Islamic University of Lebanon

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Embedded Systems Project

Drone Detection And Protection

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ELBC803 Microprocessors and Microcontrollers

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**1.Introduction:**

This project aims to develop an embedded system that detects drones using the YOLOv8 model and responds by aiming a laser pointer at the detected drone. The system processes real-time video feeds to accurately detect drones, transmits detection data to an Arduino, and controls a servo motor to target the drone with a laser pointer. The project demonstrates the integration of AI with embedded systems, offering an accessible solution for drone detection and mitigation.

**2.Literature Review:**

*2.1. Drone Detection Technologies:*

Traditional drone detection methods, including radar, radio frequency (RF) analysis, and acoustic detection, each have their strengths and limitations. Radar can detect drones at long ranges but struggles with small, low-flying drones and can be expensive. RF analysis detects communication signals between drones and their controllers but is ineffective against autonomous drones. Acoustic detection identifies drone motor sounds but is less reliable in noisy environments.

*2.2. Computer Vision and AI for Drone Detection*

Advances in computer vision and artificial intelligence have led to the development of efficient and accurate real-time drone detection systems. Convolutional Neural Networks (CNNs), particularly the YOLO (You Only Look Once) models, are widely used for their speed and accuracy. YOLO models process images in a single pass, making them suitable for real-time applications. The latest version, YOLOv8, features improvements in architecture and training techniques, enhancing its detection performance. The model features a deeper network with more convolutional layers, allowing it to capture finer details and improve accuracy. Additionally, it uses advanced training strategies such as data augmentation and transfer learning to generalize better across diverse datasets. Recent studies have demonstrated the effectiveness of YOLOv8 in various object detection tasks, including drone detection, where it has shown superior performance in terms of both precision and recall.

*2.3. Embedded Systems for Real-Time Applications*

Embedded systems are critical for implementing real-time drone detection and response mechanisms due to their low power consumption and ability to interface with various sensors and actuators. Arduino microcontrollers, in particular, are widely used for their simplicity, versatility, and strong community support. Combining an Arduino with a servo motor provides an effective way to create responsive systems that can track and target moving objects. Prior research has demonstrated the feasibility of using Arduino-controlled servo motors for various applications, including automated targeting systems and robotic arms.

**3.Problematic:**

The rapid increase in drone usage for various applications has raised significant security and privacy concerns, with unauthorized drones posing threats to sensitive areas. Traditional detection methods like radar, RF analysis and acoustic detection are often costly and complex, particularly for small, low-flying drones. Advances in artificial intelligence and computer vision, such as the YOLO (You Only Look Once) models, provide real-time detection capabilities suitable for embedded systems. There is an urgent need for a cost-effective, efficient, and reliable system capable of detecting drones in real-time and responding promptly to mitigate potential threats. This project addresses these challenges by integrating advanced AI-driven detection with responsive embedded systems, ensuring both accuracy and affordability while adhering to safety and ethical standards

**4.Methodology:**

In this project, the work will be divided into two parts:

1. Software
2. Hardware

For the software part, we will train an AI model to detect drones and then send data from this model to the hardware to aim the protection system at the center of the drone. We will use YOLOv8 for the detection and Python to communicate with the hardware.

For the hardware part, we will receive the data sent from the software and convert it into motion to aim at the center of the drone. We will use an Arduino for this purpose along with two servo motors (one for horizontal movement and one for vertical movement). Additionally, we will need a laser to target the drones accurately.

**5.Implementation:**

First, we prepared a virtual environment to train the model and run the project using Anaconda3. We created a virtual environment and installed all necessary dependencies.

Next, we gathered drone images from the internet, ensuring a variety of drone types, angles, and backgrounds.

After collecting the images, we labeled them using a tool called "LabelImg," which we installed in the Anaconda environment. We opened each photo in the "LabelImg" tool, created a class called "drone," drew a box around each drone, and assigned it to the "drone" class. To ensure compatibility with YOLO, we chose the YOLO format for labeling.And with that we prepared the dataset we will be going to use in the training.

Then we used YOLOV8 nano to