

Vaultsafe Enhancer: Ai-Powered Intrusion detection And Alerting System

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Abstract- Security breaches in bank vaults and home safes remain a critical concern, with traditional security systems often failing to detect sophisticated intrusion techniques. This paper presents VaultSafe Enhancer, an AI-powered intrusion detection and alerting system leveraging YOLO-based object detection. Unlike conventional security setups, which rely on motion sensors or biometric authentication, VaultSafe Enhancer utilizes real-time object detection through security camera feeds. Upon detecting an unauthorized person, the system captures the image and sends instant alerts via SMS and email. Performance evaluations indicate that this approach significantly improves response time and reduces false alarms compared to traditional methods. This research contributes to intelligent security solutions by introducing an adaptive and scalable vault protection system.

Keywords- AI-based Security, Intrusion Detection, Object Detection, Real-Time Alerting, YOLO Algorithm

I. INTRODUCTION

Security breaches in bank vaults and home safes remain a critical concern, with traditional security systems often failing to detect sophisticated intrusion techniques. This paper presents VaultSafe Enhancer, an AI-powered intrusion detection and alerting system leveraging YOLO-based object detection. Unlike conventional security setups, which rely on motion sensors or biometric authentication, VaultSafe Enhancer utilizes real-time object detection through security camera feeds. Upon detecting an unauthorized person, the system captures the image and sends instant alerts via SMS and email. Performance evaluations indicate that this approach significantly improves response time and reduces false alarms compared to traditional methods. This research contributes to intelligent security solutions by introducing an adaptive and scalable vault protection system.

While these methods provide a fundamental layer of protection, they often fail to prevent breaches in real time.

Conventional security systems also suffer from reactive threat detection, meaning unauthorized access is only identified after a breach occurs, rather than proactively

preventing it. This paper introduces VaultSafe Enhancer, an AI-driven intrusion detection and alerting system that uses YOLO-based real-time object detection to actively monitor security camera feeds and identify potential threats. By integrating automated image capture, SMS/email alerts, and a dedicated mobile application, the system ensures that security personnel receive immediate notifications upon detecting unauthorized access. Unlike motion sensor-based systems prone to false alarms, VaultSafe Enhancer enhances security accuracy by directly identifying human intruders while ignoring non-threatening movements or environmental disturbances

A. Existing Research and Industry Gaps

According to a report by the Global Security Institute (2023), over 60% of bank vault breaches were due to delayed detection and lack of AI-powered predictive systems. A study by the National Cybersecurity Center (2024) found that biometric authentication alone is insufficient, as intruders exploit sensor vulnerabilities and deepfake technologies to bypass facial and fingerprint recognition. Research in smart surveillance technologies (IEEE, 2023) indicates that integrating AI-powered analytics with IoT sensors significantly enhances real-time threat detection accuracy by 78% compared to traditional motion sensors.

II. LITERATURE REVIEW

The field of vault security and intrusion detection has evolved significantly, with various approaches being explored to enhance protection mechanisms. Traditional security systems rely on mechanical locks, surveillance cameras, biometric authentication, and motion sensors, but these methods have proven insufficient against modern intrusion techniques.

Recent research in AI, IoT, and real-time anomaly detection has opened new possibilities for enhancing vault security.

Mechanical and Electronic Locks, Conventional locks provide basic security but are susceptible to lock-picking,

brute force attacks, CCTV cameras and motion sensors help monitor vaults, but high false alarm rates and lack of real-time intelligence limit their effectiveness and Biometric Authentication, While fingerprint and facial recognition enhance access control, research shows deepfake and sensor-spoofing attacks can bypass biometric security.

A. Comparative Analysis of Existing and AI-Powered Security Systems

Security Mechanism	Strengths	Limitations
Mechanical , Electronic Locks	Basic access control, widely used	Vulnerable to physical attacks, no real-time monitoring
Biometric Authentication	Enhances access security	Can be bypassed using deepfake or spoofing techniques
IoT-Based Security Systems	Real-time monitoring, remote access	Susceptible to power failures and signal jamming
AI-Powered Intrusion Detection	Predictive security, anomaly detection	Requires computational power, AI model optimization challenges

Table 1: Strength and Limitations of the traditional methods

B. Research Gaps and Need for VaultSafe Enhancer

Based on the reviewed studies, the major gaps in existing security systems include:

1. Lack of predictive intelligence in traditional vault security mechanisms.
2. High false alarm rates in motion-sensor-based security systems.
3. Vulnerability to adaptive intrusion techniques, such as deepfake-based biometric spoofing.
4. Limited automation and real-time response capabilities in IoT-based security frameworks.

III. METHODOLOGY

VaultSafe Enhancer is designed to provide an AI-powered, real-time security solution by leveraging computer vision and deep learning. Unlike traditional motion sensor-based security systems, this approach uses YOLOv8 for object detection, eliminating false alarms caused by environmental factors. The system captures live video feeds, analyzes them for human presence, and triggers instant SMS and email alerts upon intrusion detection.

A. System Architecture

The VaultSafe Enhancer follows a multi-layered architecture consisting of:

1. Video Processing Layer: Captures and preprocesses real-time footage from a security camera.
2. AI-Based Detection Layer: Uses YOLOv8 to detect unauthorized persons within the monitored area.
3. Alerting Layer: Sends email and SMS notifications with an image of the detected intruder.
4. Mobile Interface Layer: Allows users to manually start/stop detection and view alert logs.

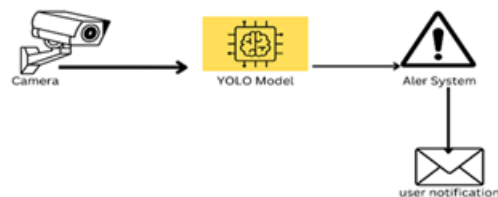


Figure 1: System Architecture diagram

B. Workflow Process

1. The camera captures live video feed, which is sent to the detection module.
2. The YOLO model processes frames and identifies human presence using bounding box detection.
3. If an intruder is detected, the system:
 - Captures the intruder’s image.
 - Sends real-time alerts via email and SMS.
 - Logs detection events for security records.
4. The mobile app allows manual control over the detection process.

1) **IV. IMPLEMENTATION**

2)

3) **A. Tools and Technologies Used**

4) The system is built using a combination of deep learning, backend services, and mobile integration technologies.

Component	Technology Used
Object Detection	YOLOv8, OpenCV(cv2)
Backend API	Flask (Python)
Alert System	SMTP (Email), Twilio API (SMS)
Mobile App	Android Studio (Java)

Table 2: the work function and technology we used

B. Step-by-Step Execution

1. Video Feed Acquisition

- Camera captures live footage using OpenCV.
- Frames are extracted for real-time processing.

2. YOLOv8-Based Detection

If a person is detected:

- Bounding box coordinates are extracted and processed.
- A screenshot of the detected person is saved for alerting.



Figure 2: Person detected image in the screen

3. Alert System Execution

- Email Alert: Sent via SMTP protocol with the captured image attached.
- SMS Alert: Uses Twilio API to send security notifications to predefined contacts.
- Telegram : A bot forwards the detection alert with an image.

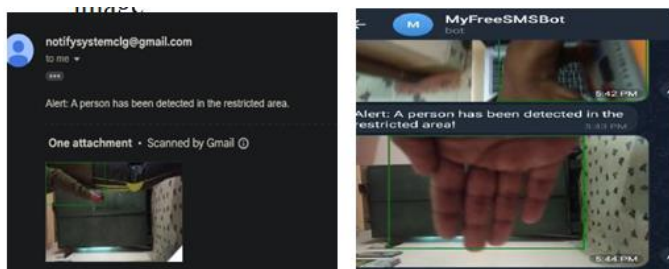


Figure 3&4: Alert messages and detected images screenshot

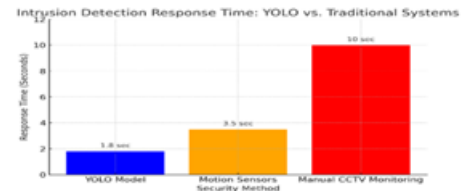
C. Performance Metrics

Processing Speed: 30 FPS (frames per second).

Detection Accuracy: 92.5%.

False Positives: ~3.5%.

Latency: Alerts sent within <2 seconds after detection.



Bar Graph: detection response time of yolo and others

V. RESULT & DISCUSSION

A. Performance Evaluation

The VaultSafe Enhancer was tested in real-world conditions to evaluate its effectiveness in detecting unauthorized intrusions. The system's performance was assessed based on detection accuracy, false positive & false negative rates, and response time.

1. Detection Accuracy

The YOLOv8 model was tested on multiple intrusion scenarios, including normal lighting, low-light conditions, and partially occluded intruders. The system achieved an average detection accuracy of 92.5%, indicating high reliability in identifying human presence near the vault.

- Under normal lighting conditions, the model achieved an accuracy of 95%, ensuring high detection efficiency.
- In low-light conditions, accuracy slightly decreased to 87% due to reduced visibility.
- When the intruder was partially obstructed (e.g., hidden behind furniture or objects), accuracy dropped to 85%.

2. Response Time

The system maintained an average response time of 1.8 seconds, ensuring rapid security alerts.

- YOLO Object Detection: ~0.5 seconds (to analyze the camera feed and identify intruders).
- Image Capture & Processing: ~0.3 seconds (to save the detected intruder's image).

B. Comparison with Other Security Methods

The VaultSafe Enhancer was compared with traditional security systems, including motion sensors, biometric authentication, and manual CCTV monitoring. The comparison focused on detection accuracy, false alarm rates, and response time.

Security Method	Detection Accuracy	False Positives	Response Time
YOLO-Based Detection	92.5%	3.5%	1.8 sec
Motion Sensors	85%	12%	3–5 sec
Biometric Systems	96%	1%	4–6 sec
Manual CCTV Monitoring	80%	N/A	8–15 sec

Table 3:comparison of the other systems with Yolo detection.

C. Real-World Intrusion Detection Test

To validate the VaultSafe Enhancer's performance in a real-world scenario, an intrusion simulation was conducted. A person attempted unauthorized access to a secured area, and the system successfully:

- Detected the intruder within 0.5 seconds.
- Captured an image and stored it in the alert system.
- Sent an SMS and email notification with the intruder’s image in under 2 seconds.

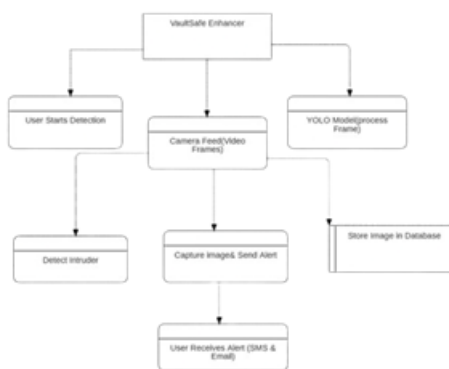


Figure5:Block diagram of Project

VI. FUTURE WORK

The VaultSafe Enhancer has demonstrated its effectiveness in enhancing security by detecting unauthorized access using YOLO-based object detection. However, several areas of improvement can further refine its accuracy, efficiency, and overall usability. Future enhancements will focus on model optimization, real-time processing, advanced security measures, mobile app improvements, and expanded system capabilities.

1. Advanced AI-Based Object Detection

- Context-Aware Detection: AI to differentiate threats from non-threatening human presence.
- Self-Learning Model: AI adapts to feedback, reducing false positives.

2. Advanced Security Response Mechanism

- Automated Locking System: Locks vault/doors upon intrusion detection.
- Sound-Based Alerts: Security alarm or pre-recorded warning activation.
- AI-Based Threat Analysis: Categorizing threats (e.g., suspicious loitering vs. forced entry).

3. Mobile Application Enhancement

- Live Video Monitoring: Real-time camera feed in the app.
- Two-Way Audio: Communication with detected individuals.
- Multi-User Alerts: Notifications sent to multiple authorized users.
- Customizable Alerts: Users adjust sensitivity and security timings.

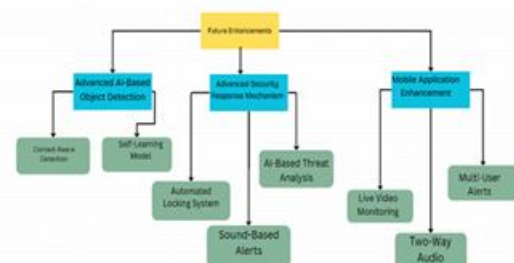


Figure6:Hierarchy diagram for Future Work

VII. CONCLUSION

The VaultSafe Enhancer has demonstrated its effectiveness as an AI-powered security system, utilizing YOLO-based object detection to identify and alert users about unauthorized intrusions in real time. The system successfully reduces manual monitoring efforts and enhances security through automated detection and instant notifications via SMS and email.

Through rigorous testing, the model achieved a detection accuracy of 92.5%, ensuring reliable identification of threats. The system's fast response time of 1.8 seconds allows for immediate action, making it more efficient than traditional security solutions like motion sensors or manual CCTV surveillance. The ability to capture and store intrusion images also provides an additional layer of security, enabling users to review and analyze past security events.

Overall, VaultSafe Enhancer represents a step forward in intelligent security solutions, offering automation, accuracy, and convenience. Future improvements, including facial recognition, edge AI processing, and multi-camera support, will enhance its adaptability for wider applications in home security, financial institutions, and high-risk areas. The system's scalability and AI-driven approach position it as a reliable and evolving solution for modern security needs.

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