

SPECTRASAFE: AN AI POWERED THEATRE PIRACY DETECTOR

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ABSTRACT

SpectraSafe is an AI-powered, IoT-integrated system designed to combat movie piracy in theaters by detecting and preventing unauthorized mobile camera usage.

IT LEVERAGES :

- YOLOv10s for real-time phone detection and alert generation, enabling immediate identification of piracy attempts.
- MTCNN for high-accuracy face detection of the suspected individual holding the recording device.
- IR Flashing System (powered by ESP32) emits invisible IR light to block camera recording without disturbing viewers.
- Seat Mapping via Grid Mapping: The detected location is translated to a specific seat number, which is included in the alert message for accurate security targeting.
- Real-time Dashboard & Email Alerts: Displays detections with timestamps and captured images, while sending automated email notifications to theater security for fast action.

INTRODUCTION

Imagine sitting in a theater where behind the scenes, smart surveillance silently watches for threats. **SpectraSafe** begins with cameras installed across the hall, running YOLOv10s to instantly detect any raised mobile phone aiming at the screen. The moment a device is spotted, MTCNN—also integrated on the camera—performs real-time facial recognition to identify the individual. Simultaneously, the exact seat location is mapped using a grid system for precise targeting.

To block the act before damage is done, the system activates IR lights installed around the screen. These lights emit invisible infrared beams that interfere with the recording without affecting the viewers' experience. Meanwhile, the system captures the suspect's face, device usage, timestamp, and seat number, all of which are pushed to a real-time dashboard. An automated email is also sent to theater security, ensuring immediate action—creating a seamless, AI-powered wall against piracy, all without disrupting genuine audiences.



OBJECTIVES

- To address the growing issue of mobile phone piracy in theaters, which leads to significant revenue loss and unauthorized content distribution in the film industry.
- To support the global shift—especially in regions like India and China—toward deploying IR-based solutions to prevent camcorder recordings
- To introduce SpectraSafe as a smart, non-intrusive system that safeguards digital content while preserving the viewing experience for genuine audiences.
- To align with the initiatives of cinema operators and anti-piracy organizations (e.g., MPAA, NATO) by providing an automated, AI-driven deterrent system.
- To balance security enforcement with ethical considerations such as privacy, accessibility, and viewer comfort through intelligent automation.

LITERATURE SURVEY

PAPER TITLE	AUTHOR	CONTEXT
YOLO-compact: an efficient YOLO network for single category real-time object detection	Lu, Y., Zhang, L. and Xie, W.	The paper proposes YOLO-Compact, a lightweight, real-time object detection network for single-category tasks, achieving 86.85% AP with only 9MB model size—outperforming YOLOv3 variants.
G-cnn: an iterative grid based object detector	Najibi, M., Rastegari, M. and Davis, L.S.	The paper proposes G-CNN, an object detection method that eliminates proposal algorithms by using a multi-scale grid of fixed boxes, iteratively refined to detect objects efficiently and accurately.
DLP based anti-piracy display system	Gao, Z., Zhai, G., Wu, X., Min, X. and Zhi, C.	The paper proposes an anti-piracy system using Temporal Psychovisual Modulation (TPVM), which leverages differences between human vision and camera sensors to disrupt recordings without affecting viewers, demonstrated using a DLP® LightCrafter 4500™ prototype.

EXISTING SOLUTION

➤ **Manual Monitoring**

Traditional surveillance relies on manual monitoring, which is inefficient and time-consuming

➤ **Infrared Detection**

Infrared detection alone may not distinguish between actual phone usage and mere reflections

➤ **Security Response**

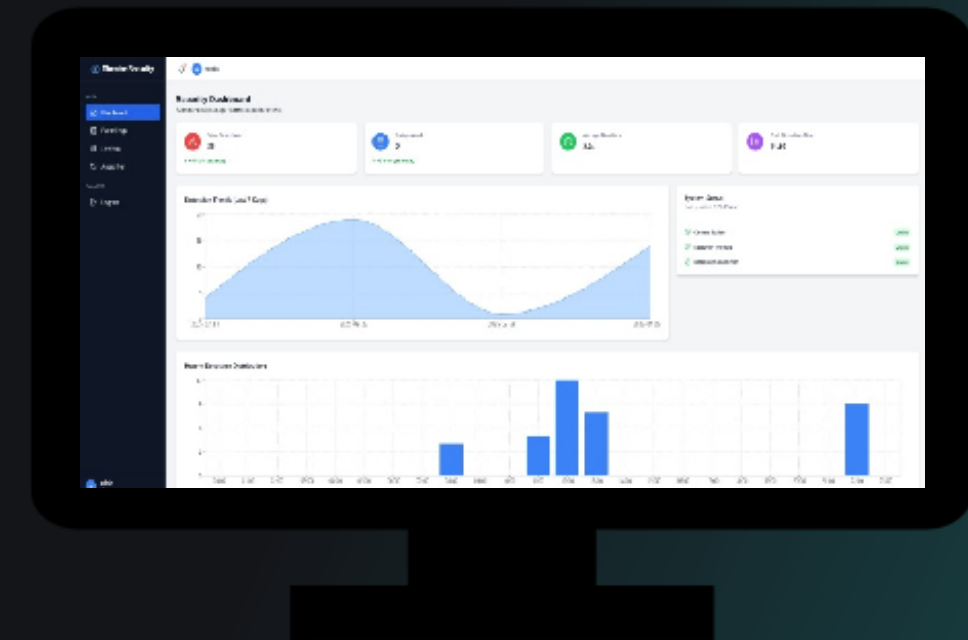
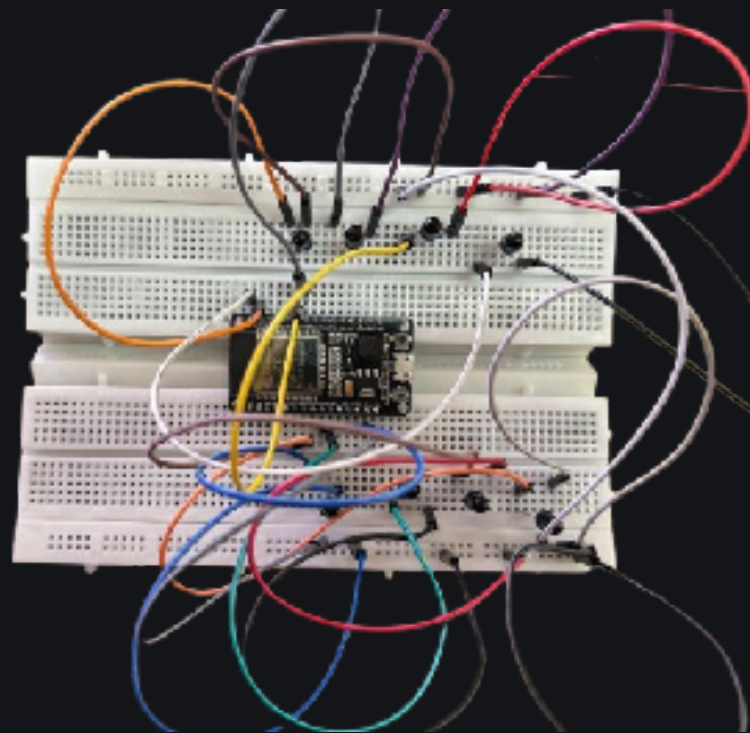
The lack of automation in alert systems leads to delays in security response during critical incidents

➤ **Facial Recognition**

Current systems do not integrate face detection technology for identifying suspects effectively.

PROPOSED SOLUTION

SpectraSafe, begins with IR-enabled CCTV cameras strategically installed inside the theater, running YOLOv10s for real-time detection of mobile phones aimed at the screen. Once a phone is detected, MTCNN facial recognition is triggered simultaneously to identify the user. A grid-based seat mapping system pinpoints the exact location of the suspect. Next, IR LEDs installed around the theater screen are activated, emitting invisible infrared light to disrupt the camera's recording without affecting human viewers. The system captures and logs critical information including the suspect's face, timestamp, seat number, and device detection snapshot. This data is automatically sent to a centralized real-time dashboard and emailed to security personnel, enabling swift, non-intrusive intervention. The entire process is automated, ensuring seamless anti-piracy enforcement while maintaining audience comfort and theater ambiance.



modules

► REAL-TIME DETECTION & IDENTIFICATION MODULE

Utilizes CCTV-integrated YOLOv10s to detect mobile phone usage during movie playback. Employs MTCNN for facial recognition, mapping faces to their respective seats. Ensures immediate detection and tagging of offenders through deep learning inference.

► IR-BASED SCREEN PROTECTION MODULE

An IoT-driven IR system using ESP32 and Arduino UNO controls IR LEDs across the screen. Flashes invisible IR light when a mobile camera is detected, corrupting the footage without affecting the audience's view. Offers a non-intrusive deterrent mechanism against piracy.

modules

➤ SEAT GRID MAPPING MODULE

Converts bounding box coordinates from detection into precise seat numbers using custom grid-mapping logic. Enables accurate localization of offenders, aiding in swift on-ground action by security. Fully integrated with alert system for seamless reporting.

➤ ALERT & MONITORING AUTOMATION MODULE

Displays detection events in a real-time dashboard showing frames, seat mapping, and face snapshots. Sends instant email alerts with offender images and location details to theater authorities. Designed for continuous monitoring and easy operator use.

COMPONENTS



**ESP32
Microcontroller**



IR Flashlights



**IR surveillance IP
Camera**

FUTURE ENHANCEMENTS

MULTI-THEATRE INTEGRATION

Enable centralized control and monitoring of multiple screens within a cinema complex. This allows seamless scalability, unified alert systems, and efficient management across branches.

CLOUD-BASED ANALYTICS & OFFENDER LOGGING

Store detection data and offender images securely in the cloud to enable long-term analysis, pattern recognition, and identification of repeat offenders, improving overall deterrence.

SMARTPHONE APP FOR SECURITY STAFF

Develop a dedicated mobile application that sends real-time alerts, seat numbers, and images to security personnel—empowering instant on-ground response without needing a control room.

REFERENCES

► IEEE RESEARCH PAPERS :

Lu, Y., Zhang, L. and Xie, W., 2020, August. YOLO-compact: an efficient YOLO network for single category real-time object detection. In 2020 Chinese control and decision conference (CCDC) (pp. 1931-1936). IEEE.

Najibi, M., Rastegari, M. and Davis, L.S., 2016. G-cnn: an iterative grid based object detector. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 2369-2377).

Gao, Z., Zhai, G., Wu, X., Min, X. and Zhi, C., 2014, December. DLP based anti-piracy display system. In 2014 IEEE Visual Communications and Image Processing Conference (pp. 145-148). IEEE.

► ONLINE SOURCES :

Research insights from Google Scholar, IEEE Xplore, and developer blogs

Articles on IR-based anti-piracy systems from platforms like The Hindu and Reddit discussions

Tools & Platforms:

PyTorch, OpenCV, TensorFlow (MTCNN), ESP32, Arduino IDE, and SQLite



THANK YOU