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AI-Based Women Safety Clip: Literature Survey and Proposed System

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Abstract: *Women's safety systems have increasingly used wearable devices, IoT communication, sensors, cameras, and machine learning to provide faster emergency assistance. This paper reviews existing research on wearable women safety systems, automatic activity detection, sensor-based monitoring, camera-based verification, and wireless alert communication. Existing systems mainly depend on manual emergency activation or physiological monitoring, while some recent systems introduce AI-based detection. However, there is still a need for a compact wearable system that can automatically identify predefined unusual activity patterns and reduce false alarms through verification. The proposed AI-Based Women Safety Clip uses a camera and MPU6050 IMU connected to an ESP32-based controller. The collected data is processed and analysed using AI/ML techniques to classify activity as Normal or Unusual. A verification stage is used before sending an alert through Wi-Fi to a smartphone. The smartphone obtains GPS location and shares the alert with a trusted contact.*

Keywords: Women Safety; Wearable Device; ESP32; MPU6050; Camera; AI/ML; Activity Detection; IoT; GPS; Emergency Alert.

I. INTRODUCTION

Women's safety remains an important concern, particularly when a person is travelling or is in an unfamiliar environment. Traditional safety devices generally depend on manual button activation, which may not always be possible during an unexpected situation. Recent research has explored wearable devices, IoT, sensors, GPS, GSM, cameras, and machine learning for improving personal safety. These technologies can support automatic monitoring and faster communication during unusual events.

This paper reviews existing women safety systems and identifies the gap between manual emergency-alert devices and intelligent automatic detection. Based on this gap, a proposed AI-Based Women Safety Clip is presented using camera sensing, IMU-based motion detection, ESP32 processing, AI/ML analysis, verification, and smartphoneassisted GPS communication.

II. SURVEY METHOD

Search Strategy

Literature was considered using keywords related to women safety wearable systems, IoTbased women safety, ESP32 safety devices, AI/ML activity detection, sensor-based anomaly detection, camera-based safety systems, and emergency alert systems.

Selection Criteria

Studies were considered when they were related to wearable safety devices, IoT communication, sensor monitoring, AI/ML-based detection, camera-based systems, or emergency alert mechanisms. The selected studies were compared according to their technology, approach, limitations, and relevance to the proposed system.

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III. LITERATURE REVIEW BY THEME

Wearable Women Safety Systems

Pardhi et al. [2] presented a smart wearable women security system using Arduino, Bluetooth, GPS, and an Android application. The system uses a physical key to activate an emergency alert. Although the approach provides quick communication, it depends on manual activation and smartphone connectivity.

AI and Multi-Sensor Safety Systems

Ajit et al. [1] proposed an AI-based wearable safety band using ESP32, GPS, GSM, microphone, PPG, and IMU sensors. The system applies TinyML and sensor fusion for detecting distress conditions. This work demonstrates the usefulness of edge AI and multiple sensors for wearable safety applications.

AI-Based Physiological Monitoring

Antony Pradeesh et al. [3] proposed an IoT-enabled wearable system using Raspberry Pi, LoRa, GPS, and biosensors. A deep-learning model is used to analyse physiological signals and detect possible safety conditions. The study shows the potential of AI and long-range communication, but its hardware requirements and validation limitations affect practical wearable deployment.

Camera-Based Safety Systems

Roy et al. [4] proposed the Safe-Women system using ESP32-CAM, GPS, GSM, health sensors, and a mobile application. The camera can provide visual information during an emergency event. This demonstrates the usefulness of camera-based evidence and verification, although the system has higher power and communication requirements.

IoT-Based Women Safety Research

Farooq et al. [5] reviewed IoT-based women safety systems using technologies such as GPS, GSM, Raspberry Pi, and sensors. The review highlights the importance of automation, multi-sensor monitoring, and reliable communication. It also identifies limitations such as manual interaction and dependence on communication infrastructure. F. Challenges and Limitations in the Literature

- Limited automatic detection of unusual activity.
- Dependence on manual emergency activation.
- False alarms in automatic detection.
- Dependence on smartphone or network connectivity.
- Higher hardware and power requirements.
- Privacy concerns related to camera-based monitoring.

IV. LITERATURE REVIEW

[1] Ajit et al. (2026): The study uses ESP32, TinyML, and multiple sensors for automatic women safety monitoring. It demonstrates the usefulness of AI and sensor-based detection. However, it depends on GSM and has limited AI features.

[2] Pardhi et al. (2022): The study presents a wearable women safety system using Arduino, Bluetooth, GPS, and a smartphone. It provides emergency alerts through manual activation. Its main limitation is the requirement for manual activation.

[3] Antony Pradeesh et al. (2026): The study proposes AI-based physiological monitoring using Raspberry Pi, LoRa, GPS, and sensors. It demonstrates AI-based safety monitoring but requires more hardware and has limited real-world validation.

[4] Roy et al. (2024): The Safe-Women system uses ESP32-CAM, GPS, GSM, and health sensors for emergency monitoring and evidence collection. However, it has higher power and network requirements.

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[5] Farooq et al. (2023): The study reviews IoT technologies used in women safety systems and highlights the importance of automated monitoring. However, it is mainly a review and does not present a single practical solution.

V. RESEARCH GAP

Existing studies demonstrate that wearable devices, IoT, sensors, cameras, and AI can support women's safety. However, most systems have limitations related to manual activation, network dependency, false alarms, or hardware complexity.

- Limited automatic detection of unusual activity.
- Dependence on manual emergency activation in many systems.
- Need for verification to reduce false alarms.
- Limited integration of camera and motion sensing in a compact wearable.
- Dependence on smartphones for communication and location.
- Need for practical and lightweight AI-based activity detection.

The proposed AI-Based Women Safety Clip addresses these gaps by combining camera and IMU sensing with AI/ML-based activity detection and a verification stage.

VI. PROPOSED SYSTEM

A. Overview

The proposed AI-Based Women Safety Clip is a compact wearable safety system designed to monitor predefined activity patterns. The device collects movement data through an MPU6050 IMU and visual information through a camera. An ESP32-based controller processes the collected information and supports communication with the smartphone.

The AI/ML module classifies the observed activity as Normal or Unusual. If unusual activity is detected, a verification stage is performed to reduce false alarms. After confirmation, the system communicates with the smartphone through Wi-Fi. The smartphone obtains GPS location and shares the alert with a trusted contact. B. System Architecture

B. Modules

- Sensing Module: Collects camera and MPU6050 movement data.
- ESP32 Processing Module: Collects and processes sensor information.
- AI/ML Module: Classifies activity as Normal or Unusual.
- Verification Module: Checks unusual events to reduce false alarms.
- Communication Module: Sends verified events to the smartphone through Wi-Fi.
- Location Module: Uses smartphone GPS to obtain current location.
- Alert Module: Sends the safety alert and location to a trusted contact.

C. Workflow

The user switches ON the Safety Clip. The camera and MPU6050 collect activity data, which is processed and analysed by the AI/ML module. The activity is classified as Normal or Unusual. Unusual activity enters the verification stage. After verification, the alert is sent to the smartphone through Wi-Fi. The smartphone obtains GPS location and sends the alert and location to the trusted contact.

- Detect predefined unusual activity patterns.
- Classify activities as Normal or Unusual.
- Reduce false alarms through verification.
- Send verified alerts to the smartphone through Wi-Fi.

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- Obtain GPS location through the smartphone.
- Notify a trusted contact.
- Provide a compact wearable safety solution.

VIII. DISCUSSION

The proposed system combines wearable sensing, AI/ML, camera-based information, and smartphone communication in a single safety solution. The use of both camera and IMU data can provide complementary information for activity detection.

The verification stage is important because automatic detection may generate false alarms. The current prototype also depends on the smartphone for GPS and communication. Therefore, wireless connectivity, camera privacy, dataset quality, and realworld testing are important considerations.

IX. CONCLUSION AND FUTURE SCOPE

The literature review shows that existing women safety systems provide useful solutions using wearable devices, IoT, sensors, cameras, and AI. However, many systems still depend on manual activation or have limitations related to false alarms, hardware complexity, and communication.

The proposed AI-Based Women Safety Clip addresses these limitations by combining camera and IMU sensing, ESP32 processing, AI/ML-based activity detection, verification, and smartphone-assisted GPS alerting.

Future development can focus on improving the AI model, expanding the activity dataset, reducing false alarms, improving privacy, and testing the system under different real-world conditions.

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