Design of Object Detection Radar Robot Prototype using Passive Intra Red Sensor Based on Arduino Microcontroller

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ABSTRACT

The research aims to design a radar robot prototype based on an Arduino microcontroller, using a Passive Infra-Red sensor and an ultrasonic sensor to identify objects within range. The objects detected are humans and RC aircraft. The RC aircraft is designed to be controlled remotely using a Flysky F16 remote control handheld radio transmitter and infrared lights installed so that ultrasonic sensors and PIR sensors can detect objects. A micro servo motor drives the radar robot. The method used is Prototype with the stages of Requirements Gathering, Prototype Design, Prototype Evaluation, System Coding, System Testing, System Evaluation, and System Implementation. The research result of the design is to detect humans and RC aircraft. In principle, the tool can read targets' movements (objects), namely humans and RC aircraft.

1. INTRODUCTION

This research is directed at designing a prototype of a wave-based object detection radar to ensure object coverage. The radar antenna transmits radio wave or microwave pulses that bounce off objects in its path (Saranya et al., 2020). This design uses a PIR (Passive Infra Red) sensor and an Arduino Uno-based ultrasonic sensor for learning prototypes in the laboratory, as well as for system prototypes. defense and security of the unitary state of the Republic of Indonesia (RI), for the survival of the unitary state of the Republic of Indonesia, a comfortable situation is needed from all threats, whether from land, sea or air, must improve air defense, includes security system elements, such as object detection radar, fighter aircraft, short-range guided missiles and air defense cannons.

The RC aircraft will be designed with various electronic components such as a DC-16V motor, 1400kv/30A brushless motor, WLTOYS F949 receiver board, and will be controlled using a Flysky F16 remote. The operational principle of the PIR sensor is that it can read target (object) movements. The objects that will be detected are humans and RC aircraft. Various examples of PIR sensor applications (Wu et al., 2021) can be found, focusing on the specific topic of monitoring and tracking, but the number of applications of PIR solutions is small.

Radar is an object detection system facilitated by radio waves to determine the distance, angle and speed of objects. This can also be used to determine the whereabouts of aircraft, ships, spacecraft, guided missiles, motorized vehicles, weather formations, as well as terrain (Sankar and Dayanithi, 2018). Radar (Radio detection and ranging) is a useful electromagnetic wave system that can identify, measure distances and create maps of objects located in the surroundings (L. Renaldi, S. Hadiyoso, 2017).

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The Passive Intra Red (PIR) sensor is a sensor used to detect infrared light emissions. The PIR sensor has a passive nature, meaning that this sensor does not emit infrared light but receives infrared light radiation from outside (Ardytyan et al., 2020). In general, this sensor is used in designing object movement detection. The PIR sensor is also a sensor that is commonly used to detect human presence (Toyib et al., 2019).

The Arduino Uno microcontroller is programmed to be able to control things that can work if one of the conditions in the microcontroller program is met (Nabila, 2020). The device can work to detect movement at a distance equal to or less than 4 m. When it detects movement, the buzzer and LED will light up for 3 seconds and turn off if it doesn't detect movement.

Servo motors (Amiruddin, R; Rais, M; Sirat, 2018) are motors that can work in 2 directions (CW and CCW) where the direction and angle of movement of the rotor can be controlled by setting the PWM duty cycle signal on the control pin. The servo consists of a DC motor, a series of gears, a potentiometer and a control circuit. There are 2 types of servo motors, namely AC and DC servo motors. AC servo motors are better able to handle large currents or heavy loads, as a driving force (Priyatna and Basry, 2021). On the other hand, DC servo motors are generally more suitable for use in smaller applications. And when differentiated by rotation, there are usually 2 types of servo motors on the market, namely 180º rotation servo motors and continuous rotation servo motors.

2. METHODS

This research uses a prototype method. A prototype is a procedure for developing software, which takes the form of a system framework model and acts as a basic type of system (Purnomo, 2017). The location of this research was carried out at the software and hardware laboratory of the Ternate Computer Science Academy. The following is the prototype research flow.

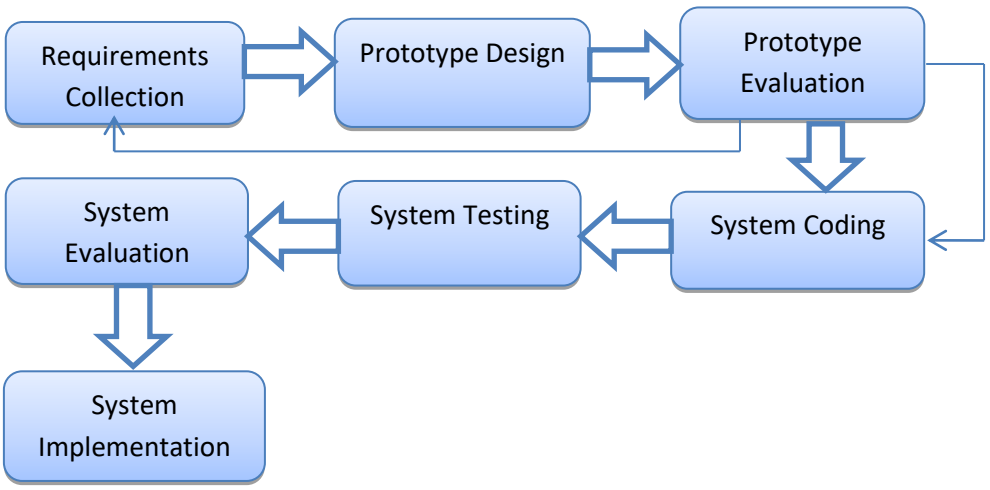

Figure 1. Prototype Design Flow Design

With this prototype procedure, a system prototype should be produced as an intermediary for developers and users so that they can interact in the process of data system development activities. In order for the prototype creation process to be successful, it is necessary to define the rules in the basic framework, namely developers and users must know the description that the prototype was created to define initial requirements. The prototype will be removed or added to its parts so that it matches the planning and analysis carried out by the designer through simultaneous testing along with the design process and can then be implemented.

3. RESULTS AND ANALYSIS

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This research uses a prototype design model to design an object detection radar robot using a passive infrared sensor based on an Arduino microcontroller. The objects detected are RC aircraft and humans. The design results are as follows.

3.1 Stages of Gathering Design Requirements

At this stage, an inventory of the devices used in the design is carried out. The following are the system requirements used; Arduino Atmega328, PIR sensor, HC-SR04 ultrasonic sensor, MPU6050 balance sensor, brushless motor, LED light, receiver and transmitter.

3.2 Design Stage

At this stage, mechanical and electrical design is carried out for the prototype design of the RC aircraft, human detection devices and radar. This stage is divided into 3 (three) parts, including:

3.2.1 Stages of mechanical and electrical design for RC aircraft

This image is a connecting circuit between Arduino, MPU5060 sensor and receiver (an electronic device that works to change audio/vibration signals).

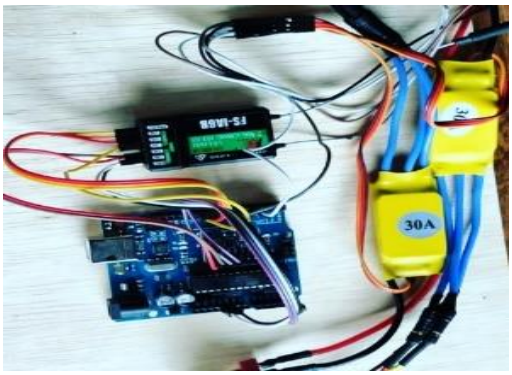

Figure 2. Electrical and mechanical circuit of RC aircraft

3.2.2 Radar Electrical and Mechanical Design Stages

The following is a radar image used to detect RC aircraft equipped with ultrasonic sensors and servo motors.

Figure 3. Object detection radar

3.2.3 Electrical and mechanical design stages for object (human) detection

At this stage, the PIR sensor is connected to an LED light as a sign that if an object (human) is detected, the LED light will turn on.

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Figure 4. Object detection circuit (human)

3.3 Prototype Design Evaluation

The following is a picture of the electrical and mechanical circuit of an RC airplane prototype. Figure 5 shows the test results of the design which was controlled using an electronic switch control equipped with an angle sensor to maintain the balance of the left-right propeller. To move the propeller left and right, use a flysky f16 remote control handheld radio transmitter.

Figure 5. Results of electrical and mechanical circuits for RC aircraft

3.4 Coding The Design System

It is a way of processing data to provide codes in the form of numbers or letters combined to represent data components.

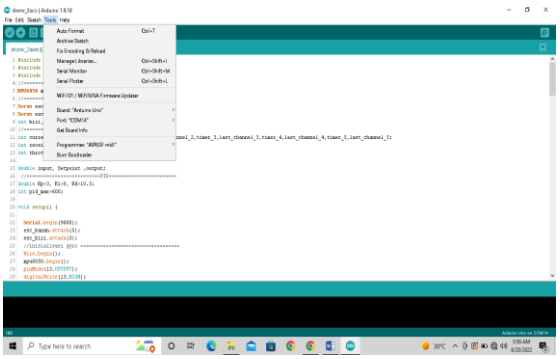

Figure 6. System coding

Figure 7 shows the display when connecting the USB to the laptop and when selecting the port to upload the program. Next, upload the program using port 14 to upload the program.

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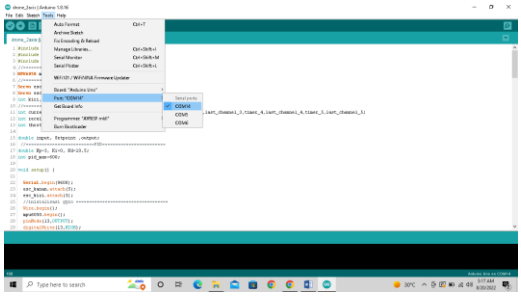

Figure 7. Program Upload

Then click the check mark at the top left to verify whether the program you want to upload is correct or still wrong. If it is correct, the next step is to upload the program. If it has been uploaded, a description will appear as in the following image.

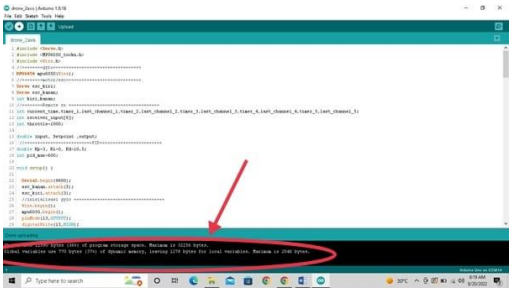

Figure 8. The program image has been uploaded

3.5 System Testing

System testing is carried out in accordance with the device specifications used in system design. The following is a picture of a bicopter or RC aircraft system design test.

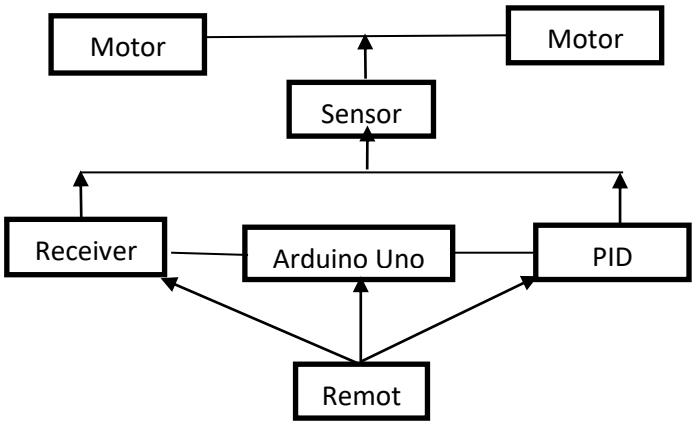

Figure 9. Diagram of the Bocopter aircraft testing system

How to control the angle of an RC plane using the PID (Proportional Integral Derivative) control system which is used so that the RC plane can be balanced, the components used are the motor, propeller, ISC (electronic speed control), angle sensor (NPU 6050), processor (Arduino Uno), Flysky remote (as transmitter), receiver is the transmitter receiver and this will be used to regulate the rotation speed. To adjust the tilt it uses two propellers so this model is usually called a becopter aircraft. The function of the controller is to make it balanced so that it is easy to control, so when we want a tilt angle of, say, 40°, this tilt will be monotonous at 40° and try to be stable at the 40° position. If there is intervention from the wind, the plane will stabilize at the appropriate 40° position. with those set via remote control. The function of the sensor is to determine whether the angle set is appropriate or not at the 40° position. When it is at the 40° position, the processor

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will try to stabilize the position so that it is at 40°. If the tilt position is greater than 40° or is tilted too downwards or to the right, it will try to change more quickly so that it can rise again to stabilize the angle at the 40° position.

3.6 Radar Testing

The detection tool (radar) is designed using an Arduino Uno, ultrasonic sensor, servo motor and satellite dish using wire. The operating principle of the PIR sensor is to directly interpret thermal variations caused by target (human) movement. The following is a diagram of the object detection radar system (RC aircraft and humans). The test results can detect objects (RC aircraft and humans) at a distance of 40 cm, 100 cm, up to 400 cm.

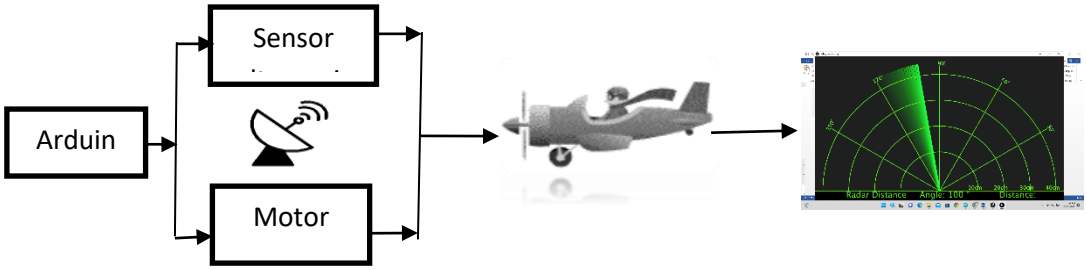

Figure 10. Diagram of the object detection radar system

Arduino is programmed with servo motors. The results of the program aim to move the ultrasonic sensor so that it can open the Arduino IDE serial monitor, as shown in Figure 11, below.

Figure 11. Servo Motor Program

After it looks like Figure 11, processing is carried out to run the program. From the programming results, the initial display will look like Figure 12, below.

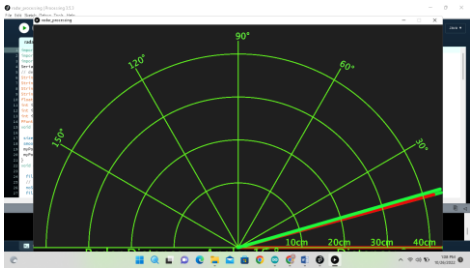

Figure 12. Display of radar programming results

In figure 12, is the initial display of the results of programming the Arduino Uno to the servo motor on the radar, explaining that no objects have been detected. In Figure 12, it shows that the object detection radar monitoring display is set at a distance of 40 cm at an inclination angle of 30^0 -150^0. If movement is detected in monitoring as in Figure 12, it can be concluded that the radar did not detect the object.

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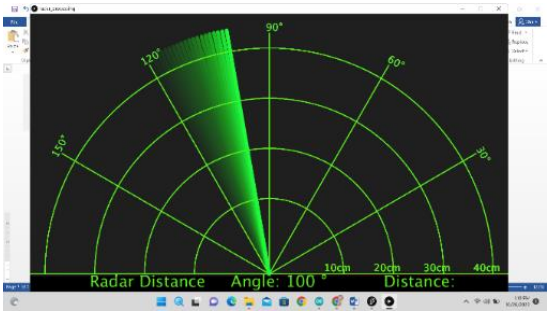

Figure 13. Display of the detector's main menu

When there is an object (RC plane and human) it is detected. As in Figure 13, it explains that an object was detected at a distance of 40 cm with an inclination angle of 150^0 which is displayed on the GUI.

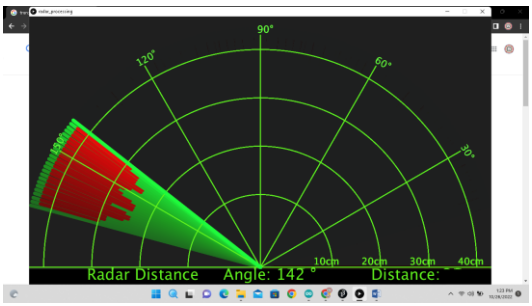

Figure 14. Object detection results

3.7 System Design Evaluation

After testing the system, an evaluation of the system design is carried out. System design evaluation is carried out on the software and hardware prototypes that are designed. Evaluation is carried out by directly observing the prototype product being designed. This evaluation is devoted to the output results of the system. So when the ultrasonic sensor designed on the radar robot detects objects (aircraft and humans), it sends data to the PC and displays the detection results.

The evaluation process is carried out in two ways, namely; 1) when there is no object passing in front of the radar, the radar does not detect anything. (2) the second evaluation is when an object (plane and human) passes in front of the radar robot at a distance of 40 cm, then the radar detects the object (plane and human) at a distance of 40 cm, 100 cm and 400 cm with an inclination angle of 30^0 -150^0.

3.8 System Implementation

Implementation is a prototype design of a theory, model with the aim of achieving something designed. The implementation stage is the stage of using the design results. In the research design, this prototype model was implemented in the development of intelligent learning systems, robotics in the hardware laboratory of the Ternate Computer Science Academy and prototypes for state defense and security detection systems.

4. CONCLUSION

This research uses a prototype method, to design an object detection system (RC aircraft and humans), the RC aircraft is designed using the main component, Arduino, while the object detection tool (radar) is designed using a servo motor and PIR and ultrasonic sensors. After designing the test results, the radar robot can detect objects (RC aircraft and humans) at a distance of 40 cm, 100 cm, up to 400 cm, with an inclination angle of 30^0 -150^0. The results of this research can be used to develop learning and prototypes for object detection for national security and defense, so that they can be developed for applied technology products.

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6. DECLARATION OF COMPETING INTEREST

We declare that we have no conflict of interest.

7. REFERENCES

Amiruddin, R; Rais, M; Sirat, M. (2018) 'Implementasi Sistem Pengontrolan Smart Parking', *Patria Artha Technological Journal*, pp. 123–132.

Ardytyan, W. B. *et al.* (2020) 'Implementasi Sistem Telemetri Pendeteksi Musuh Pada Drone S2GA Menggunakan Sensor PIR Berbasis Arduino', *Jurnal Teknik Elektro Dan Komputer TRIAC*, 7(1), pp. 5–7.

L. Renaldi, S. Hadiyoso, D. R. (2017) 'Prototipe Radar Sebagai Pendeteksi Obyek', in *e-Proceeding of Applied Science*, p. 2159.

Nabila, A. (2020) *Prototype Alat Pendeteksi Gerak Pada Sistem Keamanan Rumah Menggunakan 2 Sensor PIR Berbasis Arduino Uno - Perpustakaan UG, Perpustakaan Universitas Gunadarma*. Available at: https://library.gunadarma.ac.id/repository/prototype-alat-pendeteksi-gerak-pada-sistem-keamanan-rumah-menggunakan-2-sensor-pir-berbasis-arduino-uno-ssm (Accessed: 4 January 2022).

Priyatna, A. T. and Basry, A. (2021) 'Prototype Sistem Pengendalian Pintu Air Otomatis Dengan Menggunakan Arduino Uno', *Tekinfo*, 22(2), pp. 1–14.

Purnomo, D. (2017) 'Model Prototyping Pada Pengembangan Sistem Informasi', *J I M P - Jurnal Informatika Merdeka Pasuruan*, 2(2), pp. 54–61. doi: 10.37438/jimp.v2i2.67.

Sankar, S. and Dayanithi, D. (2018) 'The Radar System Using Arduino', *International Journal of Emerging Technologies in Engineering Research (IJETER) Volume*, 6(10), pp. 81–83. Available at: www.ijeter.everscience.org%0AThe.

Saranya, D. *et al.* (2020) 'Tracking of any intruder on territory border using 360-degree radar and sensor', in *IOP Conference Series: Materials Science and Engineering*. doi: 10.1088/1757-899X/993/1/012076.

Toyib, R. *et al.* (2019) 'Penggunaan Sensor Passive Infrared Receiver (PIR) Untuk Mendeteksi Gerak Berbasis Short Message Service Gateway', *Pseudocode*, 6(2), pp. 114–124. doi: 10.33369/pseudocode.6.2.114-124.

Wu, C. M. *et al.* (2021) 'Cooperative networked pir detection system for indoor human localization', *Sensors*, 21(18). doi: 10.3390/s21186180.

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