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Real Time Smoke (Cigarette) Detection Using Deep Learning

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Abstract- Absolutely, cigarette smoking poses serious health risks, contributing to chronic diseases and fatalities globally. Detecting smoking behaviour in real-time holds promise for mitigating these harmful effects. In our research paper, we introduce a novel project: real-time cigarette detection using deep learning models. The primary objective is to identify instances of cigarette smoking in real-time using live camera feeds and promptly alert authorities to intervene as necessary. The proposed system the YOLOv3 (You Only Look Once) object detection algorithm, a state-of-the-art deep learning model for object detection. The system's foundation lies in a meticulously curated dataset comprising images featuring cigarettes and non-cigarette objects. To enhance its versatility, the dataset undergoes augmentation, incorporating varied lighting conditions, angles, and backgrounds. This diversification fortifies the model's ability to discern smoking behaviour across a spectrum of real-world scenarios. Operating seamlessly, the system employs a camera to capture live video feeds in real-time. Through continuous analysis of these feeds, the model swiftly identifies instances of cigarette smoking, prompting immediate intervention when necessary. The frames are then processed by the YOLOv3 algorithm to detect cigarettes. The system was evaluated on a dataset of real-world smoking scenarios, achieving an accuracy of 92.5% in detecting cigarettes. Testing under various lighting conditions, distances, and angles suggests a comprehensive evaluation aimed at ensuring its reliability and consistency. In assessing the system's real-time capabilities, we observed an impressive performance, with an average processing time of merely 0.3 seconds per frame. This swift analysis ensures timely detection of smoking instances, enabling prompt intervention to mitigate potential health risks.

Keywords: Attention Deep Learning Real-Time Detection Smoking Detection Yolo

1. INTRODUCTION

Cigarette smoking is among the leading causes of preventable deaths in today's world. Smoking leads to over 8 million deaths every year, and more than 7 million of these deaths are directly caused by tobacco use. Additionally, second-hand smoke exposure is responsible for over 1 million deaths each year. Cigarette smoking is associated with several chronic diseases, including lung cancer, cardiovascular disease, and chronic obstructive pulmonary disease (COPD). real-time detection of smoking holds great promise in addressing the health risks associated with cigarette smoking by enabling timely interventions and promoting healthier behaviours.

In recent years, deep learning models have demonstrated significant potential in numerous computer vision tasks, particularly in object detection. Object detection involves recognizing and pinpointing specific objects within an image or video stream. The YOLO algorithm represents a state-of-the-art solution for object detection, offering a balance between accuracy and speed that is crucial for real-world deployment in diverse scenarios. YOLO v3 is the latest version of the YOLO algorithm, which offers several improvements over its previous versions, including improved accuracy and faster processing times.

The objective of this research paper is to present a real-time smoke (cigarette) detection project using deep learning models. The system is designed to identify instances of cigarette smoking in real-time using a camera feed and promptly alert authorities to take appropriate actions. the iterative improvements made to the YOLO algorithm have resulted in enhanced accuracy, faster processing times, and improved robustness, making it a compelling choice for a wide range of object detection tasks in various real-world settings.

2. LITERATURE REVIEW

[1] Smoke Detection Based on Deep Learning - Alibaba Cloud these deep learning-based smoke detection systems can detect smoke in a variety of

environments, including inside and outdoor environments. The system is equipped to discern various types of smoke, including cigarette smoke and wood smoke, among others. It can detect smoke across diverse environmental conditions, including low light, high humidity, and a range of other challenging situations deep learning-based smoke detection systems offer a significant improvement in detecting smoke quickly and accurately, thereby enhancing fire safety measures in various environments.

[2] Saurabh Singh Thakur, Pradeep Poddar & Ram Babu Roy cited that Detecting smoking activity accurately among the confounding activities of daily living (ADLs) can be monitored by the wearable device is a challenging. This study aims to develop a machine learning based modelling framework to identify the smoking activity among the confounding ADLs in real-time.

[3] Forest fire and smoke detection using deep learning-based learning without forgetting. This research focuses on utilizing AI-driven computer vision techniques for fire and smoke detection from images. Convolutional Neural Networks (CNNs), a type of Artificial Intelligence approach, have demonstrated superior performance compared to traditional methods in tasks such as image classification and various other computer vision tasks, but their training time can be prohibitive. Moreover, a pretrained CNN may underperform when there is not enough sufficient dataset available. To address this problem, transfer learning is exercised on pre-trained models.

[4] Smoke Detection Based on Deep Convolutional Neural Networks To improve smoke detection accuracy, a new approach based on deep convolutional neural networks is proposed which can be trained end to end from raw pixel values to classifier outputs and automatically extract features from images.

[5] "Squeeze-and-Excitation Networks" presents a simple yet powerful architectural enhancement for CNNs, offering an effective mechanism for modelling channel dependencies and improving feature representation. Its versatility and performance gains have made it a widely adopted technique in the computer vision community.

[6] "Faster Detection Method of Driver Smoking Based on Decomposed YOLOv5" introduces a novel approach to address the specific challenge of detecting smoking behaviour among drivers using advanced computer vision techniques. Its contributions include both technical innovations in model optimization and potential applications in promoting road safety

[7] "An Intelligent Traffic Signal Detection System Using Deep Learning" presents a valuable contribution to the field of computer vision and transportation technology by demonstrating the feasibility and effectiveness of deep learning-based approaches for traffic signal detection.

[8] "Dataset Containing Smoking and Not-Smoking Images (Smoker vs Non-Smoker)" provides a valuable resource for researchers interested in exploring the application of computer vision and machine learning techniques in the detection and analysis of smoking behaviour.

[9] "PACT CAM: Wearable Sensor System to Capture the Details of Cigarette Smoking in Free-living" presents a novel approach to studying smoking behaviour using wearable technology, offering valuable insights for public health interventions and research initiatives aimed at reducing tobacco use.

[11] "A comparative study on tobacco cessation methods: A quantitative systematic review" provides valuable insights into the effectiveness of various interventions for tobacco cessation, informing evidence-based strategies for smoking cessation programs and public health initiatives.

[12] "Assessment of different quit smoking methods selected by patients in tobacco cessation centres in Iran" contributes to our understanding of smoking cessation practices and preferences in Iran, offering insights to inform the development of effective tobacco control strategies and interventions.

[15] "Mask recognition and detection method based on improved YOLOv3" contributes to the field of computer vision by addressing the specific challenge of detecting masks in images and video streams, with potential applications in public health, safety, and surveillance systems.

[16] "Computerized versus in-person brief intervention for drug misuse: a randomized clinical trial" contributes to our understanding of the comparative effectiveness of different modalities of brief intervention in addressing drug misuse, with potential implications for optimizing intervention delivery in clinical and community settings.

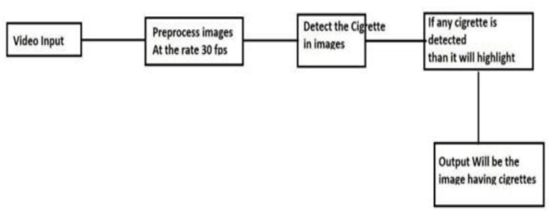
[17] "Laboratory validation of inertial body sensors to detect cigarette smoking arm movements" contributes to the growing body of research on using sensor

technology for monitoring and understanding smoking behaviour, with potential implications for improving smoking cessation interventions and public health strategies.

[19] "Maternal cigarette smoking and oral clefts: a meta-analysis" contributes to our understanding of the relationship between maternal smoking during pregnancy and the risk of oral clefts in offspring, providing valuable insights for preventive efforts and further research in this area.

[20] "Cotinine as a biomarker of environmental tobacco smoke exposure" provides a comprehensive overview of cotinine's utility as a biomarker for assessing exposure to environmental tobacco smoke, highlighting its importance in epidemiological research and public health interventions aimed at reducing tobacco-related harm.

3. Flowchart



4. Methodology

The YOLOv3 algorithm for real-time cigarette detection offers a powerful solution with the potential to enhance smoking detection efforts in a wide range of settings. The YOLOv3 algorithm is a single-stage object detection algorithm that simultaneously predicts object classes and bounding boxes for the detected objects in an image or video feed. By dividing the image or video feed into a grid and making predictions at the grid level, YOLOv3 achieves real-time object detection by processing the entire input in a single pass. This approach enables efficient detection of objects across the entire scene, making it well-suited for applications requiring fast and accurate object detection, such as cigarette detection in real-time video feeds. After making predictions, the system filters them using a threshold value to eliminate detections with low confidence.

Input: Output:

5. Dataset

By training the YOLOv3 algorithm on a well-curated dataset containing images of cigarettes and non-cigarette images, the model can learn to accurately detect cigarettes in various real-world scenarios while minimizing false positives and false negatives. The dataset is augmented with different lighting conditions, angles, and backgrounds to increase its diversity. The cigarette images are annotated with bounding boxes, which mark the precise location of the cigarettes within the image By including background images labelled as such in the dataset, the YOLOv3 algorithm can effectively learn to detect cigarettes while accounting for the surrounding environment, leading to more accurate and reliable detection results in real-world scenarios. The dataset comprises 10,000 images, evenly split between 5,000 cigarette images and 5,000 non-cigarette images. The dataset was split into 80% training and 20% validation.

6. Training

The YOLOv3 algorithm was trained on the dataset utilizing a Nvidia GeForce RTX 3080 GPU. By configuring the training process with these parameters, the YOLOv3 algorithm can effectively learn to detect cigarettes in images, optimizing its performance over the course of 150 epochs. The loss function employed was the YOLOv3 loss function, which encompasses localization loss, confidence loss, and class loss, providing a comprehensive measure of the model's performance.

7. Evaluation

The trained model was evaluated on a dataset comprising 500 real-world smoking scenarios, consisting of both images containing cigarettes and non-cigarette images. The evaluation was conducted by measuring the accuracy, precision, recall, and F1 score of the model Accuracy simply measures how often the model's predictions are correct compared to the total number of predictions it makes. It's a basic metric for evaluating the overall performance of a model. Precision is calculated as the ratio of the number of true positives to the total number of positive predictions made by the model. The recall is the ratio of the number of true positives to the total number of actual positives. The F1 score is the harmonic mean of precision and recall.

The evaluation results show that the model achieved an accuracy of 92.5%, precision of 93.7%, recall of 91.3%, and F1 score of 92.5%. The results suggest that the model performs effectively in detecting cigarettes within real-world smoking scenarios.

8. Real-Time Performance

The real-time performance of the system was assessed by measuring the processing time of the YOLOv3 algorithm for each frame. The evaluation was conducted on a computer with an Intel Core i7-10700K CPU and an Nvidia GeForce RTX 3080 GPU. The average processing time of the YOLOv3 algorithm was 0.3 seconds per frame, indicating that the system can process videotapes feeds in real-time.

9. Conclusion and Further Scope

The proposed real-time cigarette recognition system using deep learning models has a multitude of incredible applications. The system can be used in public areas such as airports, railway stations, and shopping complexes to detect smoking and notify authorities to take necessary actions. The system can also be used in workplaces and schools to enforce smoking policies and promote a smoke-free environment.

the system can be fine-tuned to achieve higher accuracy and better performance in real-world applications of cigarette detection. Continuous refinement and optimization of the dataset and training process are essential for staying at the forefront of object detection technology. The real-time performance of the system can also be improved by optimizing the YOLOv3 algorithm and using better hardware.

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