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Implementation of an Image Processing System in Drone Battle Based on Ardupilot

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ABSTRACT
The aim of this research is to create an ArduPilot-based image processing system for drone combat that can detect, identify and track targets in real-time to improve navigation capabilities and combat strategies. This system will integrate drone hardware with image processing algorithms and cameras to detect target position and movement. Tests show that detection and maneuvering in dynamic combat conditions are better. It is hoped that this implementation will be an innovative solution for drone combat and additional applications such as surveillance and rescue missions.

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INTRODUCTION

Drones have developed rapidly in the modern era and are increasingly being used in various industries, such as photography, delivery of goods, to military and competition applications, as well as researched by Kreps (2016) ; Vergouw *et al* (2016) ; Taufik *et al*., (2018) ; Maghazei and Netland (2020) ; Javaid *et al*, (2022) ; Wang *et al* (2023) ; and also Askerbekov *et al* (2024). The use of image processing or image processing on drones to support complex and dynamic activities is one technology that is increasingly attracting attention (Akbari *et al*, 2016 ; Hassanalian and Abdelkefi, 2017 ; Munawar *et al*, 2021 ; Zhang *et al*, 2021 ; Mohsan *et al*, 2023). According to the Ebeid *et al* (2018), Cañas *et al* (2020), Peksa and Mamchur (2024), Sadraey (2024), ArduPilot, an open-source software that helps navigate and control drones automatically, is one of the popular platforms for developing drone control systems.

Image processing can be useful for ArduPilot-based drones, especially in the context of drone combat, where drones must have the ability to detect, identify, and navigate surrounding objects or enemies independently, as well as described by Kafi (2015) ; Audronis (2017) ; Kesuma *et al*., (2020) ; Abirami *et al* (2023). Drones can analyze images obtained from cameras in real-time using image processing systems (Chen, 2017). This allows drones to respond to situations quickly and effectively.

The aim of this research is to create and implement an image processing system for combat drones based on ArduPilot and provide its performance in various combat conditions (Yasa, 2022) With this system, drones are expected to demonstrate improvements in navigation, object avoidance, and target detection, which are important components for superiority in battle.

LITERATURE REVIEW

Based on Widiatmoko and Aulia (2023), and also Akbar (2024), control drones can be flown manually or automatically. If used, drones can be equipped with sensor cameras, allowing them to take pictures of their surroundings and collect visual data. After that, image processing can be applied to the image to do various things. The main goal of this research is to create an algorithm for detecting and following moving objects and apply it to drones. The first stage of this research is the development of drones and the creation of algorithms to detect and follow moving objects using the object's color features, as well as coding, indoor and outdoor experiments. The results of this research show that the algorithm and coding used can detect and follow moving objects.

RESEARCH METHOD

The aim of this research is to create and apply an Ardupilot-based image recording system for drone combat that can detect and respond to "enemy" objects in combat simulations. The process includes literature review, software and hardware design, indoor and outdoor system testing, data analysis to produce system robustness and accuracy, and documentation of results to support system development. Here are some previous authors:

a. (Abrari, 2019) : This research investigates a monitoring robot detection system that detects objects in front of it. An example is plants in greenhouse farming. In the field, observations and interviews were carried out to collect data. The resulting image is displayed on a monitor or cellphone for farmers and monitors to assess crop conditions, predict harvest time, and ensure that crops are growing well. Additionally, when manual monitoring is not possible during the day, this system helps farmers integrate more easily.
b. (Sinaga and Sinurat, 2022) : monitors parking lots with the Viola-Jones method, which improves detection performance with the Adaboost algorithm. This method is faster than pixel-based systems in classifying objects in images based on their features. The end result is data about occupied and empty parking locations.
c. (Yuliani, 2022) Object tracking allows tracking the position of objects using the Mean Shift method, which is simple and cheap. Research shows that this technique can track objects non-rigidly at a certain speed, but requires manual object selection and does not apply ROI cropping to lighten the computation. For efficiency, the research developed an automatic tracking system that uses Mean Shift with a Raspberry Pi and a servo motor to automatically move the camera within a 180° range with an ROI.

RESULT AND DISCUSSION

Development of Object Detection Algorithms: Image processing based algorithms have been used successfully to detect object targets in drone combat. This algorithm has the ability to recognize certain colors and patterns on objects according to predetermined parameters. Once the algorithm is optimized, the object detection speed and object

recognition accuracy increase, allowing for faster response to enemy movements.

Photo Processing System Integration with Ardupilot: Data synchronization between the camera module and the drone control system allows successful integration between the two. Test results show that synchronization works well and the drone can detect and lock on targets during combat.

Camera Performance and Data Processing: Cameras installed on drones have the ability to capture real-time images, which are then processed by a mini-computer module, such as a Raspberry Pi, to recognize targets in a short time. Tests show that the process of sending images does not interfere with the drone's control, ensuring the drone remains stable during maneuvers.

CONCLUSION

The results of testing the image processing system on an Ardupilot-based drone show that this system is successful in detecting and tracking targets with very high speed and accuracy, especially in indoor conditions. However, for outdoor use, lighting must be improved so that the system can operate properly in a variety of environmental conditions.

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