Chapter 2
A Drone System With Vison for Fishing Activity Detection

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ABSTRACT

Illegal, unreported, and unregulated (IUU) fishing is a major threat to marine ecosystems. The local economies also affected by IUU. Traditional methods of monitoring fishing activity are often costly, labor-intensive, and only cover limited areas. To address these limitations, this study introduces a compact, low-cost aerial surveillance system that detects fishing boats and fishing gear using drone-mounted vision system. The system consists of a Raspberry Pi 4 (8GB ram version), coupled with a high-resolution Pi Camera and integrated with a LinkIt ONE board for GPS positioning and GPRS-based communication provider. A lightweight object detection model (YOLOv8n) is deployed on the Raspberry Pi to identify boats and fishing gear from aerial video footage. Each detection is geo-tagged using real-time GPS data and transmitted to a remote server/cloud. The LinkIt ONE's GPRS (cellular) module provides data transmission connectivity. It also supplies GPS data to the system for accurate positioning. This system is designed for efficiency and runs on low power. The computational overhead of the system is very low. It supports near-real-time detection at about 3 frames per second during daylight. The solution is suitable for coastal areas and protected marine areas. It can be used in inland waters (rivers or large fisheries) if necessary. The system supports both enforcement agencies and fisheries conservation programs. The vision-based system can effectively detect fishing activity. Overall experimental results show the reliable performance of the system. The overall cost is much lower than traditional aerial surveillance methods.

1. INTRODUCTION

Fishing is a critical economic and subsistence activity for many coastal and inland communities. However, illegal, unreported, and unregulated (IUU) fishing undermines sustainable fisheries and threatens marine biodiversity. It also contributes to billions of dollars in economic losses worldwide each year. Effective monitoring of fishing activity is important for enforcing environmental regulations and protecting marine ecosystems. However, traditional methods, such as patrol boats, manned aerial surveys, and satellite imaging are often expensive and time-consuming. They are also constrained by

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weather conditions and gaps in spatial coverage. Drones have recently gained attention as a cost-effective alternative for surveillance of inland and marine waters. Their capacity to operate at low altitudes and maneuver easily through complex or remote areas, making them ideal for localized monitoring. A comparison of drone-based methods with traditional methods is given in Table 1.

However, drone-based patrolling is insufficient without intelligent detection systems. Manual video inspection is labor-intensive and prone to errors. There is a growing need for autonomous, onboard systems that can detect and classify fishing activities from aerial footage (Rodofili et al., 2022; AI To Combat Illegal Fishing and Enhance Vessel Tracking, 2024).

This study addresses that need by developing a lightweight, drone-compatible detection system using the Raspberry Pi 4 and others sensing module. The system focuses on identifying two types of fishing activity: fishing boats and fishing gear (nets, rods, floats). By integrating a compact object detection model with GPS and GPRS modules (via LinkIt ONE development board), the system can geo-tag and transmit detections in near real time.

The main objectives of this work are as follows,

- To develop a low-cost, self-contained vision-based detection system deployable on drones
- To detect fishing boats and fishing gear using tuned deep learning models for edge hardware
- To integrate GPS tracking and remote communication for real-time situational awareness
- To develop web-based ground station for information visualization

This chapter presents the system's design, methodology, model architecture, and field performance. This system emphasizes accessibility, portability, and minimal hardware requirements. It is designed to be useful for governments, NGOs, and local authorities working to improve marine and inland water surveillance. This article also highlights the business value of the proposed system and its alignment with the Sustainable Development Goals (SDGs).

The chapter proceeds as follows. Section 2 reviews related studies, and Section 3 provides a detailed system overview. Section 4 explains the methodology, while Section 5 discusses the dataset, training process, and model architecture. Section 6 presents the ground station/controlling station with controlling mechanism. Section 7 reports experimental results and evaluation. Field tests outcomes are discussed in Section 8, followed by expert insights in Section 9. The alignment with the SDGs in Section 10. Business implications and challenges are addressed in Sections 11 and 12, respectively. Finally, Section 13 concludes the chapter and discusses future directions.