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AI-Eye on Campus: Detecting Smoking through CCTV-Enabled Machine Learning

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ABSTRACT: This paper presents an innovative solution to the ongoing issue of smoking on college campuses, utilizing artificial intelligence and existing CCTV systems to monitor and detect smoking activity. By applying machine learning algorithms, we aim to develop a proactive system that fosters a healthier environment for students, staff, and faculty alike. Traditional methods of enforcing smoking policies largely depend on self-reporting and occasional patrols, which often prove ineffective as they miss real-time smoking violations. Our AI-driven system fills this gap by offering continuous surveillance and immediate alerts upon detecting smoking activity. Beyond enforcement, our system provides added value through data collection and analysis of smoking behaviors, offering insights to support tobacco prevention efforts. These data-driven insights enable the creation of targeted educational programs, support services, and policies tailored to each campus's unique needs. We believe this pioneering approach has the potential to transform how colleges and universities address smoking. By leveraging existing infrastructure and AI technology, we can build healthier, smoke-free campuses that prioritize the well-being of all community members.

KEYWORDS: Machine Learning, Computer Vision, CCTV, Smoking Detection, Health Promotion, Campus Safety..

I. INTRODUCTION

Colleges are increasingly focused on creating safe, inclusive environments for students and staff, making it essential to address smoking on campus. Smoking affects not only those who smoke but also exposes others to secondhand smoke, which has well-documented health risks. Additionally, smoking detracts from the campus atmosphere and contributes to litter, fire hazards, and higher maintenance costs. While many institutions have adopted smoke-free policies, enforcing these rules across expansive campus areas can be challenging. Ensuring compliance is difficult without effective monitoring, even with dedicated efforts.

This is where advanced AI and surveillance technology step in. Picture AI-enhanced CCTV systems that can detect smoking in real time on campus. Using machine learning, these systems analyze video feeds to identify the recognizable signs of smoking. When a potential violation is spotted, the AI can immediately notify security, allowing for quick intervention. This approach not only streamlines enforcement but also encourages greater adherence to smoke-free policies.

This research focuses on evaluating the effectiveness of AI-powered CCTV systems for detecting smoking on college campuses. We'll examine the technical capabilities, potential challenges, and anticipated outcomes of implementing this technology. Our goal is to highlight how AI-driven monitoring could promote healthier choices, minimize exposure to secondhand smoke, and contribute to safer, cleaner campus environments for all.

II. LITERATURE SURVEY

	Description
Advances in Visual Detection	Machine learning and computer vision have expanded the possibilities in visual detection, including facial recognition, object detection, and activity identification. Deep learning algorithms, particularly convolutional neural networks (CNNs), excel at recognizing complex visual patterns, such as detecting smoking, in controlled environments with minimal distractions.
Research on Deep Learning Models	Studies indicate that machine learning models, especially deep learning techniques, perform well in detecting specific activities. CNNs have demonstrated high accuracy in identifying behaviors like smoking under controlled conditions, where lighting, environment, and other variables remain consistent.
Challenges in Real-World Application	Transitioning AI-powered detection from controlled lab settings to active campus environments presents challenges. Campuses are dynamic, with varying lighting, diverse settings, and constant activity. AI models trained on clean, controlled data often struggle with false positives or missed detections in these uncontrolled environments.
Lack of Real-World Smoking Detection Research	Limited research exists on implementing AI for smoking detection in complex, real-world settings like active campuses, which present unique challenges compared to laboratory environments. This gap in research highlights the need for further exploration in adapting AI detection to less predictable scenarios.
Objective of Current Research	This study aims to explore the feasibility of deploying machine learning to reliably detect smoking on college campuses. By adjusting and enhancing AI models to process the varied and unpredictable footage from campus CCTV systems, this research seeks to create an accurate detection system capable of real-world performance.
Significance of the Study	The project will test the boundaries of existing detection models, advancing the understanding of how AI can enhance campus safety and health. By refining machine learning applications in campus environments, the research demonstrates the potential of AI to contribute to cleaner, safer spaces for everyone on campus.

III. METHODOLOGY

Our proposed system leverages existing campus CCTV infrastructure to detect smoking behaviors in real-time. By utilizing machine learning models to interpret video feeds, we provide a cost-effective solution that minimizes hardware costs while addressing the complexities of monitoring open campus environments. The system development methodology encompasses the following key stages:

- **Data Collection and Annotation:** A large dataset of CCTV footage will be curated, capturing smoking and non-smoking activities under diverse conditions (time of day, weather, indoor/outdoor locations). Frames will be annotated to label smoking vs. non-smoking behaviors, and the dataset will be split for training, validation, and testing.
- **Model Selection and Training:** State-of-the-art computer vision algorithms (CNNs, RNNs, vision transformers) will be explored for their ability to identify subtle smoking cues. Multi-task learning and transfer learning techniques will be employed to adapt pre-trained models to the specific smoking detection task.
- **Preprocessing and Data Augmentation:** Normalization, contrast enhancement, and noise reduction will be applied to ensure consistent input quality. Data augmentation techniques (rotation, scaling, color adjustments) will be used to simulate varying environmental conditions.
- **System Architecture Design and Real-time Processing:** An end-to-end pipeline will be designed, integrating dedicated or cloud-based processing to handle computational demands. A motion-triggered system will focus analysis on relevant motion detection to optimize performance.
- **Alerting and Response Mechanisms:** Upon smoking detection, alerts will be generated for campus security via a monitoring dashboard, mobile app, or email. The dashboard will include time-stamped video snippets for verification. Privacy-preserving protocols (e.g., blurring non-targeted individuals) will be implemented to address surveillance ethics.

Additional Features for Enhanced Functionality

To further enhance the system, the following features will be considered:

- Heatmaps: To track high-frequency smoking areas and inform policy or interventions.
- Predictive Analytics: To identify likely times and locations of smoking, guiding targeted efforts.
- Facial Recognition (if permissible): To identify repeat offenders and provide data for personalized support or education.

IV. EXPERIMENTAL RESULTS

Figures show the results of smoking detection from an CCTV and inpainting by using Machine Learning Algorithm. Figs. 1 (a) shows the original image of student smoking inside college labs and being detected by CCTV using smoking detection algorithm applied onto campus protection. Fig 2 (b) shows that watchman is smoking inside college campus and being detected via CCTV outside college thus proves that algorithm works good on both indoor and outdoor environment by detecting smoking inside college campus



Fig 1

(a)

(b)



Fig 2

(c)

(d)

Fig. 2 (a) & Fig 2(b) Shows the most common spot in campus for smoking i.e Cafetiere .It shows that it is able to detect smoking in heavy crowded areas such as cafeteria and college hallway

V. CONCLUSION

We have implemented an innovative use of machine learning integrated with CCTV systems to encourage healthier, smoke-free college environments. By accurately identifying smoking behavior, the system can support enforcement efforts, guide the development of preventive measures, and contribute to a safer, healthier campus atmosphere. These insights will not only add value to public health strategies but also expand the current understanding of AI-driven health interventions in real-world contexts, ultimately paving the way for broader applications of technology in health promotion and campus safety initiatives..

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