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Fire and Smoked Detection from CCTV footage using Deep Learning

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Abstract: *This Project aims to Detect and alert Specified user on an event of Fire or smoke for public saftey. It uses Deep learning and computer vision .It uses Twilio module to sent SMS notification to specified user .The successful implementation of this project can drastically reduce human intervention , save time and resource usage and improve the effectiveness of public safety measures.*

Keywords*:* computer vision, opencv, fire and smoke detection,YOLOv8,AI surveillance system

I. INTRODUCTION

To guarantee public safety and avoid property damage, fire, and smoke detection is an essential responsibility. Utilizing customised datasets, recent computer vision and deep learning developments have made it possible to construct precise fire and smoke detection systems. YOLOv8, a cutting-edge object identification model that can be trained on a specific dataset to identify fire and smoke, is one such system.

When used with customized datasets, YOLOv8 is a potent tool for smoke and fire detection systems in buildings. It is a viable option for real-world applications that need quick and effective fire and smoke detection because of its speed and precision. For instance, the YOLOv8 code is supplied for monitoring and identifying flames and smokes in real-time video. The project has the ability to accurately detect fire and smoke in real-time video and send an SMS to the predetermined phone number. On a specific dataset, the YOLOv8 model may be adjusted to increase detection and tracking performance.

II. PROPOSED SYSTEM

The proposed system provides live monitoring of the scene to ensure human safety by providing alert to the user on an event of fire or smoke .It uses the advanced architecture of YOLOv8 to offer recognition and detection of fire or smoke from a footage with high fps .Implementation of the project on a public space enables high safety and security for the individuals as well as the properties .

III. METHODOLOGY

The methodology for the system comprise of several steps .collecting the CCTV footage from a CCTV camera. Preprocessing the video to suitable size for the Yolo architecture. The model then analyse the footage frame by frame for any potential threat of fire ,if any,it will sound an alarm and send notification to user by SMS .we can set confidence level according to scene it is analysing which lets decrease the chance of false positive triggering

The procedure of the proposed model is described in the following points:

1. **Collect and annotate the dataset**

Collect a dataset of images containing fire and smoke. Annotate the images by marking the regions of interest that correspond to fire and smoke. The annotated dataset can be created using tools like RoboFlow or Labelimg. Split the dataset into a training set and a validation set for use in the training process . The dataset used in this project is collected and prepared from scratch

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2. **Setup YOLOv8 environment**

Install the necessary packages and set up the environment for YOLOv8. Ultralytics YOLOv8 is developed in PyTorch and can run on both CPU and GPU.

3. **Train the YOLOv8 model**

Train the YOLOv8 model on the custom dataset of fire and smoke images. Use the training set for training the model and the validation set to evaluate its performance during the training process. Adjust hyper parameters as needed to optimize the model's performance.

4. **Evaluate the model**

Evaluate the trained model on the validation set by running the evaluation script. The script will output the mean Average Precision (mAP) score for the validation set, which is a measure of how well the model is able to detect the objects of interest in the validation set.

IV. SYSTEM ARCHITECTURE

The system comprise of several layers. Data collection step consist of CCTV camera which capture live video and fed into the model file we are trained in custom dataset .The feed footage has been preprocessed by the system so it could be analysed by the model. we adjust each frame size .YOLO model receives 224x224 frame size. We have dataset which has been made by scraping from the web .Then we split the dataset into test and train .we use train dataset to train the dataset and we use test dataset to evaluate hte performance of the created model. Once model achieve a promising performance we deploy the model to ant y system we want and the system will be ready to analyse real-time scenes from CCTV .It will sound an alarm and send SMS notification to user on an event of fire or smoke.

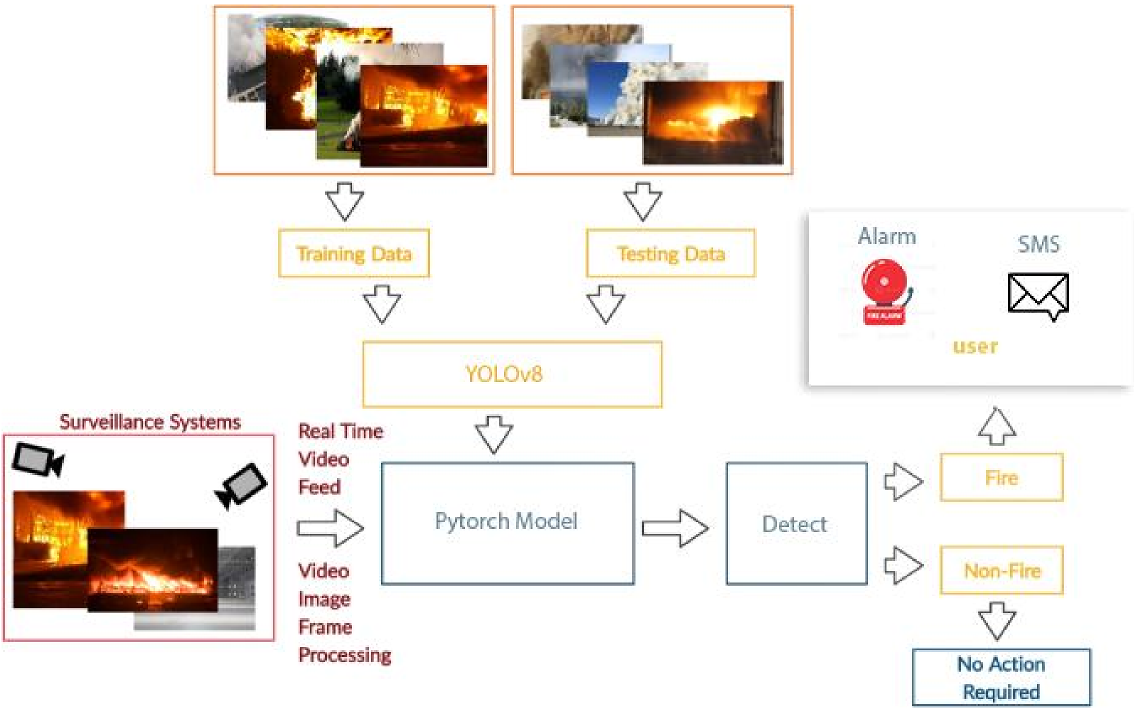


Fig1 System architecture

V . ALGORITHM IMPLEMENTED

YOLOv8 from Ultralytics is a groundbreaking object detection algorithm that combines state-of-the-art techniques to achieve remarkable speed and accuracy. Its advanced architecture, improved accuracy, and versatile capabilities make it a preferred choice for real-time object detection tasks. Ultralytics' dedication to pushing the boundaries of AI research has resulted in an algorithm that empowers researchers, developers, and organisations to create innovative applications in computer vision and beyond.

VI. RESULT AND ANALYSIS

Dataset

The dataset used in this project is a combination from different sources .mainly the dataset consist of above 5000 images of fire and smoke scenarios . The dataset is created by scraping images from the web.4000 images for training and 1000 images for testing the modal performance. Also got some images from kaggle . Kaggle is an online community and platform that provides a collaborative environment for data scientists, machine learning practitioners, and AI enthusiasts. Founded in 2010, Kaggle has grown into one of the most prominent platforms for data science competitions, datasets, and machine learning resources.

Training Result

YOLOv8 has shown to be a promising solution for real-time fire and smoke detection in various indoor and outdoor scenarios. The lightweight architecture of YOLOv8 allows it to be deployed on low-cost, low-performance hardware such as NVIDIA Jetson Nano, making it suitable for embedded applications. When compared to other object detectors, such as R-CNN and Fast R-CNN, YOLOv8 is significantly faster, achieving up to 25 times higher speed in fire and smoke detection.

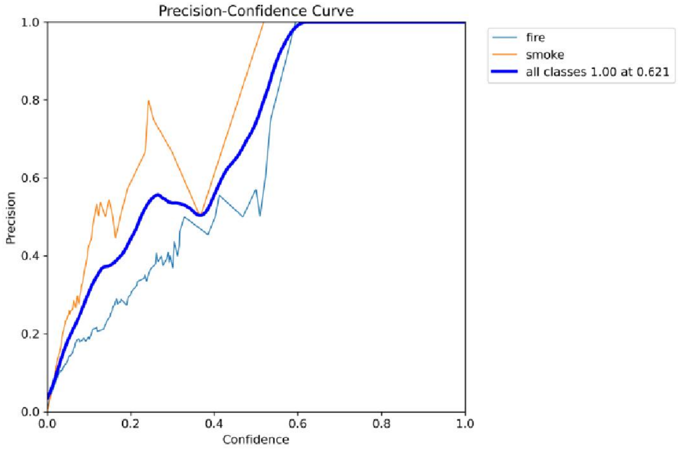
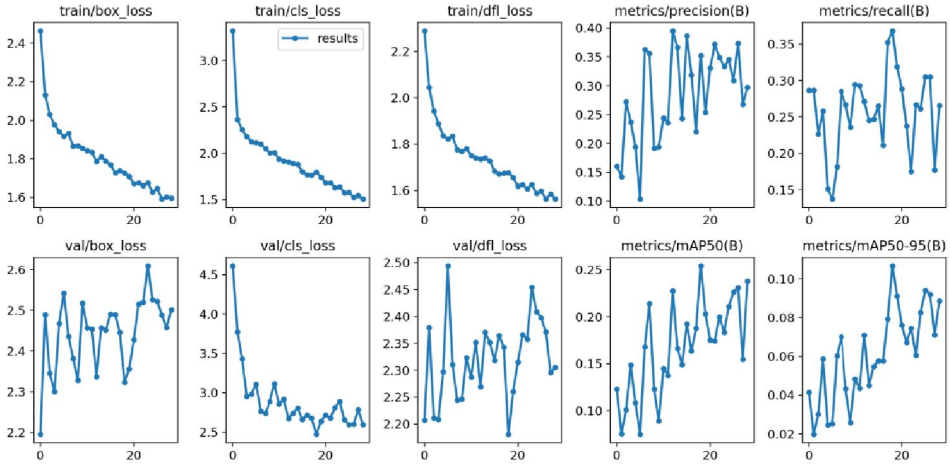


Fig3 .different metrics



Sample screenshots

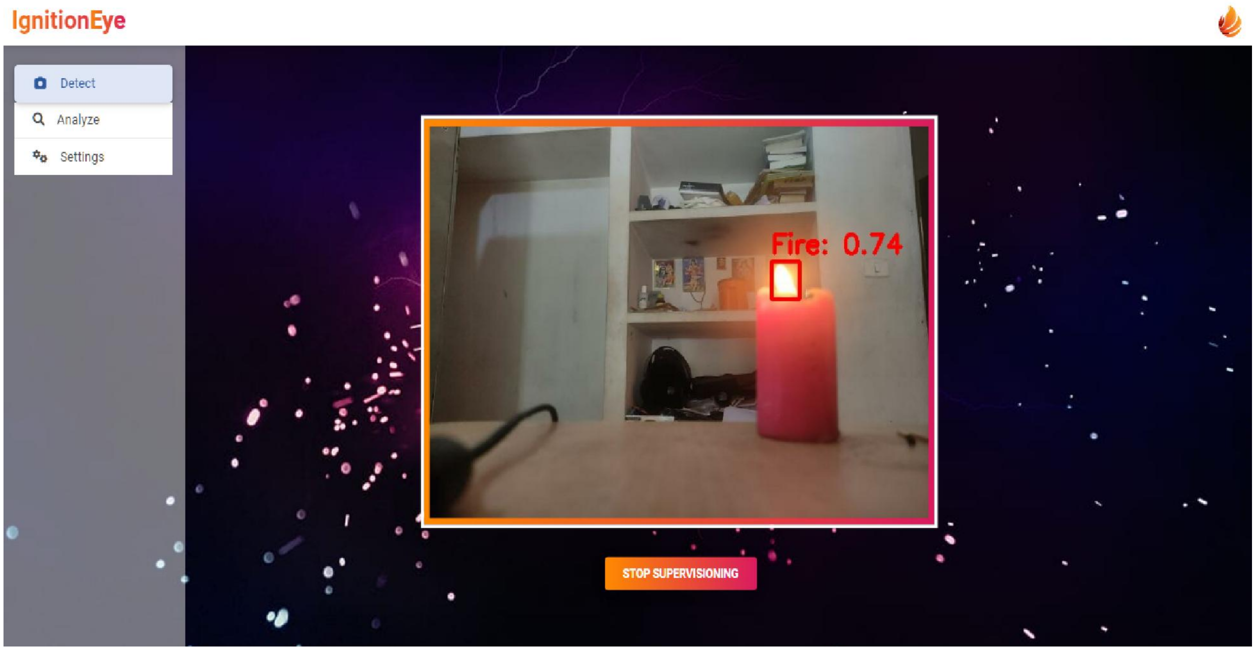


Fig 4.sample output of fire detection

VII. CONCLUSION

In conclusion, The Fire And Smoke Detection system shown promising performance for detecting fire and smoke .It has worked well on different test scenarios very well .By using the most advanced single shot detection architecture of YOLOv8 it performed well with decent accuracy on both indoor and outdoor scenarios .it sends alert to users when a fire is detected, the provided code snippet suggests using Twilio for sending SMS notifications and Pygame for triggering sound alarms. These alert mechanisms can help in providing early warnings to users, enabling them to take appropriate actions to mitigate the risks associated with fire incidents.

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