A COMPUTER VISION APPROACH FOR REAL-TIME DETECTION OF WILDFIRE AND HUMANS AMIDST IT

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MOTIVATION / INTRODUCTION

- The current increasing trend in rising temperatures and resulting wildfires necessitates the automation of early detection and rescue processes mitigating human interference.
- The monitoring systems that use ground-based methods fall short since they lack comprehensive coverage and they take time to detect fires and involve human risks during inspections a result UAVs are widely preferred.
- This project focuses on implementing an aerial monitoring system consists of the YOLOv8 and EfficientNetV2 deep learning models to detect smoke, fire along with human presence in video sequences including preprocessing techniques.

OBJECTIVES

- The objective is to integrate the real time object detection using the deep learning model such as YOLOv8 and EfficientNetV2B0 to identify correctly fire, smoke and the presence human in the live drone footage or webcam streams.
- The goal is to optimize these models for both performance as well as efficiency to allow the solution to be deployed on the real time inference speed without sacrificing any detections accuracy, and thus to be suitable for deployment on lightweight edge devices.
- A key goal is to develop an anomaly detection mechanism based on heatmaps to detect abnormal temperature spikes at a stage before smoking or pre-smoke, something that is critical for proactive mitigation.

SCOPE OF THE PROJECT

This project explores the use of a vision based detection model to detect fire, smoke, and presence of human in video frames using combination of YOLOv8 and EfficientNetV2B0 and also real time temperature mapping for identifying the anomalous heat zones within thermal imagery.

The system also includes an integration between an ESP8066 and an MQ135 sensor to record and send air quality information that is visualized on a cloud platform like ThingSpeak for monitoring air pollutants raised by firebreaks.

METHODOLOGY

The methodology employs YOLOv8 and EfficientNetV2B0 along with generation of temperature intensity map of corresponding input RGB image with voice detection and MQ-135 Sensor integration on ESP8066 Microcontroller with alert generation via Email.

- Extracting the Spectral, Spatial and Temporal features from the input Image/ Video frames and fusing it together via weighted sum technique before feeding it into the Model.
- Train the YOLOv8 and EfficientNetV2B0 with the Acquired Dataset.
- Apply model optimization methods such as quantization and L1 Structured pruning to reduce the resource and memory usage, and speed up the process.
- The integration of the sensor and microcontroller to obtain and record air quality that is visualized on Thingspeak platform.
- The noise filtering, voice detection and speech to text modules are part of the acoustic subsystem followed by the delivery of human audio identification real time email alerts for designated contacts.

ARCHITECTURE

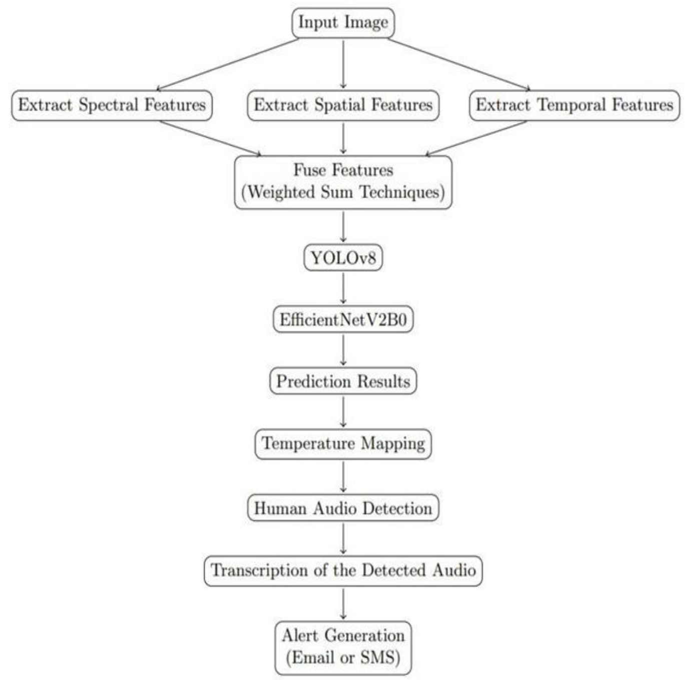

Fig.1: Model Architecture

RESULTS

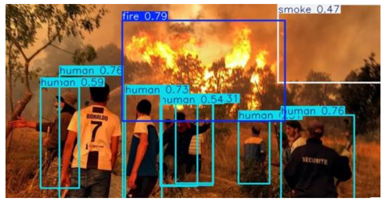

Fig.2: Prediction of YOLO Model

Fig.3: Generated Temperature Map

METRICS	VALUE
Train/Box Loss	0.73
Train/Class Loss	0.43
Train/DFL Loss	1.10
Val/Box Loss	0.50
Val/Class Loss	0.40
Val/DFL Loss	0.95
Precision	0.87
Recall	0.79
mAP50	0.83
mAP50-95	0.68

Table 1: Evaluation Metrics

CONCLUSION

This project successfully demonstrated the implementation of the Enhanced Model with Preprocessing techniques and compared with a baseline model's prediction results without the employment of any preprocessing or optimization Techniques.

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