# Project Idea

Develop an intelligent VSS capable of Intruder detection, compromised region of interest (ROI) detection, compromised Item of interest (IOI) detection, robust alert system, metadata contextual notification and remote monitoring

# Template Used

Camera Surveillance System from CM3065 – Intelligent signal processing

# Motivation/ Problem Statements

1. The Inefficiency of Human-Centric Surveillance
2. Homeowners and small-to-medium businesses (SMEs) with valuable assets often seek real-time security to prevent unauthorized access. Traditional surveillance systems primarily function as deterrents (Abdurrahman, 2017), providing post-event evidence but lacking real-time preventive capabilities (Khadse and Pardeshi, 2016). Constant human monitoring of video feeds is required to achieve real-time intervention, which is impractical and costly for many users (Khadse and Pardeshi, 2016).

**Proposed Solution:** Intruder Detection

Implement a computer vision technique based on either motion detection, object detection (Cob-Parro *et al.*, 2021), or a hybrid approach combining both, to detect motion and trigger immediate alerts.

1. In certain sensitive areas, prolonged presence may indicate potential security or operational risks. Common concerns include:

* Discovery of hidden valuable or personal items.
* Improper handling of critical equipment, increasing risk or inefficiency.
* Other security or operational vulnerabilities linked to extended presence in high-risk areas.

**Proposed Solution:** Compromised Region of Interest (ROI) Detection

A surveillance system designed to monitor specific regions of interest (ROIs) can issue alerts if an individual remains in a designated area for longer than a defined threshold. This proactive alerting mechanism serves as an early warning to help prevent suspicious activities or potential hazards.

Using OpenCV, the geometric area of an ROI can be mapped with shapes, and intruder movement can be tracked with object-tracking algorithms, such as Kalman filters, as used in Cob-Parro et al. (2021). The alert is generated based on the tracked position within the ROI and the duration of time spent there."

1. Specific items may require monitoring to detect unauthorized movement. For instance, the movement of a fixed asset like a television may indicate potential theft.

**Proposed Solution:** Compromised Item of Interest (IOI) Detection

A surveillance system that generates alerts upon detecting movement of designated items (IOIs) from their original location, allowing for quick responses to potential security breaches. Leveraging computer vision techniques similar to those used for monitoring regions of interest (ROIs), with tailored modifications, allows for effective implementation of IOI tracking and alerts.

1. Alert notifications limited to a single communication channel increase the risk of missed notifications. For example, workers on offshore oil rigs may not have access to GSM networks but can access the internet provided by the rig .

**Proposed Solution**: Robust Alert System

A multi-channel alert system (e.g., combining SMS, email, and internet-based notifications) would ensure critical alerts reach users regardless of their network restrictions, enhancing reliability and responsiveness.

In contrast, previous works by Khadse and Pardeshi (2016) and Baretto et al. (2021) primarily focused on single-channel solutions, such as email alerts, which may not meet diverse communication needs.

1. Traditional Video Surveillance systems often fail to leverage metadata effectively

* Basic alerts lack context, making it difficult for users to assess the urgency of a situation (e.g., human vs. animal intrusion).
* Limited searchability in archived footage complicates evidence retrieval, making it challenging to locate specific events in a timely manner.

**Proposed Solution:** Event Metadata Collection and Contextual Alerting

Utilize object detection techniques such as MobileNet-SSD and YOLO-v3 (as detailed in Khadse and Pardeshi, 2016), AI models can classify intruder types and provide valuable metadata descriptions to support alert precision and investigative effectiveness

Incorporate metadata within video storage systems to enable searchable archived footage based on criteria such as event time and detected object type. This functionality supports faster evidence retrieval.

1. Traditional surveillance systems consume significant storage by continuously recording, capturing uneventful footage that often complicates evidence review. This increases storage costs and makes it time-consuming to locate relevant events (Khadse and Pardeshi, 2016).

**Proposed Solution:** Optimize Storage and Review Time

1. Use motion-triggered recording to conserve storage space by saving footage only when relevant activity is detected (Khadse and Pardeshi, 2016).

1. Despite the desire for remote access to surveillance footage, privacy concerns and the risk of data breaches (Deligiannidis, 2021) have led many users to favor local storage over cloud-based solutions.

**Proposed Solution:** Secure Remote Monitoring with Privacy Protection

Design a locally hosted surveillance system that keeps video footage on-site while allowing secure remote access through encrypted channels, ensuring data privacy while enabling convenient monitoring.

Utilization of technologies like WebRTC for real-time streaming (Baretto et al., 2021) or end-to-end encryption with a web server relay node (Deligiannidis, 2021) provides a viable solution.

# **Related Work**

1. Smart video surveillance system based on edge computing (Cob-Parro *et al.*, 2021)

* The system aims to detect, track and count people movement in a surveillance area.
* It employs the MobileNet-SSD architecture for object detection.
* To enhance tracking capabilities, the researchers integrated Kalman filters into the MobileNet-SSD architecture.
* The study referenced other state-of-the-art methods for performance comparison, including ACF, PCL-MUNARO, DPOM and YOLO-v3 ( YOLO-v3 was also employed in Baretto et al.'s (2021) research).
* The discussion of existing models enriches my understanding of feasible alternatives, guiding strategic choices aligned with precise use case specifications.
* The study highlighted HOG (Histogram of Oriented Gradients) and SVM (Support Vector Machine) as popular classical approaches for people detection in video surveillance.
* These methods can be combined with techniques like Kalman filtering and PCA (Principal Component Analysis) to improve detection accuracy and efficiency.

1. An Effective Object Detection Video Surveillance and Alert System (Khadse and Pardeshi, 2016)

* This paper proposes a system that uses a motion detection algorithm to identify moving objects in the video stream and distinguishes motion from lighting changes to ensure robust detection.
* The authors utilize a method akin to frame differencing for motion detection but enhance the approach by computing histogram differences between consecutive frames instead of performing pixel-wise subtraction. They assert that this algorithm effectively distinguishes motion from variations in lighting conditions, providing a more robust detection mechanism.
* Afterwards, the SOBEL filter edge detection algorithm was utilized to enhance edges and transitions in the image.
* It utilizes the motion detected to triggers an alarm; initiate video recording for storage and an email notification for users.

1. Real-Time WebRTC based Mobile Surveillance System (Baretto *et al.*, 2021)

* The authors introduce a real-time mobile surveillance system that leverages WebRTC technology for low-latency video streaming, incorporating the YOLO (You Only Look Once) algorithm for object detection.
* The system utilizes the YOLO object detection algorithm for detecting intruder.
* The proposed solution relies on cloud-based servers to handle the computationally intensive tasks of object detection and inference, while the mobile device is responsible for capturing the video.
* This design also featured Intruder alerting by email.
* Multi-Device Access: Users can access the live video feed and inference results from multiple Android devices, allowing them to monitor events from various locations.
* WebRTC for Real-Time Streaming: The system employs WebRTC, an open-source web standard that prioritizes UDP for data transport, to establish peer-to-peer connections between the mobile device (acting as the camera) and other devices for real-time communication.

1. Remote Video Surveillance (Deligiannidis, 2021)

* Demand and Challenges
  1. The author highlight the increasing demand for video surveillance solutions driven by faster internet speeds and the affordability of cameras.
  2. Cloud-based solutions are presented as a popular alternative due to their simplicity, but the authors raise concerns about privacy and trust in third-party cloud providers.
* To enhance security, the author recommends that camera owners maintain control over encryption keys, allowing the server to function solely as a relay for the encrypted stream without the capability to decrypt it.
* The author notes that while VPNs offer a secure method for transmitting video remotely, they often require compatible hardware and software on both the client and router sides, leading to additional costs and configuration efforts.
* Multiple Access Methods: The system provides three options for accessing the remote video feed: through a web browser, a mobile app, and a command-line interface (CLI).

# References List

Abdurrahman, S. (2017) ‘Smart video-based surveillance: Opportunities and challenges from image processing perspectives’, pp. 10–10. Available at: https://doi.org/10.1109/icitacee.2016.7892400.

Baretto, A. *et al.* (2021) ‘Real-Time WebRTC based Mobile Surveillance System’, *International Journal of Engineering and Management Research*, 11(3), pp. 30–35. Available at: https://doi.org/10.31033/ijemr.11.3.4.

Cob-Parro, A.C. *et al.* (2021) ‘Smart video surveillance system based on edge computing’, *Sensors*, 21(9). Available at: https://doi.org/10.3390/s21092958.

Deligiannidis, L. (2021) ‘Remote Video Surveillance’, *Proceedings - 2021 International Conference on Computational Science and Computational Intelligence, CSCI 2021*, pp. 771–776. Available at: https://doi.org/10.1109/CSCI54926.2021.00064.

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