

IMPLEMENTATION OF ENEMY IDENTIFICATION SYSTEM USING IMAGE PROCESSING TECHNOLOGY AUTOMATIC SECURITY ROBOT

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IMPLEMENTATION OF ENEMY IDENTIFICATION SYSTEM USING IMAGE PROCESSING TECHNOLOGY ON AUTOMATIC SECURITY ROBOT

Abstract: *The Industrial Revolution brought significant advances in military technology, one of which was the development of a robotic system to improve security. Indonesia, particularly Papua, still faces armed threats. This study designed and implemented an image processing-based SS7 shield guard robot prototype to distinguish between friend and foe. The system uses a camera as a visual sensor, Raspberry Pi as a transmission center, and wireless data transmission to the guard post in real time. Tests were conducted at varying distances (2-16 meters), viewing angles (0°–90°), and light intensity (0-maximum Lux). The best results were obtained at a distance of 2-12 meters, an angle of 0°-60°, and a minimum illumination of 169 lux, with stable detection accuracy across a wide range of objects. The system demonstrated optimal performance in bright conditions and decreased at 0 Lux illumination. These findings demonstrate that the integration of hardware and image processing algorithms can support improved security for military posts and serve as an initial step towards the development of more adaptive automated security systems in the future.*

Keywords: *Guard Robot, Image processing, Enemy Recognition, Face Recognition.*

INTRODUCTION

The Industrial Revolution completely transformed the world in every aspect of life. This era was marked by rapid technological advancements and digital integration into various aspects of human activity. Major changes began to affect the way people live, work, and interact with one another (Barang et al., n.d.). Security is a key requirement of this industrial era, driven by efficiency, speed,

and improved quality across various sectors.

Unlike previous eras, the Industrial Revolution introduced high connectivity through data-driven technology and automation. Collaboration between digital devices and internet networks has enabled the system to operate remotely in real time. Several sectors, such as education, manufacturing, and healthcare, have experienced significant impacts from this

transformation. The food, textile, electronics, automotive, and chemical industries are also being pushed towards automation and digitalization (Irfansyah et al., n.d.).

Papua Province is a region where armed conflict frequently occurs. Tensions between security forces and armed groups persist in this region. Data from 2022 recorded dozens of violent incidents in Papua (2_ *This is Number of fatalities Due to violence and Armed Conflict in Papua Throught 2022*, n.d.). the conflict has caused significant losses for both the public and security forces. Armed groups such as the KKB have been accused of being the primary perpetrators of a number of these acts of violence. The attacks have targeted not only civilians but also military and police personnel. Several military posts have even targeted (4_ *TNI Confirm Kkb Terrorist Attacked Military Post in Mugi-Nduga _ Republika Online*, n.d.).

A possible solution is the use of a visual technology-based sentry robot. This robot is expected to be able to detect enemy presence quickly and accurately. The robot's visual recognition system allows identification of friend and foe through uniform patterns. Through cameras and image processing algorithms, the robot can provide direct visual information. This visual data is sent to a command post in real time to facilitate decision-making. Furthermore, this robot can

be equipped with a weapon as a form of passive defense

In practice, the system uses a camera integrated with a minicomputer; the camera's output is processed to identify color or shape patterns that match enemy criteria. The system then transmits the detection results via wireless communication. This information is displayed on a monitor located inside the guard post. With live visualization, officers can respond more quickly to emerging threats, and the robot guard design (Ananda & Dewa, n.d.). The robot's initial design was adapted for operational needs in hazardous terrain. The system was designed to operate autonomously in various lighting conditions. This research aimed to develop an effective and responsive visual-based security robot prototype.

RESEARCH METHOD

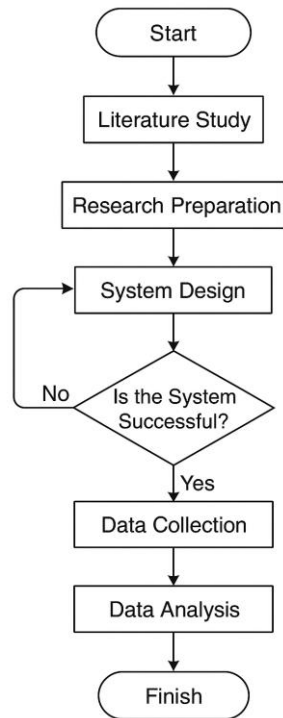


Figure 1. Research Flowchart

The research stage begins with a search for literature sources from journals and online tutorials. The information obtained is the basis for understanding the image processing system and the design of security robots. Once the literature is gathered, the researcher prepares by determining the list of tools and components, and programming the system is the main focus in this early stage. The system design is carried out using flowcharts to facilitate workflow mapping. This diagram shows the relationship between each component used, and implementation is

acknowledged in stages based on the initial design that has been prepared

The Hardware assembly process starts from the camera installation to the control system. The Raspberry Pi was chosen as the main control center in the robot system. The camera connects with the Raspberry Pi as the main visual input image processing algorithms are applied to recognize enemy and friend patterns, the output of the system is transmitted via radio wave-based transmission medium

How The System Works

For the test, the researcher calibrates the system to be responsive to different inputs. Evaluation is carried out through several testing scenarios, and data from each test is recorded and statistically analyzed. The performance of the tool is tested based on the parameters of distance, angle, and light intensity. The trial was conducted indoors with controllable lighting. Each test result is compared to initial expectations. The collected data is used to determine the

success rate of the system. Analysis also helps identify weaknesses in visual recognition. The entire process to refine the system's design and functionality. Each testing iteration results in improved robot performance. This stage culminates with initial conclusions regarding the system's overall effectiveness. An example of the results of the friend or enemy recognition process displayed on a monitor is shown in Figure 3



Figure 1. The results of the process of getting to know an enemy or friend

RESEARCH RESULTS

The Research produces a system that is able to recognize objects based on visual images. Initial testing is carried out to determine the capabilities of the tool in static conditions. The camera is positioned five meters away from the object.

a. Device performance testing

The Camera is positioned five meters away from the target object. The object tested consisted of two categories, namely

friends and enemies. The position of the object is set facing forward, side, and back. Detection is performed five times for each position to obtain average accuracy. Under all conditions, the system successfully detects the object well. The lighting of the room at the time was measured at 176 Lux. The results of this test are shown in Table 1.

Table 1. Tool performance test results

No	Condition	Detection	
		Friend	Enemy
1	Facing forward	Detected	Detected
2	Facing Left	Detected	Detected
3	Facing Right	Detected	Detected
4	Facin Rear	Detected	Detected

b. Distance change test

Furthermore, tests were carried out based on distance variations. The distance between the camera and the objects is set from 2 meters to 16 meters. The test was conducted with a camera resolution of 1920x1080 pixels. The system is capable of recognizing objects well at distances, but the accuracy begins to decrease, and the object is not detected. The results of this test area are shown in Table 2

Table 2. Distance Change test results

No	Distance (m)	Enemy Detection	Friend Detection
1	2	Detected	Detected
2	4	Detected	Detected
3	6	Detected	Detected
4	8	Detected	Detected
5	10	Detected	Detected
6	12	Detected	Detected
7	14	Not Detected	No Detected

8	16	Not Detected	Not Detected
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DISCUSSION

Based on the test results, the system has stable performance under ideal conditions. The ideal distance for object detection is in the range of 2 to 12 meters. The camera angle also affects the detection results, with the best accuracy at 0-60°. beyond those angles, the system has difficult recognizing objects accurately, which affects the accuracy of visual detection

The system failed to recognize objects in total darkness. Redetection is effective when the exposure is above 169 lux. The number of objects in the frame does not affect the accuracy of the system. The image processing algorithm used is quite effective in various test conditions. The combination of hardware and software results in synergistic performance. In general, the system performs as expected under controlled test conditions.

CONCLUSION

This research successfully designed and implemented an automated image processing-based enemy detection system. The system utilizes cameras as visual sensors, a Raspberry Pi for image processing, and video senders to display detection results in real time at guard posts. The test was carried out on various conditions such as variations in the direction of facing the object, distance of 2-16 meters, viewing angle

0°-90°, lighting from 0 Lux to maximum, and best results are obtained at a distance of 2 - 12 meters, an angle of up to 60°, and a minimum illumination of 169 Lux with stable detection performance.

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