



BIRD STRIKE DETERRENT PROTOTYPE BASED ON ESP32 MICROCONTROLLER AND PIR SENSOR USING AUDIO AT YOGYAKARTA INTERNATIONAL AIRPORT

Wawan Setyawan¹, Paino², Said Hafas³, Catra Indra Cahyadi⁴, Donna Nurhaida Masdiana Sirait⁵

^{1, 2, 3, 4, 5} Teknik Telekomunikasi Dan Navigasi Udara, Politeknik Penerbangan Medan, Indonesia

✉ Corresponding author:
wawanariyati@gmail.com

Abstrak

Keberadaan burung di area landasan pacu bandara menimbulkan ancaman terhadap keselamatan penerbangan baik saat lepas landas maupun mendarat, karena dapat mengakibatkan insiden tabrakan burung. Di Bandara Internasional Yogyakarta, pengendalian burung dilakukan melalui patroli manual menggunakan kendaraan operasional yang dilengkapi dengan pengeras suara yang menyiarkan suara predator. Namun, metode ini memakan waktu dan mungkin menjadi kurang efektif dalam kondisi cuaca buruk. Oleh karena itu, sistem penangkal burung otomatis diperlukan untuk membantu personel bandara dalam mengurangi risiko tabrakan burung. Proyek akhir ini bertujuan untuk merancang dan mengembangkan prototipe penangkal burung berbasis mikrokontroler ESP32 dan sensor Inframerah Pasif (PIR) menggunakan audio predator sebagai output. Prototipe ini menggunakan empat sensor PIR untuk deteksi gerakan, ESP32 sebagai pengontrol utama, relay sebagai sakelar elektronik, modul pemutar MP3 untuk pemutaran audio, amplifier TDA2030 untuk memperkuat sinyal audio, pengeras suara sebagai output audio, dan LCD untuk menampilkan status sistem. Ketika sensor PIR mendeteksi gerakan, ESP32 memproses sinyal input dan mengaktifkan relai, memungkinkan pemutar MP3 untuk memutar suara predator melalui speaker yang diperkuat oleh amplifier TDA2030. Hasil menunjukkan bahwa prototipe berhasil dirancang dan diuji melalui simulasi skala terbatas sesuai dengan tujuan penelitian. Sensor PIR mampu mendeteksi gerakan dalam jarak maksimum 4,5 meter dan mengirimkan sinyal ke ESP32, memungkinkan relai dikontrol secara otomatis. Hasil pengujian dan simulasi mengkonfirmasi bahwa perangkat keras dan perangkat lunak berhasil diintegrasikan dan dioperasikan sesuai dengan desain sistem. Prototipe yang dikembangkan dapat berfungsi sebagai solusi alternatif untuk masalah yang diidentifikasi dalam penelitian ini dan dapat dikembangkan lebih lanjut untuk implementasi di masa mendatang oleh otoritas bandara.

Kata Kunci: Prototipe Penangkal Serangan Burung, ESP32, Sensor PIR, Relai, Audio Predator

Abstract

The presence of birds in airport runway areas poses a threat to flight safety during both take off and landing, as it may result in bird strike incidents. At Yogyakarta International Airport, bird control is carried out through manual patrols using operational vehicles equipped with speakers that broadcast predator sounds. However, this method is time-consuming and may become less effective under adverse weather conditions. Therefore, an automated bird-deterrent system is needed to assist airport personnel in reducing the risk of bird strikes. This final project aims to design and develop a bird-deterrent prototype based on an ESP32 microcontroller and Passive Infrared (PIR) sensors using predator audio as the output. The prototype utilizes four PIR sensors for motion detection, an ESP32 as the main controller, a relay as an electronic switch, an MP3 player module for audio playback, a TDA2030 amplifier

to amplify the audio signal, a speaker as the audio output, and an LCD to display the system status. When the PIR sensors detect motion, the ESP32 processes the input signal and activates the relay, allowing the MP3 player to play predator sounds through the speakers amplified by the TDA2030 amplifier. The results show that the prototype was successfully designed and tested through limited-scale simulations in accordance with the research objectives. The PIR sensors were able to detect motion within a maximum range of 4.5 meters and transmit the signal to the ESP32, enabling the relay to be controlled automatically. Testing and simulation results confirmed that the hardware and software were successfully integrated and operated according to the system design. The developed prototype can serve as an alternative solution to the problems identified in this study and may be further developed for future implementation by airport authorities.

Keywords: *Bird Strike, Bird-Deterrent Prototype, ESP32, PIR Sensor, Relay, Predator Audio*

INTRODUCTION

On-the-Job Training (OTT) is an activity aimed at applying knowledge and carrying out direct work practices. Students are expected to develop ideas that will improve employee performance and provide solutions to problems experienced by technicians at the airport. These ideas will be developed into a final assignment on campus. While conducting On-the-Job Training at PT. Angkasa Pura Indonesia, specifically at Yogyakarta International Airport, the author participated in the implementation of daily activities (Meisak et al., 2022). Daily implementation includes equipment maintenance, equipment repair, equipment installation, and so on. The author also participated in checking equipment on the runway and participated in patrols to repel flocks of birds around the runway. These bird repellent patrols are carried out in the morning, afternoon, and evening. The aim is to improve flight safety and prevent bird strikes (Firman et al., 2022). This patrol activity is in accordance with the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 95 of 2021 concerning Civil Aviation Safety Regulations Part 139 (CASR Part 139) concerning Aerodromes, airport operators are required to maintain the operational safety of aerodromes, including controlling hazards in the runway area, one of which is the presence of birds that can cause bird strikes (Suprihardi, Yaman, 2020).

If there are still many flocks of birds in the runway area, there is a concern that bird strikes or collisions between birds and aircraft will occur. Bird strikes are very dangerous for flights because birds can enter the jet engine of the aircraft which can cause the engine to catch fire, collisions with the cockpit glass which can impair the pilot's vision, and collisions with the fuselage of the aircraft. To overcome this problem, bird repellent devices are needed in the area around the runway (Khoiruroziq & Nilakresna, 2021b). The implementation of bird repellent at Yogyakarta International Airport is carried out by driving around in a car with speakers equipped with eagle sounds (Zewdie et al., 2022). This patrol takes time to get to the runway and there is a risk that officers will face bad weather in the runway area. In addition, when there are aircraft about to take off and land, anyone is prohibited from approaching until the aircraft has completed take off or landing (Priambodo, 2021).

To provide a solution to the problems that occur, a tool is needed that can be installed around the runway as an automatic bird repellent. A tool that can detect birds and can repel birds quickly. So the author had an idea to make a prototype bird strike deterrent based on the ESP32 Microcontroller and a PIR sensor (passive infrared receiver) with eagle sound audio (Syahnas et al., 2023). This eagle sound is the same as the sound from the Yogyakarta International Airport speaker used for bird repellent patrols on the runway (Pilot et al., 2023). This prototype was made for the needs of the final assignment and research that was tested in simulation. It is hoped that this prototype can be an illustration of an alternative solution in increasing the effectiveness of bird repellent that helps airport officers and can be further developed by Yogyakarta International Airport technicians. The author raised the research Title

"Prototype Bird Strike Deterrent Based On Esp32 Microcontroller And Pir Sensor Using Audio At Yogyakarta International Airport."

Prototype testing will be conducted around campus as a simulation and to complete the author's final assignment course (Endriatno et al., 2024). The simulation will be conducted to test the PIR sensor distance using human hands and pigeons as objects on a limited or small scale. From this simulation, the maximum detection distance of this tool will be obtained (Khoiruroziq & Nilakresna, 2021a). The creation of this prototype also serves as a learning tool for the author to build the tool. It is hoped that this prototype can be one solution to solve the problems encountered by the author, namely the need for time to get to the runway during patrols and the potential danger of bad weather for employees who are on patrol. This prototype is also expected to be further developed by technicians at the airport as an illustration of alternative solutions to the problems encountered by the author (Nurdiyanto & Harduyo, 2020).

RESEARCH METHOD

The research method is the procedure chosen in conducting the research. In the process of completing this research, the Research and Development (R&D) method is used because it allows researchers to design, develop, and evaluate products systematically and structured. The Research and Development (R&D) method is a research method used to produce a particular product and test its effectiveness according to the plan. The purpose of this method is to find solutions to existing problems or improve existing products and processes. This research method is very helpful for the author to write and the process of making prototypes. In this study, the product developed is a prototype bird strike deterrent based on ESP32 and PIR sensors, the aim of which is to provide a solution to the problem of the presence of flocks of birds in the runway area of Yogyakarta International Airport (Fauzi & Iga, 2020).

This stage is the initial stage of research, to identify problems that occur at the airport. Problems were obtained based on observations and work during the On-The-Job Training activities at Yogyakarta International Airport. In addition, the problems were discussed with technicians and safety personnel (Raihan & Firmawati, 2022). The author found a problem in the form of airport officers patrolling around the runway area to ward off flocks of birds. This method is time-consuming and poses a potential risk to patrol officers, especially in bad weather. Therefore, a solution was found to create a prototype that was tested in simulations to be developed into a final project at the Medan Aviation Polytechnic campus (Lubis & Lubis, 2020).

In this stage, data collection is carried out through literature studies related to the research by collecting journals related to the research. The data is based on the preparation of the prototype so that the components to be used can be arranged. The data used includes theories regarding the ESP32 microcontroller, PIR sensor as a bird detector, audio system as a sound output to repel birds, relay as a switch, power supply, LM2596 Module as a voltage reducer, MP3 Player as an audio player, and TDA 2030 Amplifier. In addition, airport data is also sought to support the preparation of the prototype. The data for these components is placed in chapter 2 as a theoretical basis.

The next stage is the preparation of a prototype that discusses the preparation of hardware and software. The hardware of this prototype consists of a power supply, ESP32 microcontroller, PIR sensor, relay, TDA 2030 Amplifier, LM2596 Module, MP3 Player, speaker, and LCD. The prototype is designed to detect movement so that it activates the predator sound from the speaker. The movement here uses a human hand as an object. The software in this prototype is Arduino IDE which is used to program the system of this prototype so that it can work properly (A. R. Hakim et al., 2020).

This stage is the prototyping stage based on the previously created assembly. The components are assembled into a prototype that can detect movement and emit predator sounds from a speaker. Furthermore, programming is performed using the Arduino IDE to ensure the

prototype system functions properly (Lawhon, 1976). Prototype development begins with the hardware. Once the hardware is complete, programming is performed using the Arduino IDE.

Prototype testing was conducted to ensure the device was functioning properly by conducting prototype trials and simulations. This testing was conducted by programming the Arduino IDE and inserting libraries for each sensor. Next, the PIR sensor was tested to detect movement to achieve maximum distance. Then, an eagle sound output experiment was conducted from the speaker. Simulations were conducted by detecting human hand movements and using pigeons as objects around the Medan Aviation Polytechnic campus (Nisa & Aryni, 2023).

This research aims to design a prototype of an automatic bird repellent device that can be used as an alternative solution to the problems found by the author. The prototype will be tested in simulation to obtain data on LCD status, PIR sensor performance distance, and speaker status. If there is movement around the PIR sensor, the speaker will activate the relay so that the eagle sound comes out of the speaker. The data needed is the object's distance data to the PIR sensor, which will prove the maximum distance of the PIR sensor to detect object movement. In addition, the speaker's active status data will also be tested to prove the speaker's performance. These two data will be combined to obtain distance data and speaker status data. Prototype testing will be carried out in simulation around the campus as a requirement for the author's final assignment using human hands (Tantia, 2018).

RESULTS AND DISCUSSION

This research produce *prototype bird strike deterrent* ESP32 based and PIR sensor using audio. *Prototype* This developed For detect existence movement object and activate the speaker that emits the eagle audio. *Prototype* This done with simulation and testing For needs task end (Zada, 2023). This *prototype* designed through a number of stage that is compilation device hard, arrangement device software and simulation and trials *prototype* This as task end writer with scale limited or scale small and not intended for use on airport *runways* in a way directly, but rather in a way simulation in the field Aerospace Polytechnic Medan Flights.

Compilation Device Hard

In the research this, is needed a number of device hard connected One each other. As for the device hard (*hardware*) in research This These include a power supply, LM2596 module, ESP32 microcontroller, PIR sensor, relay, MP3 player, TDA 2030 amplifier, and speaker. Each device hard This own function certain. Every device hard must connected One The same others. Compilation device hard shared become a number of the part that is poured into the part below (L. Hakim & Lefudin, 2020).

Connect Power Supply with LM2596 Module

Power supply here used For accept 220 volt AC voltage from PLN then changed become DC voltage of 12 volts. This power supply also maintains stability DC voltage so that remains at 12 volts. Voltage DC output from the next power supply used For supply need power on *prototype* This. From this power supply continued to LM2596 module. LM2596 module works For lower DC voltage of 12 volts becomes 5 volts DC so that incoming voltage to in ESP32 accordingly with the input voltage that must be accepted by ESP32. LM2596 will share voltage to ESP32 module, relay, MP3 player, TDA2030 amplifier, speaker, and LCD. This LM2596 module will guard stability DC voltage so that still be at value 5 volts and the incoming voltage to ESP32 still safe.

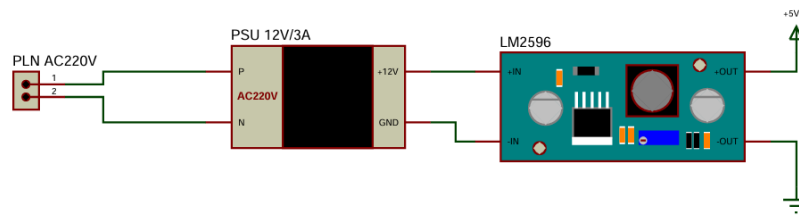


Figure 1. Power Supply and LM2596 Connection

Connecting the LM2596 Module with the ESP32

The voltage that has been derived by LM2596 by This 5 volt DC Then continued to ESP32. On the LM2596 module it is done arrangement voltage so that output voltage become 5 volts DC. From the module This then ESP32 has safe voltage that is 5 volts DC. After that the ESP32 will lower voltage Again become 3.3 volts DC as voltage trigger ESP32 control. The LM2596 module plays a role in guard stability voltage from the power supply that will accepted by the ESP32 so that own voltage 5 volt DC. Voltage from the power supply no can direct accepted by the ESP32, therefore That needed reducer voltage so that voltage enter with safe.

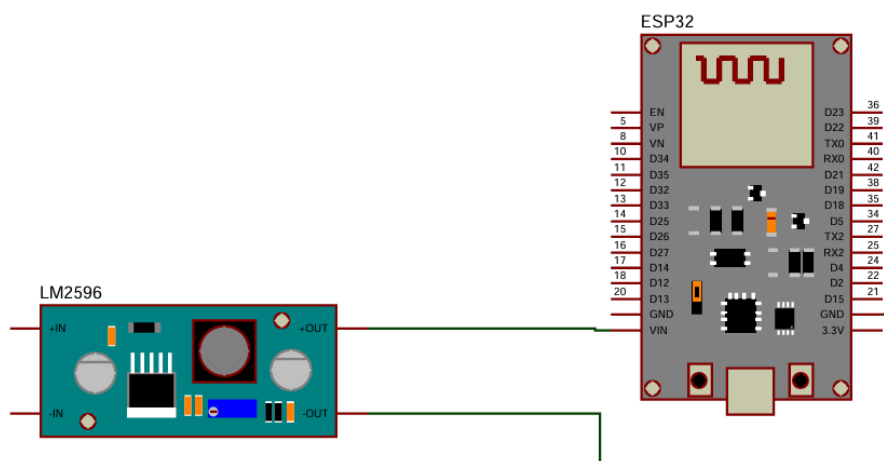


Figure 2. Connection of LM2596 and ESP32 Modules

Connecting ESP32 with PIR Sensor

This ESP32 will control the PIR sensor so that the data obtained can continued to ESP32. One of the connected components with ESP32 is a PIR sensor. PIR sensor works For detect movement birds around *prototype*. This PIR sensor is a sensor with method active high, where when the sensor detects existence movement then PIR will give High signal. PIR sensors are installed in 4 corners different so that can distinguish in which area there is detection movement. The AM312 PIR sensor has a number of lack including distance range only a few meters, there is pause active For detect movement more, and less responsive. In research this, the shortcomings from the AM312 PIR sensor poured to in the suggestion so that can developed more carry on

Connecting ESP32 with Relay

Next the ESP32 is connected with functioning relay module as switch or switching. Relay is functioning components as switch electronics controlled by an ESP32 microcontroller. In this *prototype*, a relay is used. For arrange the life and death of the MP3 Player so that voice hawk will active in a way automatic when the PIR sensor detects existence movement. This relay is an active low relay, where the relay will active when get low signal. When the PIR sensor detects existence movement object, ESP32 will send signal to ESP32 then continued relay. Signal This turn on the relay so the MP3 Player will live and play voice the eagle that has stored on *the memory card*

Connecting a Relay to an MP3 Player

Relay and Mp3 Player are interconnected connected, relay function here as switch or switching Mp3 Player so key the Mp3 player comes from from the relay. In this Mp3 player there is *memory card* that stores audio files eagle, so that If the Mp3 Player is on, the audio will play played. MP3 Player is used as a storage and playback medium voice hawk. So that the MP3 Player does not Work in a way continuously, then the MP3 player is connected to the relay, with Thus Mp3 Player will active when accept low signal from ESP32. This relay functioning as Mp3 Player switch so that No Work Keep going continuously.

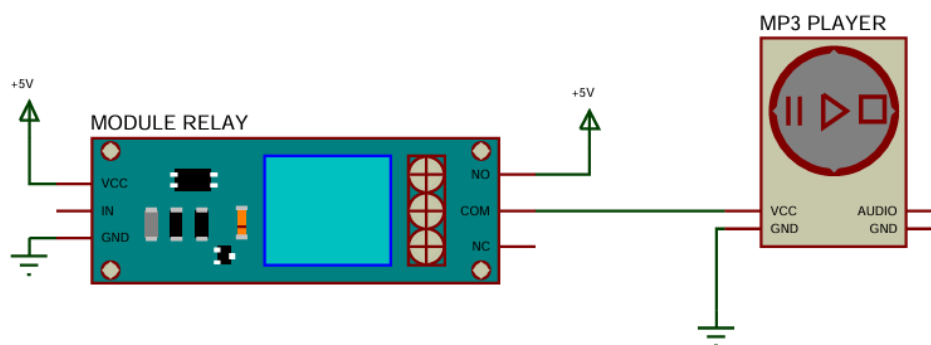


Figure 3. Relay and MP3 Player Connection

Connecting an MP3 Player with a TDA2030 Amplifier

Mp3 Player is working For play audio, then this Mp3 Player connected to the TDA2030 Amplifier. This TDA2030 Amplifier functioning as amplifier voice so that the audio produced by the Mp3 Player becomes more strong and sufficient For need *prototype*. The audio signal produced by the Mp3 Player has relative power small. This sound No capable produce voice with sufficient intensity strong if direct connected to the speaker. Therefore That amplifier is required for increase Power incoming audio signal to more speakers strong

Connecting the TDA2030 Amplifier with Speaker

TDA2030 amplifier connected with speaker, TDA2030 Amplifier works as audio amplifier. Output from this TDA2030 become more strong and forwarded audio to the speaker to be more strong and clean. Speakers here functioning as output voice hawk For chase away birds around *prototype*. In this *prototype* using Horn Speaker NSH-70N type speakers. These speakers capable produce voice with level 85 dB noise

Connecting ESP32 and LCD

Liquid Crystal Display (LCD) is used as an information medium For display results PIR sensor reading on *the prototype*. LCD works For displays PIR sensor data when detect movement and No detect movement. In position At the beginning, the LCD will displays OFF data on each PIR. If the PIR detects movement, then the LCD will displays ON data on the PIR sensor that detects movement. With existence this LCD display will help see which PIR sensor is active (Novi Eko Saputro, 2018).

Series Prototype

Prototype This combine a number of module become one, so that can Work in accordance with planning. Series started from the power supply that receives PLN voltage 220 volts AC, then changed become DC current and voltage lowered to 12 volts DC. With the existence of a power supply, then incoming power will stable, so that series running normally and safely. After the power supply, the circuit going to to LM2596 for lowered the voltage become 5 volts DC so that can shared to ESP32, PIR sensor, relay, Mp3 Player, TDA2030 amplifier, and speaker. With the presence of this LM2596 voltage become safe For continued to series next, so that series can Work with good. LM2596 will share voltage 5 volt to the ESP32 so that the ESP32 can Work with safe. ESP32 is microcontroller from *prototype* this is what works For regulate and control series so that Work in accordance with planning. On this ESP32 there are programs that can arranged as device the software, so that function series can seen from the serial monitor program.

This ESP32 will reading the PIR sensor, where the PIR sensor functions as detector movement. PIR sensor here only can detect movement only, besides that's the PIR sensor own limited capabilities. PIR sensors only can detect movement at a distance maximum 4.5 meters, and only from front of the sensor only movement can detected. This PIR sensor only can detect from corner view minimum front of the PIR sensor. If the PIR sensor detects movement, then will send data to ESP32 to processed, and the ESP32 will activate the relay. The relay is module as switch on *the prototype*. If There is movement detected, then the ESP32 will control the relay to ative. Active relay will trigger the Mp3 player to work, so that voice hawk will played by Mp3 Player. Then voice hawk This will continued to the TDA2030 amplifier for strengthened so that the audio is inserted to the appropriate speaker standard. With With the TDA2030 amplifier, the audio becomes more strong and quality voice more clear (Alamsyah et al., 2023).

Planning Software

Device hard that has each other connected will controlled by the Esp32 microcontroller using device soft that is Arduino IDE programming. Device soft functioning as regulator or the command entered to in ESP32 so that *prototype* Work with Good in accordance desires and needs. The program determines How *prototype* This work. Programming can changed if required in accordance with needs. The program created functioning For read data from the PIR sensor, then processing received signal, as well as control the relay as Mp3 Player switch so that the speaker turns on which is amplified by the TDA2030 amplifier.

ESP32 Program for PIR Sensor

ESP32 program for PIR sensor is designed For read and process data generated by the PIR sensor as system input. In *the prototype* This use four PIR sensors installed on four side different For distinguish detection areas movement around *prototype*.

The PIR sensor is a sensor with active high, so that when the sensor detects movement then the sensor will give signal high.ESP 32 will do initialize the connected pins with each PIR sensor as an input pin. Configuration This aim so that the ESP32 can receive and read signal sent by the PIR sensor. After the initialization process finished, ESP32 will do sensor data reading continuously (looping) during in condition active. PIR sensor is working with detect change radiation infrared caused by the presence of movement objects in its coverage area. When the sensor detects movement, the sensor output pin will produce signal high logic. On the other hand, if No there is movement is detected, the sensor will produce signal low logic.

ESP32 will read condition logic from each PIR sensor and perform the capture process decisions based on the data received. If one of the PIR sensors produces high signal, then the ESP32 will identify that there is movement around *prototype*. Next, ESP32 will operate instructions For activate the relay so that system voice hawk can Work. On the other hand, if all PIR sensors are in low condition, then ESP32 will maintain the relay in condition No active. In condition said, MP3 Player does not get Power so that voice hawk No played and system still is at in condition standby.

ESP32 Program for Relay

The ESP32 program for the relay is working as controller switch electronics used For connecting and disconnecting MP3 Player module. Relay controlled in a way directly by ESP32 based on the results reading from a working PIR sensor as detector movement object. The relay module is module with method active low, so that if given low signal then the relay will active.

This program show that if there is an Mp3 Player on off function is controlled by Boolean on and off. If on off is correct, then the relay will active. Active here given low signal, because this relay is an active low relay. On the other hand, if the Mp3 Player is deactivated then the relay will be off. Off here shown with high signal.

ESP32 Program to LCD

The ESP32 program against the LCD works For display information condition *prototype* when working. On *the prototype* Here, LCD is used For display condition of the PIR sensor installed on the four side *prototype*. With the presence of this LCD, the use of *prototype* No need open serial monitor again when system Work.

This program show that background back of the LCD will light up Then will read the text correctly with the program written namely in the column one line one will written the word PROTOTYPE. Then in the column one line two will written with the words BIRD REPELLENT. This article will endure for five seconds, after that writing will clean and change to the next article. After the opening article clean, then the LCD will switch to the next article namely P1 PFF, P2 OFF, P3 OFF, and P4 OFF. P is symbol from the pir sensor and the numbers there indicate identity pear to how much. P will changed becomes ON when detect existence regulated movement with this program :

Initial program Work For arrange time, with count time system lag. Time lag arranged for 600 seconds before the speaker will light up with itself. At the time calculation time pause, there is two ongoing processes that is count time and sensor initialization. If in this process PIR sensor 1 or PIR sensor 2 or PIR sensor 3 or PIR sensor 4 is one of them active, then the ESP32 will activate the relay. When the relay is active then the Mp3 Player, TDA2030 amplifier, and speakers are also active. The program will count speaker time for 10 seconds, after time active speaker for 10 seconds This Already finished then the ESP32 will turn off the relay so that the speaker turns off. However if in 10 seconds This there is another PIR sensor active, then time count the speaker will turn on return to count One seconds. If there is another PIR sensor involved active too, then calculation time voice will Keep going return to count second first. This process will Keep going continue until No there is an active PIR sensor or until the PIR sensor turns off. If time speaker light up for 10 seconds Already finished and not There is again the PIR sensor is active then the relay will dead followed by Mp3 Player, TDA2030 amplifier, and speakers that follow dead too. Then the program will return to beginning.

But at the moment PIR sensor initialization not working there is an active PIR sensor, then time count pause will Keep going continue until with 600 seconds. When the time pause Already finished then the relay will active followed with Mp3 Player, TDA2030 amplifier, and accompanying speakers active so that voice hawk will lights up. After that the program will count time turn on the speaker for ten seconds. If in time ten second This there is an active PIR sensor, then calculation time voice will return to second first. If There is follow-up again the PIR sensor is active, then calculation time voice will return to second First again. this process will ongoing until No there is an active PIR sensor. If time voice Already finished then the relay will dead. If the relay is dead then the Mp3 Player, TDA2030 amplifier, and speakers will die too. Then the process will return to beginning.

Discussion of Research Results

Prototype This capable integrate device hardware and devices soft so that *prototype* can Work in accordance with plan. In the research In this, ESP32 plays a role as center control that regulates performance *prototype* This. ESP32 receives data and input from four PIR sensors mounted on four side. Placement of PIR sensors on several side aim For get detection movement from several areas. Simulation and trial results show that the PIR sensor is capable of detect existence movement objects and send signal to the ESP32. When one of the PIR sensors detects

movement, ESP32 will process data and send data to ESP32 which is then continued to the relay so that the relay is active. Relay then Turn on the Mp3 Player so that the audio plays.

The eagle audio that is played by the Mp3 Player next continued to the TDA2030 amplifier for strengthened before issued through the speaker. The amplifier amplifies the audio so that predator sounds appropriate with speaker needs. With The presence of the TDA2030 amplifier also results in the audio having clear quality. The integration between the PIR sensor, ESP32, relay, Mp3 Player, TDA2030 amplifier, and speaker shows that all over component can Work in a way sequentially in accordance with program logic that has been designed. Workflow system started from the detection process movement by the PIR sensor, then the PIR sensor sends signal to the ESP32, the ESP32 will give signal to the relay, the relay turns on the Mp3 Player so that the audio plays, the audio is continued to the TDA2030 amplifier for amplified, and audio played by the speakers.

PIR Sensor Simulation

PIR sensor simulation is performed For know ability internal sensor detect movement around *prototype*. Simulation The test was carried out on each sensor, namely the PIR1 sensor, PIR2 sensor, PIR3 sensor, and PIR4 sensor. The PIR sensors were tested use bird dove in a way directly. Based on the results PIR sensor testing can detect existence movement and sending HIGH (1) signal to the ESP32. When not there is movement, the PIR sensor produces LOW (0) signal so that *prototype* is at in condition *standby*.

Relay Trial

Relay test was conducted For know relay capability in connecting and disconnecting the Mp3 Player. Testing done with observe change relay condition based on signal output from ESP32 namely HIGH signal (1) and LOW signal (0). Test results show that the relay can Work with Good in accordance with commands given by ESP32. When the relay receives low signal, relay contact moves position to active. Conversely, when the relay receives high signal, relay contacts remain in position the beginning which means the relay is not active.

LCD Test

LCD testing was carried out For ensure that the data captured by the LCD is appropriate with data when the PIR sensor detects existence movement. The LCD will displays ON when the PIR sensor detects movement. When not There is movement, then the LCD will displays the text OFF. Test results show that the LCD is working in accordance with draft planning *prototype*. This is show that LCD can functioning with God.

Table 1. LCD Trial

PIR Sensor Condition	LCD Condition	Results
PIR 1 Active	PIR 1 ON	Succeed
PIR 1 Inactive	PIR 1 OFF	Succeed
PIR 2 Active	PIR 1 ON	Succeed
PIR 2 Inactive	PIR 1 OFF	Succeed
PIR 3 Active	PIR 1 ON	Succeed
PIR 3 Inactive	PIR 1 OFF	Succeed
PIR 4 Active	PIR 1 ON	Succeed
PIR 4 Inactive	PIR 1 OFF	Succeed

Speaker Test

Speaker testing was carried out For ensure that eagle audio Work with good. Trial done with listen eagle audio output produced by the speaker. Test results show that the speaker is working in accordance compilation *prototype* with strength maximum 85 dB. This is show that the speaker can functioning with Good as audio output on *the prototype*. With speaker type This Already Enough For need *prototype* (Raihan & Firmawati, 2022). Bird Afraid with voice eagle, proven with trial bird frightened dove moment hear eagle audio from *prototype*.

Table 2. Speaker Test

Relay Status	Speaker Status	Distance (meters)	Noise Level (dB)
ON	Active	0	85
OFF	Not active	-	-
ON	Active	2	83
OFF	Not active	-	-
ON	Active	4	81
OFF	Not active	-	-
ON	Active	6	79
OFF	Not active	-	-
ON	Active	8	67
OFF	Not active	-	-
ON	Active	10	75
OFF	Not active	-	-

CONCLUSION

Based on the results testing in research *Prototype Bird Strike Deterrent* Based on ESP32 and PIR Sensor using Audio, then can concluded that : (1) *Prototype bird strike deterrent* based Esp32 microcontroller and PIR sensor using this audio succeed built and running with good. All device hard (*hardware*) and devices soft (*software*) succeed integrated with OK. The PIR sensor detects movement and ESP32 microcontroller successfully activate the relay and the speaker can emit eagle audio. (2) Based on the results PIR sensor testing on *prototype* This capable detect movement objects at a distance maximum 4.5 meters. The PIR sensor has a number of limitations that is there is a delay of two second before the sensor resets again For detect and coverage sensor detection from front only. The speaker has ability limited in scale small However Enough For need *prototype*. This speaker capable produce level noise 85 dB and enough For chase away bird guinea pigs. Birds dove Afraid to the eagle audio that the speaker emits. (3) *Prototype* This No can do identification and classification type object, *prototype* only respond movement without differentiate type moving object. *Prototype* This expected can become solution alternative from problems found writer and can developed by technicians at Yogyakarta International Airport.

Based on the results research that has been done, there is some suggestions that can used as material development tool next, namely : (1) This PIR sensor own limitations distance, coverage detection and response to movement where the sensor only can detect distance maximum 4.5 meters as well as coverage detection from front only. This is due to sensor capabilities that are still limited in scale small. This is also caused by limitations cost writer. For study to in front can using motion sensors with ability more detection sharp and more range wide such as the Hokuyo UST-10X LiDAR and other sensors that have to ability more tall. (2) Horn Speaker NSH-70N and amplifier TDA2030 used in the research This Still limited. For study next writer recommend so that can using amplifier and speakers with high specifications so that capable produce sound and level more noise high, for example speakers with specification 50 watt or 100 watts.

Further research can add technology processing image (*image processing*) use camera so that system can recognize type detected objects.

REFERENCES

- Alamsyah, R., Solikhah, M. D., Kismanto, A., & Heryani, S. (2023). Production Of Coco-Biodiesel From Cno (Coconut Natural Oil) For Small Scale Industries/Coconut Farmers Using Static Mixer And Dry Washing. *Iop Conference Series: Earth And Environmental Science*, 1235(1), 012004. <https://doi.org/10.1088/1755-1315/1235/1/012004>
- Endriatno, N., Safarun, M., & Kaimuddin, J. S. (2024). Rekayasa Prototype Keran Elektronik Berbasis Sensor Infrared Untuk Penghematan Air. *Seminar Nasional Teknik Elektro*, 1, 9–13.

- Fauzi, M., & Iga, S. (2020). Enhance The Institution Reputation With Open Learning System-Based Distance Learning Development Prototype In Globalization Era. *2nd International Conference On Islam, Science And Technology (Iconist 2019)*, 231-239. <https://doi.org/10.2991/assehr.k.200220.042>
- Firman, A. J., Ni'mah, U., & Asvio, N. (2022). Prototype Curriculum: Concepts And Its Role In Strengthening Character Education After The Covid-19 Pandemic. *Ejip: Educational Journal Of Innovation And Publication*, 1(1), 10-17. <https://doi.org/10.2991/assehr.k.200220.042>
- Hakim, A. R., Handoyo, W. T., Fauzi, A., & Sarwono, W. (2020). Desain Dan Kinerja Mesin Ekstruder Twin Screw Untuk Pembuatan Pakan Ikan Terapung. *Jurnal Keteknik Pertanian*, 7(2), 129-136. <https://doi.org/10.19028/jtep.07.2.129-136>
- Hakim, L., & Lefudin. (2020). Pengembangan Buku Ajar Konsep Dasar Ipa Sekolah Dasar Untuk Meningkatkan Pemahaman Konsep Mahasiswa. *Jurnal Literasi Pendidikan Fisika (Jlpf)*, 1(01), 1-10. <https://doi.org/10.30872/jlpf.v1i01.85>
- Khoiruroziq, F., & Nilakresna, S. (2021a). Perancangan Prototype Adgs Menggunakan Sensor Jarak Berbasis Arduino Di Bandar Udara Djalaluddin Gorontalo. *Airman: Jurnal Teknik Dan Keselamatan Transportasi*, 4, 51-55.
- Khoiruroziq, F., & Nilakresna, S. (2021b). Perancangan Prototype Adgs Menggunakan Sensor Jarak Berbasis Arduino Di Bandar Udara Djalaluddin Gorontalo Design Of Adgs Prototype Using Arduino-Based Distance Sensor At Gorontalo Djalaluddin Airport. 4, 51-55.
- Lawhon, D. (1976). Instructional Development For Training Teachers Of Exceptional Children: A Sourcebook. *Journal Of School Psychology*, 14(1), 75. [https://doi.org/10.1016/0022-4405\(76\)90066-2](https://doi.org/10.1016/0022-4405(76)90066-2)
- Lubis, A., & Lubis, N. (2020). Prototype Produk Buku Program Magang Iii Fkip Universitas Muslim Nusantara Al Washliyah. *Prosiding Seminar Nasional Hasil Penelitian*, 3(1), 63-69.
- Meisak, D., Hendri, & Agustini, S. R. (2022). Penerapan Metode Prototype Pada Perancangan Sistem Informasi Penjualan Mediatama Solusindo Jambi. *Storage: Jurnal Ilmiah Teknik Dan Ilmu Komputer*, 1(4), 1-11. <https://doi.org/10.55123/storage.v1i4.1066>
- Nisa, K., & Aryni, Y. (2023). Development Of A Scientific Writing Book Based On Tpack To Support The Merdeka Belajar-Kampus Merdeka Program. *Al-Ishlah: Jurnal Pendidikan*, 15(2), 1257-1269. <https://doi.org/10.35445/alishlah.v15i2.2857>
- Novi Eko Saputro. (2018). Asuhan Keperawatan Pada Klien Post Operasi Apendisitis Dengan Masalah Keperawatan Kerusakan Integritas Jaringan. *Journal Of Materials Processing Technology*, 1(1), 1-8.
- Nurdiyanto, A., & Harduyo, S. I. (2020). Rancang Bangun Prototype Pembangkit Listrik Tenaga Angin Menggunakan Turbin Angin Savonius. *Jurnal Teknik Elektro*, 9(1), 711-717. <https://ejournal.unesa.ac.id/index.php/jte/article/download/29892/27395>
- Pilot, Imron, A., & Taswiyah. (2023). Pengaruh Gaya Kepemimpinan Otentik Terhadap Kepuasan Kerja Guru (Kajian Empiris Prototype Kepemimpinan Otentik). *Amal Insani: Indonesia Multidiscipline Of Social Journal*, 3(2), 2746-6426.
- Priambodo, A. D. (2021). Rancangan Prototype Visual Docking Guidance System (Vdgs) Berbasis Arduino Uno Dan Rf Lora Sebagai Alat Bant Pembelajaran. <http://repo.poltekbangsby.ac.id/id/eprint/943>
- Raihan, A. A. R., & Firmawati, N. (2022). Rancang Bangun Prototype Sistem Smart Greenhouse Untuk Sayur Bayam (*Amarantus Hybridus L.*) Berbasis Internet Of Things (Iot). *Jurnal Fisika Unand*, 11(4), 494-500.
- Suprihardi, Yaman, E. (2020). Prototype Lampu Led Hemat Energi Sebagai Penerangan Rumah Tangga. *Jurnal Teknik Elektro Politeknik Negeri Lhokseumawe*, 4(1), 2598-3954.
- Syahnas, A., Mulyana, A., & Hafidudin. (2023). Perancangan Dan Realisasi Prototype Perangkat Keras Sistem Smart Parking Berbasis Iot. *E-Proceeding Of Applied Scince*, 9(1), 171-176.
- Tantia, M. D. (2018). Penerapan Akuntansi Aktiva Tetap Menurut Psak No. 16 Pada Pt Perkebunan Nusantara Iii (Persero) Medan Skripsi. *Journal Of Materials Processing*

Technology, 1(1), 1-8.

Zada, K. (2023). Sharia And Islamic State In Indonesia Constitutional Democracy: An Aceh Experience. *Ijtihad: Jurnal Wacana Hukum Islam Dan Kemanusiaan*, 23(1), 1-18. <https://doi.org/10.18326/Ijtihad.V23i1.1-18>

Zewdie, T. A., Delele, M. A., Fanta, S. W., Vanierschot, M., Alemayehu, M., Alemayehu, G., Adgo, E., Assaye, H., Verboven, P., & Nicolai, B. M. (2022). Design And Evaluation Of A Prototype Solar Energy Driven Onion Curing System Using Cfd Modeling. *Frontiers In Sustainable Food Systems*, 6, 1030915.