Bewda Boys Cheesehacks 2023 Submission Details

Introduction

Schools are meant to be safe, nurturing environments where students can learn and grow. To ensure a secure and positive learning atmosphere, it is essential to monitor and prevent undesirable behaviors. The use of artificial intelligence (AI) in schools has the potential to significantly enhance security and safety. This project explores the use cases and implementation of an AI-based detection system designed to identify violent actions, guns, nudity, drinking, drugs, and vandalism in educational institutions.

Use Cases

1) Security Enhancement: The AI system can be deployed to improve school security. It can detect the presence of firearms or weapons in real-time, triggering alerts to security personnel and administrators, helping prevent potential threats. It can identify violent actions, such as physical altercations, and immediately notify authorities to intervene, ensuring a safer environment.

2) Content Monitoring: The system can monitor classroom activities to detect inappropriate activities, such as nudity or related to drugs and alcohol, thus promoting a more secure and focused learning environment.

3) Vandalism Prevention: The AI system can monitor security camera feeds and detect acts of vandalism or property damage. It can then alert school staff or authorities in real-time, facilitating a prompt response to incidents.

Implementation

1) Multiple Cameras: The system should be scalable to handle feeds from multiple IP cameras. This will require a robust backend system capable of real-time processing.

2) Different Locations: Account for variations in camera placement, angles, and lighting conditions to ensure consistent performance across all locations.

Response System

1) Customized Alerts: Upon detecting an anomaly, the system is programmed to generate instant alerts. These alerts can be highly customized, allowing for different responses depending on the nature and severity of the anomaly. Currently we are choosing to use a text message to a virtual phone number. The system is integrated with a communication module that can send text messages and notifications to designated first responders, including school security personnel, administrators, or local law enforcement.

2) Location Information: The alerts sent to first responders often include location data, enabling them to pinpoint the exact site of the anomaly. This information assists in quickly responding to the incident.

3) Video Clip Access: The alert could include a link to a securely stored video clip that captures the event, allowing for immediate review. This feature provides crucial visual evidence to aid responders in assessing the situation and making informed decisions

Tech Stack: Python and YOLOv7 are solid for a project like this. They're commonly used in real-time object detection scenarios and have a broad community support. We used Twilio API to send text messages.

Architecture Overview

1) Data Ingestion Layer: The system connects to multiple IP cameras to retrieve real-time video feeds. To efficiently manage these feeds, it may necessitate the utilization of a multiplexing service. Furthermore, the system should possess the scalability to accommodate an increasing number of cameras from various locations, along with the implementation of a load balancing mechanism to efficiently manage multiple concurrent threads. Additionally, the consideration of SSL termination is imperative, and deliberation should be given to determine the optimal location for its implementation within the system architecture.

2) Pre-processing Layer: Adapts to compensate for potential sources of image distortion, variations in lighting conditions, and other relevant factors as needed.

3) Detection and Classification Layer: Use YOLO or other object detection algorithms to identify objects and activities that align with predefined scenarios such as firearms or violent behavior.

4) Decision-making Layer: This process involves the filtration of identified objects and scenarios according to their associated confidence scores.

5) Alerting Mechanism: A potential solution for sending alert messages, optionally accompanied by video clips, could involve the utilization of an SMS gateway service such as Twilio.

Computer Vision Techniques

1) Object Detection: The YOLO (You Only Look Once) algorithm is an excellent choice for real-time object detection due to its efficiency and speed. Alternatively, one could also use the utilization of other algorithms such as SSD (Single Shot MultiBox Detector) or Faster R-CNN (Region-based Convolutional Neural Network), although these alternatives may exhibit slower performance in comparison.

2) Activity Recognition: To identify occurrences of actions such as vandalism or violence, it is often necessary to employ temporal models such as Long Short-Term Memory (LSTM) networks, three-dimensional Convolutional Neural Networks (3D CNNs), or Temporal Convolutional Networks (TCN).

3) Data Augmentation: Used to increase robustness to different lighting conditions and angles.

4) Optimization: It may be necessary to fine-tune the models for speed vs. accuracy trade-offs, especially given the real-time requirement.

5) Multi-threading: Considering multiple cameras, it is advisable to concurrently execute detection processes in order to enhance processing speed.

6) Action Framework - Twilio can be used for SMS alerts.

Ethical Considerations

1) Privacy : There is no personal identification of students and it only operates within the boundaries of the school.

2) Consent:Clear signage is posted in all areas under surveillance, informing the public of the technology in use. The system operates in full compliance with [relevant laws and regulations, e.g., GDPR, CCPA].

3) Bias and Discrimination: The model has been trained on a diverse dataset to minimize bias. Outside of that the model only focuses on object detection to minimize bias against humans and students.

4) Transparency and Accountability: A log of all alerts and actions taken by first responders is maintained for accountability.

5) Data Security: Strict Access Control is enforced since the owner of the surveillance camera is the only one with access to the videos.