purpose of this process is to determine the most appropriate method for solving the problem related to bird pests.
6. **Device Development:** In this phase, the researchers design and build a device aimed at reducing the impact of bird pests in rice fields. The development process includes selecting the required components and integrating them into a working system.
7. **Device Testing:** After the device is completed, testing is conducted directly in agricultural areas. The researchers observe how the system performs, analyze the results obtained during testing, and evaluate the effectiveness of the device in repelling birds.
8. **Results:** Based on the testing and evaluation process, the researchers present the developed device as an alternative solution to help farmers protect their rice crops from bird disturbances.

In the proposed system design, several electronic components are connected and work together as one integrated system. When the PIR sensor detects movement caused by birds, the sensor sends a signal to the Arduino microcontroller to indicate the presence of pest activity. The Arduino then processes the incoming signal and activates the buzzer. The buzzer produces ultrasonic sound waves that are intended to frighten the birds and keep them away from the rice field. At the same time, the servo motor moves mechanically to create additional disturbance, helping to prevent the birds from approaching and damaging the crops.

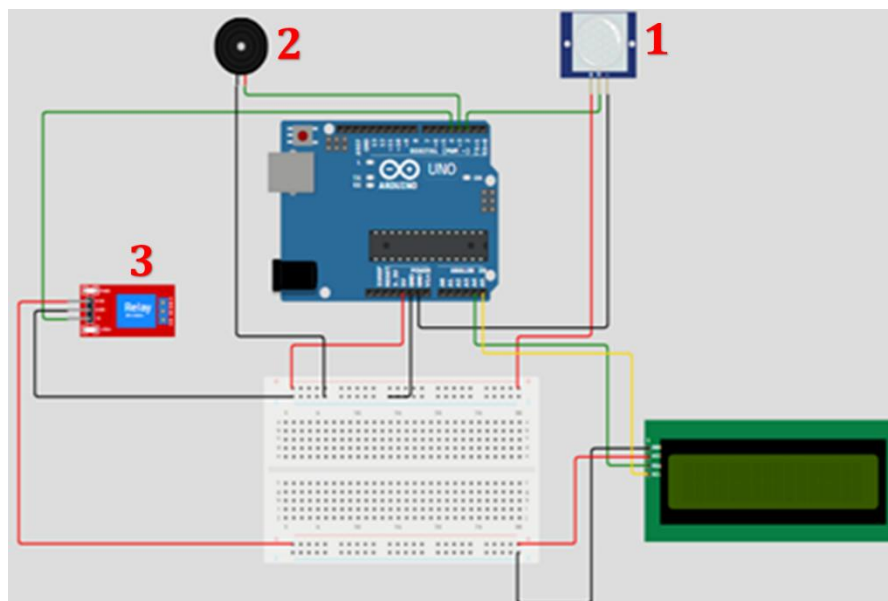


Fig 3. Design of a Bird Pest Repellent Device

1. **PIR Sensor Design:** At this stage, the PIR sensor is arranged to work together with the Arduino Uno microcontroller. The VCC pin on the PIR sensor is connected to the VCC pin of the Arduino as the power source, while the GND pin is connected to the Arduino GND pin to complete the circuit connection. In addition, the output pin of the PIR sensor is linked to the Arduino digital pin D2 so the microcontroller can receive signals whenever motion is detected by the sensor.
2. **Buzzer Design:** The buzzer serves as one of the main components in the bird repellent system. Its role is to produce sound whenever birds are detected near the monitored area. When the PIR sensor

senses movement, the Arduino automatically activates the buzzer so that sound is generated to scare the birds away from the rice field. In this setup, the VCC pin of the buzzer is connected to Arduino digital pin D3, while the GND pin is attached to the Arduino ground pin. A buzzer is an electronic device that changes electrical energy into sound energy. Its operating principle is similar to a loudspeaker because it uses a coil and diaphragm. When electric current passes through the coil, an electromagnetic force is produced, causing the diaphragm to vibrate and create sound waves.

3. **Servo Motor and Relay Design:** The servo motor acts as an output component in the proposed bird pest repellent system. In this design, the servo motor is used to pull and move a rope connected to several small bells placed around the rice field. As the servo motor rotates, the bells ring and create additional sound to help drive birds away from the crops. The servo motor is connected to the Arduino Uno through digital pin D9, which functions as the control signal pin. Meanwhile, the VCC pin of the servo motor is connected to the Arduino VCC pin for power supply, and the GND pin is connected to the Arduino GND pin to complete the circuit. Besides the servo motor, a relay module is also included in the system to operate as an automatic switching component within the overall device. The relay is connected to the Arduino Uno through several pins, where the IN pin of the relay is linked to the Arduino digital pin (D8), the GND pin is connected to the Arduino GND, and the VCC pin of the relay is connected to the VCC pin of the Arduino to provide the necessary power supply.

3. RESULTS AND DISCUSSION

After completing the design phase, the next step involves implementing the device in accordance with the previously established plan. At this stage, the process includes the construction, procurement of components, and assembly of the system based on the specifications that have been defined during the design stage.

A. System Implementation Process

The implementation of the bird pest repellent device describes the operational method of the system that has been developed and applied in the field. The components used in this bird deterrent system are arranged in such a way that they form an integrated system consisting of several essential components. In this configuration, the Arduino microcontroller acts as the central controller that manages and coordinates the operation of all components within the system. The Arduino is responsible for receiving input signals from the sensors, processing the data, and controlling the output devices so the entire system can work properly and efficiently [9].

Arduino is a microcontroller board based on the ATmega328 chip. This board is equipped with 14 digital pins that can be used for both input and output functions. In addition, the Arduino can be connected to a computer through a USB serial connection, allowing communication between the computer and the microcontroller. Through this interface, the Arduino is able to receive program instructions from the computer and also send data back for monitoring or processing purposes [10].

The PIR (Passive Infrared) sensor is used in this system to detect changes in infrared radiation in the surrounding environment. Infrared radiation is naturally emitted by objects that have temperatures above absolute zero, meaning almost all objects around us can produce infrared energy. Based on this principle, the PIR sensor is capable of detecting movement by sensing changes in temperature caused by moving objects. The sensor is equipped with a special lens that focuses infrared radiation from the monitored area onto the sensor detector. When movement or temperature changes occur, the sensor recognizes the difference and sends a signal to the Arduino microcontroller for further processing.

In this system, a buzzer is used as an output device that generates sound to scare birds away from the rice field. Besides the buzzer, a servo motor is also applied to create mechanical movement through a rope mechanism installed in the field. The movement produced by the servo motor helps increase disturbances around the crops, making the birds less likely to approach the area.

To maintain stable system operation, a power bank is utilized as the main power source that supplies electrical energy to all electronic components used in the device. In addition, a project box is provided to store and organize the hardware components such as the Arduino board, PIR sensor, buzzer, servo motor, relay module, and LCD I2C display. The enclosure helps protect the electronic components from environmental conditions while also keeping the system arrangement neat, safe, and more organized.

B. Design of Hardware Components

The hardware design presented in this study describes the integration process of several electronic components used to build a bird pest repellent system. Each component is connected and arranged into a single functional system that is able to operate automatically in detecting and responding to bird activity within agricultural environments. Through this integration, the system is expected to work efficiently in supporting crop protection efforts carried out by farmers. This device was developed as an alternative technological solution to reduce the impact of bird pests that frequently damage rice plants. Bird attacks on rice fields often cause significant losses for farmers, particularly during the grain-filling and harvesting periods. Therefore, the implementation of an automated repellent system is considered important to help improve the effectiveness of field monitoring and crop protection activities.

In this research, the system is specifically designed for application in the rice fields located in Pasirmalati Village, Dawuan District, Majalengka Regency. The use of this technology is expected to assist local farmers in minimizing crop losses while also reducing dependence on conventional bird-scaring methods that generally require continuous human supervision. The arrangement and connection of the hardware components utilized in this system are illustrated in the following figure. The figure demonstrates how each electronic module is interconnected to support the overall operation of the bird pest repellent device.

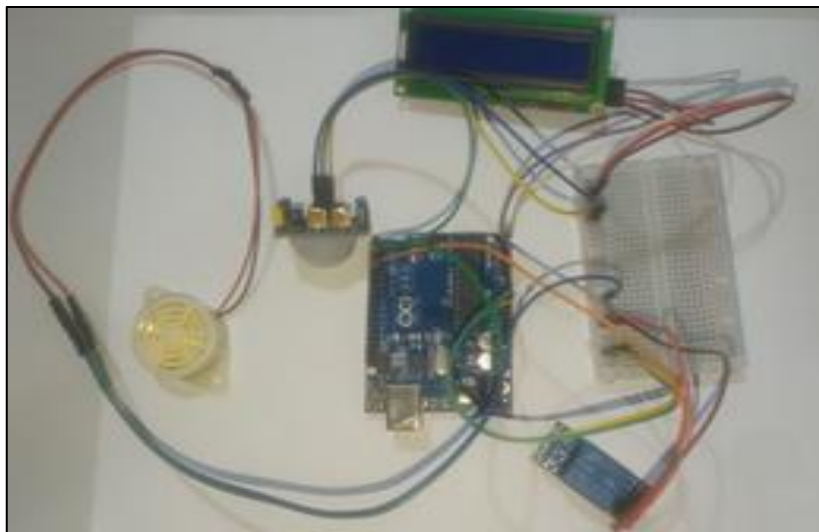


Fig 4. Hardware Configuration of the Bird Deterrent Device

C. Design of Software Components

The software aspect of this system covers all applications, programming platforms, and development tools used in designing, configuring, and testing the Arduino-based microcontroller system. The software plays an essential role in controlling the operational logic of the device so that the bird pest repellent system can function automatically whenever bird activity is detected in the agricultural area. Through proper software integration, the system is able to respond efficiently and perform the required actions without continuous human intervention.

In this research, the programming and system development process is conducted using the Arduino Integrated Development Environment (Arduino IDE). Arduino IDE is widely recognized as a software platform designed specifically for creating, editing, and uploading program codes, commonly referred to as sketches, to Arduino microcontroller boards. The platform provides a user-friendly interface that simplifies the coding process, making it easier for developers and researchers to design embedded system applications. Besides supporting program writing, Arduino IDE also offers several important features such as source code compilation, syntax checking, and program uploading to the microcontroller board. These features assist developers in ensuring that the program runs according to the intended design. Furthermore, the software includes debugging capabilities that help identify, analyze, and correct errors within the program during the development and testing stages [11]. Its functionality is particularly important to improve system stability and minimize operational failures during implementation in the field.

Arduino IDE itself is developed using the Java programming language and utilizes C/C++-based libraries through the Wiring framework. This framework simplifies the process of handling

communication between software instructions and the hardware connected to the microcontroller. As a result, developers can more easily manage input and output operations without needing to write highly complex low-level programming commands. In addition to the primary development platform, the system also requires several supporting libraries to ensure proper communication and functionality between the hardware components and the Arduino microcontroller. Libraries are collections of prewritten program codes that are specifically designed to simplify hardware control and system integration. The use of libraries not only accelerates the development process but also helps reduce programming errors and improves overall system reliability during testing and implementation.

Several libraries are applied in the development of this bird pest repellent system, including the Arduino core library, PIR sensor library, buzzer control library, and LCD I2C library. Each library has a specific function in supporting system operations. The Arduino core library manages the main microcontroller functions, the PIR sensor library processes motion detection input, the buzzer library controls the sound output used to repel birds, and the LCD I2C library enables efficient communication with the display module. Through the integration of these libraries, the Arduino microcontroller can communicate effectively with all connected hardware components, allowing the bird pest repellent system to operate automatically, accurately, and efficiently.

D. System Evaluation and Testing

System testing was carried out after all hardware and software components had been successfully assembled into a complete bird pest repellent device. The main purpose of this stage was to ensure that the Arduino-based system could operate properly in accordance with the planned design and operational objectives. Through this testing process, researchers were able to evaluate whether every component functioned correctly and whether the entire system could work together in a stable and efficient manner. The testing phase focused not only on examining the functionality of individual components but also on analyzing the communication and integration between those components. In addition, the researchers evaluated the overall response of the system when detecting the presence of objects, particularly bird pests, through the PIR sensor. This process was important to determine whether the device could respond automatically and activate the output system as intended.

To obtain more accurate results, the hardware testing was conducted directly in the rice fields. The implementation of field testing allowed researchers to observe the actual performance of the device under real agricultural conditions. Through direct deployment, the effectiveness of the bird pest repellent system in minimizing disturbances caused by rice-eating birds could be evaluated more realistically. This stage also helped identify potential weaknesses or technical adjustments needed to improve the overall system performance before wider implementation. The system evaluation in this study applied the black box testing method. In this method, the testing process concentrates on examining the relationship between input and output without analyzing the internal structure of the program code. Each function of the system was tested to determine whether the resulting output matched the expected results based on the given input conditions. This method is commonly used because it provides a practical way to verify system functionality from the user's perspective.

Both component-level testing and overall system testing were conducted during this stage. Each electronic module was first tested individually to ensure proper operation before being integrated into the complete system. Afterward, the entire device was tested as a unified system to observe the interaction between sensors, microcontroller, buzzer, and display components during real-time operation. One of the most important stages of testing involved the Passive Infrared (PIR) sensor, which functions as the primary detector for bird movement in the agricultural area. The PIR sensor was connected to the Arduino microcontroller to transmit detection signals whenever movement was identified within the sensor's range. Once the signal was received by the Arduino, the system automatically activated the buzzer to generate sound waves intended to scare away bird pests from the rice fields.

The PIR sensor testing was conducted at various distances ranging from 1 meter to 7 meters. Based on the testing results, the sensor demonstrated the capability to detect the movement of sparrow birds effectively within the targeted area. The successful detection process confirmed that the PIR sensor could function properly under field conditions and support the automatic operation of the bird pest repellent system. The testing activities were carried out in the rice fields located in Pasirmalati Village, Dawuan District, Majalengka Regency, West Java. The results obtained from the field implementation

indicate that the system has the potential to assist farmers in reducing crop damage caused by bird pests while improving the efficiency of traditional crop protection methods.

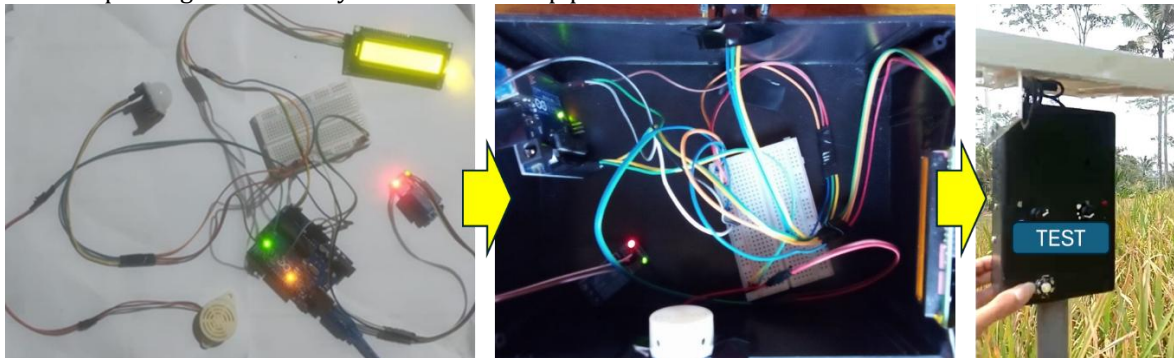


Fig 5. Device Implementation and System Testing for Bird Pest Control

The testing results indicated that the PIR sensor performed effectively at detection distances ranging from 1 to 5 meters. Within this range, the sensor was able to identify movement properly and transmit signals to the Arduino microcontroller without significant interference. As a result, the bird pest repellent system could respond automatically by activating the buzzer to produce sound waves intended to scare away the birds from the rice field area.

However, during testing at distances between 6 and 7 meters, the PIR sensor experienced difficulties in detecting movement. This limitation was mainly caused by the condition of the rice plants in the field, which had grown tall and dense enough to obstruct the sensor's detection range. The dense vegetation reduced the sensor's ability to capture movement accurately, resulting in decreased detection performance at farther distances.

Despite these limitations, the overall testing demonstrated that the developed system was able to operate properly according to the intended design. All integrated hardware components functioned as expected during the testing process. The device successfully operated automatically whenever movement was detected by the PIR sensor, indicating that the communication between the sensor, Arduino microcontroller, and output components worked effectively.

The Arduino microcontroller also showed stable performance in controlling and coordinating the entire system. It was capable of processing sensor input signals and managing the operation of connected hardware components, including the buzzer and display modules. This confirms that the microcontroller can serve as the main control center of the bird pest repellent system.

The following data presents the results of the PIR sensor distance testing, which was conducted to evaluate the effectiveness of the sensor as the primary control mechanism in the bird pest repellent device.

Table 2. PIR Sensor Testing in Detecting Bird Distance

No.	Distance (cm)	Description
1	50	Bird Detected
2	100	Bird Detected
3	200	Bird Detected
4	300	Bird Detected
5	400	Bird Detected
6	500	Bird Detected
7	600	Bird Not Detected

4. CONCLUSION

The results of testing and implementation show that the Arduino-based bird pest repellent system using a PIR sensor is able to operate properly and effectively in detecting and repelling birds in rice field areas. The system can automatically respond when bird movement is detected, allowing the repellent mechanism to work in real time. The integration of components such as the buzzer, relay module, mini speaker, and LCD I2C display also supports the overall performance of the system in monitoring and reducing bird disturbances.

The effectiveness of the system is reflected in the significant reduction of crop losses experienced by farmers. Before the implementation of the device, bird attacks caused rice losses of

around 647 kg within seven months. After the system was applied, the losses decreased to 0 kg, indicating that the tool was highly successful in minimizing bird-related damage and reducing economic losses in agricultural activities.

Despite these positive results, the study also identified several limitations. The PIR sensor showed reduced sensitivity when detecting birds moving at high speeds, which may affect the accuracy of detection under certain conditions. Therefore, further development is recommended, particularly in improving sensor responsiveness and integrating additional detection technologies to enhance system performance and reliability in wider agricultural environments.

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