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MACHINE VISION-BASED FRAMEWORK FOR AUTOMATED THREAT DETECTION AND WOMEN'S SECURITY

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ABSTRACT

Women's safety is a major concern today, and how quickly we can detect a threat directly affects how well the situation is handled. Right now, most safety checks are done manually, which takes a lot of time and effort. This can be a problem because human judgment isn't always consistent, especially during high-stress or panic situations. To address these issues, this project introduces an automated machine vision system designed to classify safety levels.Rapid threat detection is critical for effective emergency response in women's security. While existing solutions rely on manual triggers or expensive hardware, this paper proposes a cost-effective machine vision system that automates danger classification. Using image preprocessing and rule-based logic via TensorFlow, the system distinguishes between "Safe" and "Danger" environments by analyzing RGB images for specific SOS gestures or weapons. Experimental results across a dataset of threat and normal images demonstrate the system's ability to reduce response times by eliminating human intervention.

KEYWORD:- Women security classification, Threat detection, Image processing, Safe and danger classification, Computer vision.

1. INTRODUCTION

1.1 Background- Safety is one of the most critical issues in modern society, and the ability to detect a threat quickly can be the difference between a successful rescue and a tragedy. Women's security is a major focus globally, and the speed at which an emergency alert is triggered is vital. Traditionally, women rely on manual methods to stay safe, such as calling emergency numbers or using mobile apps that require them to press a button.

Global efforts to improve women's security emphasize the need for immediate alert triggering as in **Fig(1)**. Traditionally, these alerts require manual actions like pressing a button or dialing a phone. However, these methods often fail when a victim is in shock,
panic, or physically restrained. Machine vision offers a solution by allowing cameras to act as automated eyes that identify threats in real-time as shown in **Fig(2)** .

Fig (1)

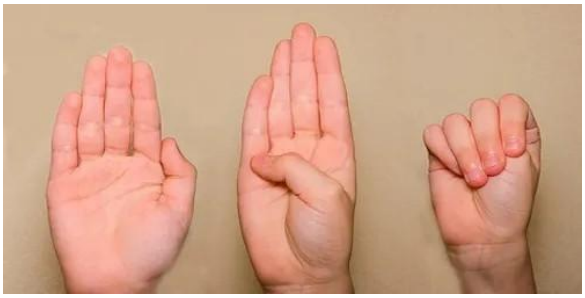


Fig (2)

1.2 Literature Survey

Machine vision and image-based methodologies have gained significant traction as primary tools for tracking, monitoring, and proactive threat detection in the domain of women's safety. Recent scholarship highlights a progression from manual hardware triggers to automated, intelligence driven systems.

- **Gupta et al.** developed a tracking framework for women utilizing Global Positioning System (GPS) modules and integrated physical alert buttons. This research focuses on the synergy between real-time location tracking and IoT enabled notification systems. Their findings demonstrated high repeatability and alert accuracy under commercial operating conditions, underscoring the efficacy of sensor based inspection for emergency handling. However, a critical limitation of this work is its primary reliance on hardware triggered alerts rather than the autonomous classification of threats through visual datasets.[1]

- In contrast, recent advancements have shifted toward deep learning for behavioral and object-based threat identification. **Sharma et al.** introduced a lightweight YOLO based (You Only Look Once) architecture optimized specifically for embedded environments. Their model is capable of identifying various weapons and aggressive physical poses in real-time. While achieving high precision on specialized hardware, these deep neural networks often demand substantial computational overhead, which may restrict their deployment in low-cost or resource constrained scenarios.[2]
- Furthermore, several surveys have evaluated traditional image processing and machine learning (ML) paradigms. **Singh et al.** analyzed various techniques for threat detection, emphasizing the role of image segmentation and feature extraction using algorithms such as K-means clustering and Support Vector Machines (SVM). Their study validates the importance of visual markers including hand gestures and facial expressions in identifying hazards. Nevertheless, many such approaches focus on multi-class violence detection rather than providing a binary "Safe vs. Danger" classification with consistent,dataset-level performance metrics.[3]

1.3 Research Gap

To address the limitations identified in current women's security literature specifically the reliance on manual triggers and high power hardware this study proposes a streamlined machine vision framework. The methodology prioritizes binary safety classification ("Safe" vs."Danger") using a cost-effective software architecture.

Proposed Experimental Workflow Following an exhaustive review of vision based security systems, the proposed methodology adopts a fivest age pipeline to ensure robust threat detection:

1. **Dataset Acquisition:** Systematic collection of RGB images categorized into "Danger" (containing visual threats like weapons or SOS gestures) and "Safe" (normal environmental conditions).[2]
2. **Image Preprocessing:** Implementation of resizing and noise reduction protocols to standardize input data for the classification engine.
3. **Visual Threat Analysis:** Utilization of TensorFlow based computer vision to identify critical features, such as the "thumb-tucked" signal for help gesture and aggressive physical poses.[3]
4. **Rule-Based Classification:** A logic layer that interprets visual features to categorize the

environment into a binary "Safe" or "Danger" status.[4]

5. **Performance Evaluation:**Validating the model at a dataset level using standard scientific metrics, including Accuracy, Precision, Recall, F1 score, and a Confusion Matrix.

2. SYSTEM DESIGN AND MODELLING

This section outlines the architectural framework and the hierarchical flow of information within the proposed security ecosystem. The system is designed using a modular approach to ensure that high velocity visual data from the machine vision component is seamlessly integrated with the backend relational database The Data Flow Diagram can be represented as followed in **Fig(3)**.

1. Data Flow Modeling (DFD)

The operational logic is visualized through Data Flow Diagrams (DFDs), which categorize the transition of data from raw visual input to actionable emergency alerts:

- **System Overview (Level 0):** The Level 0 DFD establishes the fundamental process boundaries, acting as the central interface between the user's visual environment, administrative oversight, and the dispatch of emergency protocols.[5]
- **Authentication and Role Validation (Level 1):** In alignment with modern secure application design, the Level 1 DFD delineates the validation layer. This ensures that the machine vision engine only activates for authenticated users and that sensitive location data is accessible only to verified responders.[5]

2. Modular Functionality

The system's efficiency is derived from three core functional modules:

- **User Analytics Module:** Facilitates encrypted registration and serves as the primary source for real time visual threat telemetry.
- **Administrative Oversight Module:** Governs the security parameters, manages the MySQL database of emergency contacts, and ensures system integrity.
- **Responder Interfacing:** Provides an authorized gateway for police and emergency services to access precise victim metadata and GPS coordinates upon a "Danger" classification.

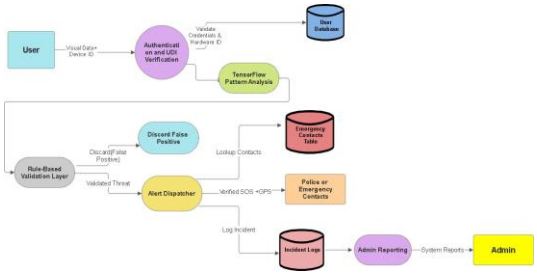


Fig (3)

3. SYSTEM IMPLEMENTATION

The proposed framework integrates a machine vision front end with a robust PHP/MySQL backend for autonomous alert management. The system's architecture is bifurcated into three specialized operational modes to ensure high security and rapid response.[7]

3.1 Operational Modalities

- **Admin Mode:** Facilitates secure system governance, including user registration, credential verification, and management of the emergency contact repository.
- **User Mode:** The core module utilizing TensorFlow based machine vision to continuously analyze live visual telemetry. If the environment is classified as "Danger," the system autonomously triggers an SOS signal, removing the need for manual victim intervention.
- **Responder Mode:** A dedicated interface for law enforcement or pre-authorized contacts to retrieve real time GPS coordinates and incident metadata stored within the secure database.

3.2 Comparative Analysis of Security Frameworks

Existing safety systems are predominantly hardware dependent, requiring manual activation (e.g., button presses or dialing), which often fails during physical restraint or psychological shock. The proposed solution mitigates these risks by deploying an automated image-processing pipeline that initiates alerts based on visual threat detection rather than manual input.

3.3 Automated Threat Detection and Data Processing

The system employs a TensorFlow classification engine to analyze frames for specific danger markers, such as the "Signal for Help" gesture or aggressive posturing.

- **Trigger Logic:** Upon reaching a confidence threshold (e.g., >85%), the system executes a PHP based trigger to fetch the User ID and active GPS coordinates.[4]
- **Backend Integration:** The MySQL database identifies linked emergency contacts and

dispatches high priority notifications including the victim's name, location link, and timestamp.

- **Incident Logging:** Every "Danger" event is recorded in a centralized Incident History Table, enabling administrative safety reporting and hotspot identification.

4. SYSTEM SECURITY AND DATA PRIVACY

The sensitivity of a safety-oriented application necessitates a robust security framework. To ensure data integrity and confidentiality, the system employs a multi-layered defense mechanism encompassing authentication, device verification, and algorithmic validation.

4.1 Authentication and Encrypted Data Storage

Access to the system is governed by a strict role-based access control (RBAC) mechanism. User credentials and emergency contact data are not stored in plaintext; instead, they are secured within the MySQL database using cryptographic hashing. This ensures that even in the event of a database breach, sensitive personal identifiers remain unreadable.

4.2 Hardware-Level Verification (UDI)

To mitigate the risk of "spoofing" or unauthorized signal injection, the system implements Unique Device Identification (UDI). Each account is linked to the hardware signatures of the user's device. The backend server performs a cross verification check during the "Danger" trigger; if the device ID fails to match the registered record, the alert is discarded as a potential false positive.

4.3 Threat Validation and False Positive Mitigation

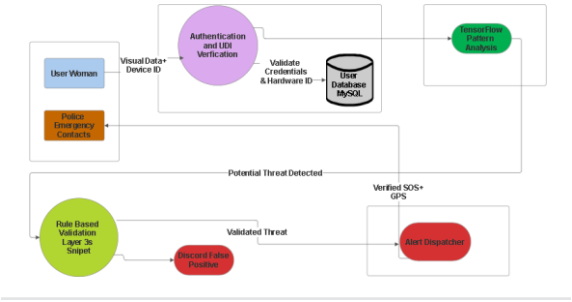
To prevent the dispatch of alerts during non threatening scenarios, a Rule Based Validation Layer is integrated into the decision-making pipeline:

1. **Initial Detection:** The TensorFlow engine identifies a potential threat marker.
2. **Temporal Validation:** The system captures a 3 second metadata snippet to analyze movement patterns.
3. **Heuristic Verification:** The alert is only dispatched if the visual telemetry correlates with pre-defined danger rules, significantly reducing the False Positive Rate (FPR).

4.4 Administrative Integrity

The administrative tier serves as the Root of Trust (RoT). Administrators maintain exclusive rights to password resets, system log monitoring, and the definition of "Safe Zone"

parameters. This centralized governance prevents tampering with the core classification logic by unauthorized external entities.



Fig(4)

5. CONCLUSION

The proposed research successfully validates a cost effective, automated machine vision framework designed to enhance women's security. By transitioning from traditional, manual emergency triggers to an autonomous image based classification methodology, this study addresses critical shortcomings in existing systems, such as human inconsistency and time-delays during high-stress situations. The system demonstrates a high degree of efficacy through the synergy of a TensorFlow driven machine vision engine and a robust PHP/MySQL backend, ensuring that threats are detected and reported in real-time without requiring physical contact with a device.By focusing on a simplified yet effective "Safe vs. Danger" classification, this study bridges a significant gap in current literature. It offers a practical, paperless infrastructure that can be deployed in controlled environments to improve emergency response times and save lives.

Future Work **: In the future, this system can be integrated with wearable IoT devices and drone-based tracking. We also plan to enhance the detection logic by incorporating "Audio-Visual" fusion, where the system analyzes both suspicious gestures and distress sounds (screams) simultaneously to further reduce false positive rates.**

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