Real-Time Vision-Based Violence Detection for Unmanned Aerial Vehicle Surveillance

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Abstract

Unmanned aerial vehicles (UAVs) are increasingly being used for public safety, crowd surveillance, and emergency response. However, current surveillance systems rely significantly on manual observation, resulting in slower response times and worse situational awareness in dynamic contexts. This research describes an intelligent UAV-based threat detection system that combines real-time computer vision, multi-dataset training, behavioural analysis, and self-guided navigation.

To improve robustness under different environmental conditions, the proposed system incorporates object detection, human activity recognition, and aggression classification models trained on a variety of UAV and surveillance datasets. Person identification, crowd monitoring, recognising harmful behaviour, and classifying real-world violence are examples of detection tasks. A multi-stage pipeline is built with deep learning architectures designed for lightweight deployment and near-real-time inference.

To improve operational autonomy, the system incorporates obstacle avoidance with distance sensors (VL53L0X Time-of-Flight modules) controlled by an ESP32-C3 microprocessor. This allows for safe navigation in crowded settings while preserving visual tracking capabilities. The architecture also includes UDP-based communication to enable real-time data sharing and system collaboration.

Experimental results show that multi-dataset training increases generalisation across a variety of scenarios, while lightweight model configurations maintain practical inference speeds suited for UAV deployment. The system's goal is to provide a scalable, cost-effective alternative to standard fixed surveillance infrastructure, with possible applications including stadium security, public events, emergency monitoring, and perimeter defence.

This study presents a modular and adaptable UAV intelligence framework that combines computer vision, embedded systems, and autonomous robotics to detect real-world threats.