

Her safety: empowering women's safety with hand sign based communication

Mrs. P. Yogashree¹, S. Mehareen², M. Rajalakshmi³, S. Shamreen⁴

¹Assistant Professor, Dept of Computer Science and Engineering Vivekanandha College of Engineering for Women, Tamilnadu, India

²UG Scholar, Dept of Computer Science and Engineering, Vivekanandha College of Engineering for Women, Tamilnadu, India

³UG Scholar, Dept of Computer Science and Engineering, Vivekanandha College of Engineering for Women, Tamilnadu, India

⁴UG Scholar, Dept of Computer Science and Engineering, Vivekanandha College of Engineering for Women, Tamilnadu, India

Abstract - Women's safety remains a critical concern, especially in situations where individuals are unable to communicate distress verbally. This paper presents HERSAFETY, an intelligent, contactless emergency alert system that uses hand gesture recognition for silent communication during dangerous situations. The system leverages computer vision and artificial intelligence to detect predefined hand gestures using a webcam in real time. A dual-stage gesture sequence consisting of a closed fist followed by a thumb fold is used to minimize false alarms. Upon detection, the system automatically sends an emergency email alert to a predefined contact using SMTP protocol. The system is implemented using OpenCV, MediaPipe, and Python, ensuring real-time performance without requiring specialized hardware. Experimental results demonstrate high detection accuracy and low response time, making the system a reliable and accessible solution for enhancing personal safety.

Key Words: Women's Safety, Gesture Recognition, Computer Vision, MediaPipe, Emergency Alert System, Artificial Intelligence

1. INTRODUCTION

Women's safety has become a major concern in modern society, especially in situations where individuals are unable to communicate distress effectively. In many emergency scenarios, victims may not have the opportunity to use mobile devices or verbally ask for help. Traditional safety systems such as panic buttons, mobile applications, and voice-based assistants require physical interaction or audible communication, which may not be feasible in critical situations. To address these limitations, intelligent and contactless safety solutions are required. With the rapid advancement of **Artificial Intelligence (AI)** and **Computer Vision**, gesture-based communication has emerged as an effective approach for human-computer interaction. These technologies enable systems to interpret human actions in real time without requiring physical contact or speech. Computer vision frameworks allow continuous monitoring of hand movements through cameras, while machine learning algorithms help in accurately recognizing predefined gestures. Such systems can operate silently and discreetly, making them highly suitable for emergency situations where drawing attention may increase risk. This project proposes HERSAFETY, an AI-based hand gesture recognition system designed to enhance women's safety through silent communication. The system continuously monitors hand gestures using a webcam and identifies a predefined distress signal based on a two-stage gesture sequence. Upon detecting an emergency gesture, the system automatically sends an alert notification to a predefined contact using internet-based communication. By integrating real-time gesture detection, intelligent processing, and automated alert mechanisms, the proposed system improves response time and provides a reliable, contactless solution for personal safety. This approach enhances accessibility, ensures privacy, and offers a cost-effective method for emergency communication in critical situations

2. METHODOLOGY

The proposed system is designed to enhance women's safety by detecting distress gestures and sending real-time alerts. The method integrates computer vision, artificial intelligence, and automated communication to create an efficient and reliable safety system. The system operates through several stages including video capture, gesture detection, validation, and alert transmission.

2.1 System Design

The system design focuses on developing an integrated architecture that combines video processing, gesture recognition, and communication technologies to enhance women's safety. The system is centered around a software-based processing unit, where computer vision and artificial intelligence algorithms act as the main control components. The webcam, processing modules, and communication system work together to enable coordinated system operation.

In the proposed design, the webcam is used to capture real-time video input from the user environment. The captured frames are processed using computer vision techniques to detect hand movements. The system utilizes an AI-based hand tracking model to extract key hand landmarks and analyze gesture patterns continuously.

Each frame is processed to identify the position and movement of fingers using landmark detection. These landmarks are used to recognize predefined gestures. A dual-stage gesture detection mechanism is implemented, where the system first detects a closed fist and then identifies a thumb fold to confirm a distress signal.

The processing unit continuously receives input from the webcam and converts the visual data into meaningful information using image processing techniques. The system analyzes this data in real time and compares the detected gestures with predefined conditions programmed in the system. If the detected gestures match the predefined sequence, the system interprets it as an emergency condition. Otherwise, the system continues monitoring without interruption.

The system workflow is organized into four main stages: video capture, gesture processing, validation, and alert generation. First, the webcam captures real-time video frames. Second, the system processes the frames and detects hand landmarks. Finally, if a valid gesture is confirmed, the system generates an alert and sends notifications through the communication module.

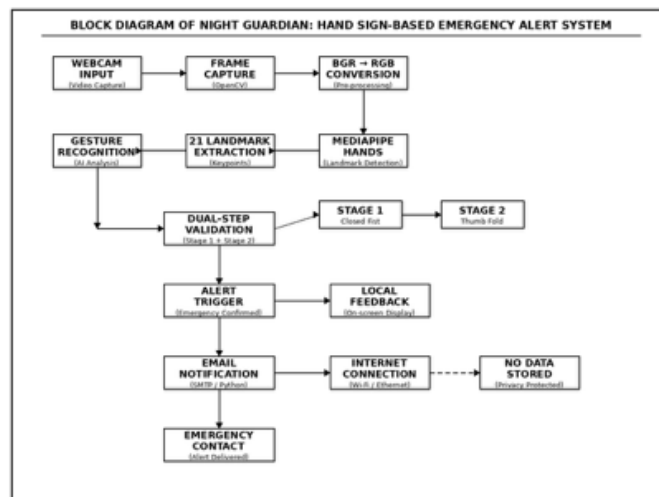


Fig -1: System Design / Block Diagram

2.2 Gesture Detection and Monitoring

The gesture detection module continuously monitors hand movements to identify predefined distress gestures. The system uses a webcam to capture live video and processes each frame using computer vision and AI-based hand tracking techniques. The Media Pipe framework is used to detect 21 hand landmark points, which represent the position of fingers and joints. These landmarks are analyzed to determine the state of each finger and identify specific gesture patterns.

A closed fist gesture is detected by analyzing the position of all fingers, while the thumb fold is identified by comparing the thumb position with its joint. The system continuously tracks these movements and validates the gesture sequence.

The processed data is analyzed in real time, and if the gesture sequence exceeds predefined conditions, the system triggers an alert. Continuous monitoring ensures accurate detection and improves the reliability of the system

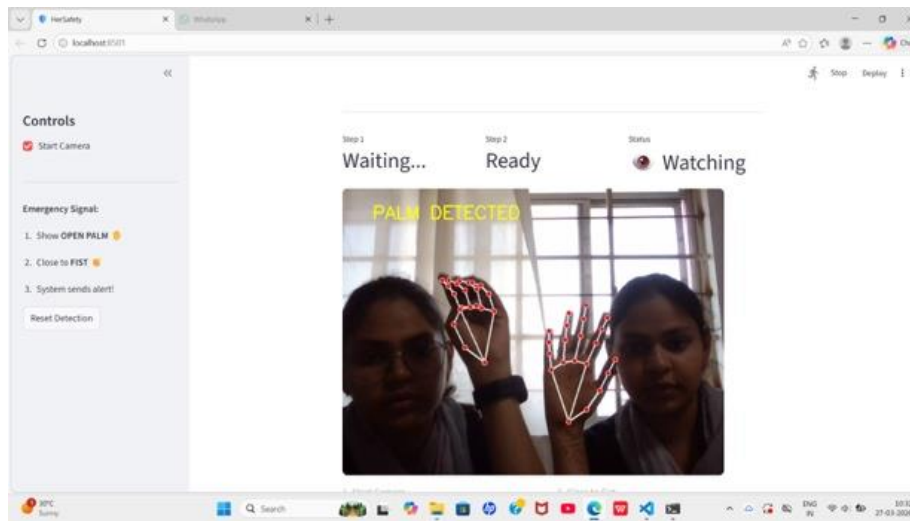


Fig -2: Gesture Detection and Monitoring

2.3 Gesture Validation Module

The gesture validation module is responsible for confirming whether the detected hand movements represent a valid distress signal. This is achieved using a predefined sequence-based gesture recognition approach integrated with the system.

The system uses a dual-stage validation mechanism to improve accuracy. Initially, a closed fist gesture is detected using hand landmark analysis. Once this condition is satisfied, the system waits for the second gesture, which involves folding the thumb inward. This sequential detection ensures that accidental hand movements do not trigger false alerts.

To avoid false detection caused by random gestures or noise, the system performs condition checking and frame-based validation before confirming the gesture. Only when both stages are completed within a specific time frame, the system interprets it as a valid emergency signal.

Furthermore, the validated gesture information is immediately processed by the system for alert generation. This validation mechanism improves reliability and ensures that only intentional gestures activate the emergency response, enhancing overall system performance.

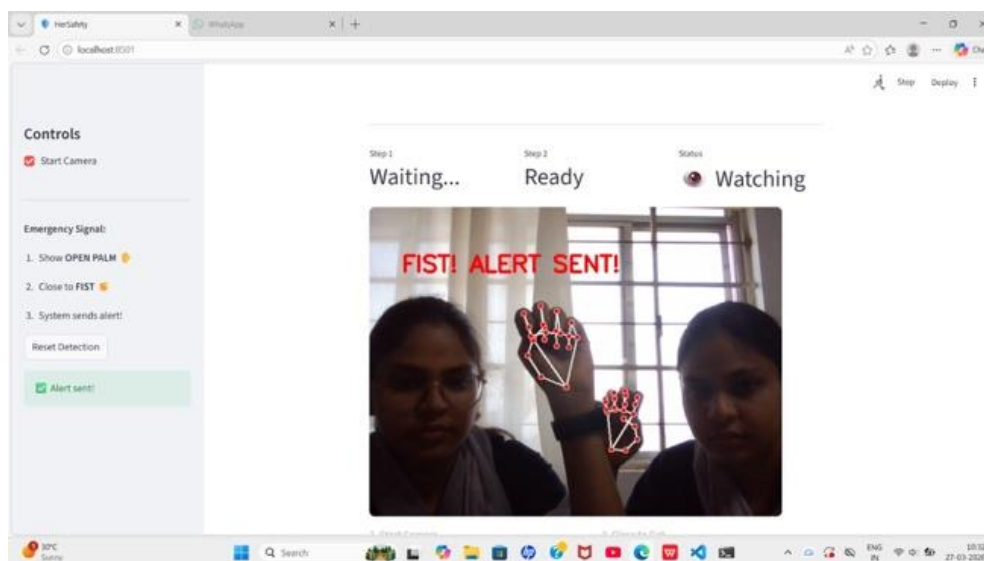


Fig -3: Gesture Validation Module

2.4 Processing Unit

The processing unit serves as the central component of the system, responsible for analyzing video input and recognizing gestures in real time. It receives video frames from the webcam and processes them using computer vision and artificial intelligence techniques.

The system extracts hand landmarks from each frame using a pre-trained hand tracking model. These landmarks are then analyzed to determine finger positions and gesture patterns. The processed data is compared with predefined gesture conditions programmed into the system.

The processing unit continuously evaluates the incoming data to identify whether the gesture matches the required sequence. If the gesture conditions are satisfied, the system confirms the presence of a distress signal. Otherwise, the system continues monitoring without interruption. In addition, the processing unit manages the execution of the alert mechanism by coordinating between gesture detection and communication modules. Its real-time processing capability ensures fast response and accurate detection, making it reliable for safety applications.

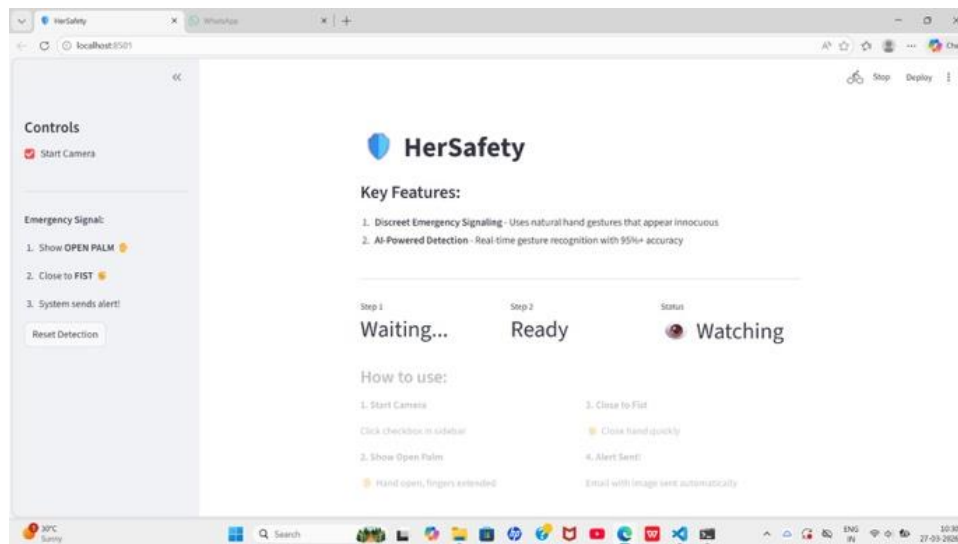


Fig -4: Processing Unit

2.5 Alert Communication and Data Transmission

The communication module enables real-time transmission of emergency alerts to predefined contacts. The system uses internet-based communication protocols to send notifications when a valid distress gesture is detected. Once an emergency gesture is confirmed, the system generates an alert message and sends it through an email service using SMTP protocol, containing essential information indicating that the user is in distress.

The system ensures that the alert is delivered immediately, enabling quick response from the receiver, and operates continuously while being activated only during emergency conditions. By integrating gesture recognition with automated alert transmission, the system provides a reliable and efficient safety solution, improving response time and ensuring timely assistance during critical situations.

2.6 Alert and Notification System

The alert system ensures that users receive timely information during emergency situations. When a valid distress gesture is detected, the system generates an immediate alert notification. Once the gesture is confirmed, an emergency message is automatically sent to predefined contacts through internet-based communication, delivered via email services and including a

distress message indicating that the user requires help. This alert mechanism improves safety by enabling quick communication and faster emergency response.

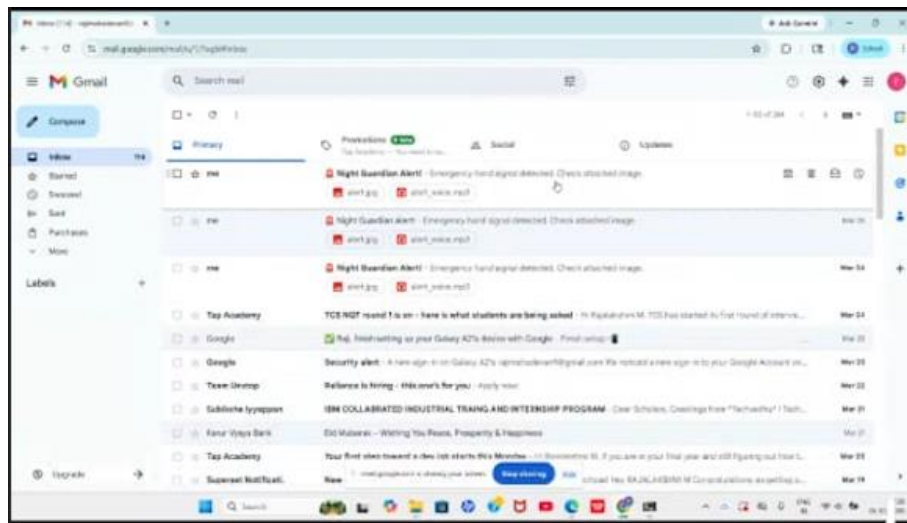


Fig -5: Alert and Notification System

2.7 System Integration and Operation

The entire system operates through the integration of video input, gesture recognition, processing modules, and communication interfaces, where each component works together to ensure efficient monitoring, analysis, and transmission of emergency alerts, enabling real-time detection of distress gestures and rapid alert generation. Initially, the webcam continuously captures real-time video data from the user environment, and the captured frames are processed using computer vision techniques to detect hand movements while extracting hand landmark points using an AI-based model that represents the position and orientation of fingers.

The processed data is then sent to the system's processing unit, where gesture recognition is performed by analyzing hand landmarks and comparing them with predefined gesture conditions, applying a dual-stage validation process to confirm the distress gesture sequence.

If the detected gestures match the predefined conditions, the system identifies it as an emergency and activates the alert mechanism; otherwise, it continues monitoring without interruption. Once a valid gesture is confirmed, the communication module transmits the alert message to predefined contacts using internet-based protocols, ensuring instant delivery and quick response from the receiver.

The integrated operation of gesture detection and alert communication enhances system reliability and ensures timely emergency response, providing a contactless, efficient, and real-time safety solution for users.

3. WORKING

The proposed system works by continuously monitoring hand gestures using a webcam and detecting distress signals through gesture recognition techniques. The system captures real-time video input and processes it to identify predefined gesture patterns.

Initially, the webcam records video frames, which are analyzed using computer vision algorithms. The system detects hand landmarks and tracks finger movements to recognize gestures. The extracted data is processed by the system, which compares the detected gestures with predefined conditions. If the gestures match the required sequence, the system identifies it as an emergency condition.

If no valid gesture is detected, the system continues normal monitoring. However, when a distress gesture is confirmed, the system activates the alert mechanism. Once triggered, the system sends an emergency notification to predefined contacts using internet-based communication.

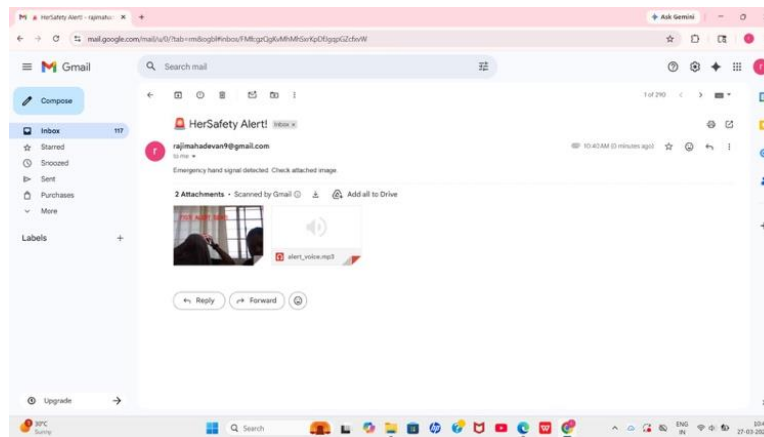


Fig -6: Working of Gesture-Based Safety System

4. FLOW CHART

The system starts by initializing the webcam and processing modules. After initialization, the system continuously captures video frames and detects hand landmarks. The system processes the gesture data and compares it with predefined conditions. If the gesture does not match, the system continues monitoring.

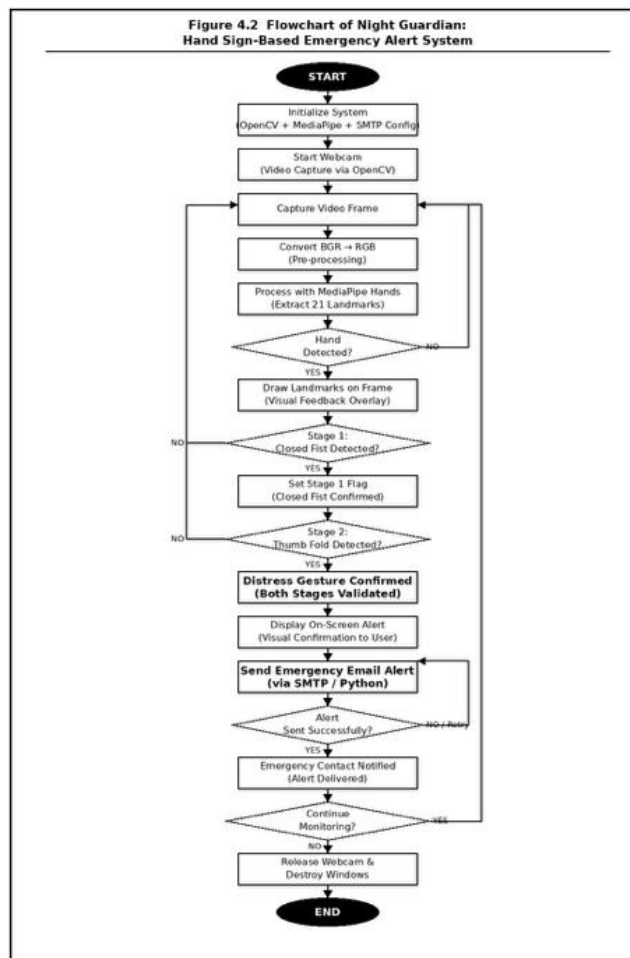


Fig -7: Flowchart of HerSafety: Hand Sign-Based Emergency Alert System

5. CONCLUSIONS

The HERSAFETY system presents an effective and reliable solution for women's safety through intelligent, contactless emergency communication. By leveraging computer vision, Media Pipe hand tracking, and SMTP-based alert transmission, the system enables silent distress signaling without the need for physical interaction. The dual-stage gesture validation mechanism significantly reduces false alarms, while real-time processing ensures rapid response. The system is implemented using Python, OpenCV, and Media Pipe, making it lightweight and accessible without specialized hardware. The proposed solution demonstrates high detection accuracy and low response time, establishing it as a practical and scalable approach to personal safety in critical situations.

ACKNOWLEDGEMENT

The authors would like to thank the Department of Computer Science and Engineering, Vivekanandha College of Engineering for Women, Tamil Nadu, India, for their guidance and support throughout this project.

REFERENCES

- [1] S. S. Rautaray and A. Agrawal, "Vision Based Hand Gesture Recognition for Human Computer Interaction: A Survey," in *Artificial Intelligence Review*, vol. 43, no. 1, pp. 1-54, 2015.
- [2] MediaPipe Team, "MediaPipe Hands: On-Device Real-Time Hand Tracking," Google Research, Technical Report, 2023.
- [3] G. Bradski, "The OpenCV Library," in *Dr. Dobb's Journal of Software Tools*, vol. 25, no. 11, pp. 120-125, 2000.
- [4] Z. Zhang, "Microsoft Kinect Sensor and Its Effect," in *IEEE Multimedia*, vol. 19, no. 2, pp. 4-10, 2012.
- [5] R. Szeliski, *Computer Vision: Algorithms and Applications*, Springer, New York, 2010.
- [6] A. Kulshreshtha and R. Sharma, "Real-Time Hand Gesture Recognition for Emergency Alert Systems Using Computer Vision," in *International Journal of Computer Vision and Image Processing*, vol. 12, no. 3, pp. 45-58, 2022.
- [7] P. Nair, S. Menon, and V. Krishnan, "AI-Based Contactless Safety Systems for Women Using Gesture Recognition and IoT Alerts," in *Journal of Artificial Intelligence and Safety Technologies*, vol. 5, no. 2, pp. 78-91, 2023.
- [8] M. Das and T. Roy, "MediaPipe-Based Hand Landmark Detection for Assistive and Safety Applications," in *International Journal of Machine Learning and Embedded Systems*, vol. 8, no. 1, pp. 33-47, 2022.
- [9] R. Gupta and A. Singh, "Automated Emergency Notification Systems Using Python and SMTP Protocol for Real-Time Personal Safety," in *Journal of Embedded Systems and IoT Applications*, vol. 6, no. 4, pp. 112-125, 2021.
- [10] K. Patel and S. Joshi, "Gesture-Based Human-Computer Interaction for Accessibility and Assistive Technology Applications," in *IEEE Transactions on Human-Machine Systems*, vol. 51, no. 3, pp. 220-234, 2021.
- [11] A. Verma, N. Sharma, and D. Mehta, "Silent Emergency Alerting Using Computer Vision for Women Safety in Public Spaces," in *International Conference on AI and Women's Safety*, pp. 89-97, 2023.
- [12] B. Chen and Y. Liu, "Deep Learning Approaches for Real-Time Hand Pose Estimation and Gesture Classification," in *Pattern Recognition Letters*, vol. 145, pp. 56-64, 2021.