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## Night Guardian: Empowering Women's Safety with Hand Sign-based Communication and AI

A.Sravanthi<sup>1</sup>, Ch.Supriya<sup>2</sup>, D.Ratnavali<sup>3</sup>, Dr. C.Balaja<sup>4</sup>, Dr.R,Shoba Ranai<sup>5</sup>, Dr.F.Jerald<sup>6</sup>

[atmakurisravanthi11@gmail.com](mailto:atmakurisravanthi11@gmail.com)<sup>1</sup>, [supriyachennamsetti024@gmail.com](mailto:supriyachennamsetti024@gmail.com)<sup>2</sup>, [ratnavalidasari@gmail.com](mailto:ratnavalidasari@gmail.com)<sup>3</sup>, [cbalaji.cse@drmgrdu.ac.in](mailto:cbalaji.cse@drmgrdu.ac.in)<sup>4</sup>, [shobarani.cse@drmgr.ac.in](mailto:shobarani.cse@drmgr.ac.in)<sup>5</sup>, [Jerald.ece@drmgr.ac.in](mailto:Jerald.ece@drmgr.ac.in)<sup>6</sup>

**Abstract-** Over the past few years, the safety of women has emerged as an important issue in society, particularly in the presence of other people and when the circumstances are unfavorable during the nights. As the number of harassment and emergency incidents increases, the need to find intelligent, non-obtrusive safety solutions that will work in real time is growing. The proposed project is called Night Guardian: Empowering Women Safety with Hand Sign-based Communication and AI and suggests a new solution that would be based on leveraging artificial intelligence and computer vision to provide immediate assistance in case of distress scenarios without having to engage with the user directly. The system is developed based on the latest technologies like MediaPipe and OpenCV to record and process real-time video feeds of a webcam. MediaPipe is applied in the correct hand landmark detection and keypoint extraction in order to determine hand gestures very precisely. These features are extracted and converted into numerical forms and input to machine learning algorithms like Random Forest, Support Vector Machine (SVM) and K-Nearest Neighbor (KNN). Performance measures such as precision, recall, and F1-score are used to train and test the models to be reliable at gesture recognition. After a distressing gesture has been identified, an alert system is automatically triggered. This involves raising a local alarm to draw attention locally and an automated email notification and a picture of the gesture to emergency contacts or authorities that are predetermined. The combination of these alert mechanisms is to make sure that there is quick response hence increasing the possibility of intervention in time. With the application of AI, the system can be continuously and effectively used even in dynamic environments. Altogether, the offered system will be an effective and scalable way to enhance the safety of women with the help of intelligent automation. It offers a quick, convenient, and free form of emergency communication by using machine learning and real-time gesture recognition to deliver a hands-free form of communication. This project, apart from fostering innovation in technology, helps to enhance social well being by making people be empowered with proactive safety tools.

**Keywords:** Women Safety, Gesture Recognition, MediaPipe, OpenCV, Machine Learning, Random Forest, SVM, KNN, Computer Vision, Real-Time Alert System.

### I. INTRODUCTION

The safety of women has emerged as a significant issue in contemporary society because of the rising number of harassment and assaults, and unsafe conditions, especially in the open area and at night. Conventional safety protocols like helplines, mobile apps, and panic buttons usually involve the active engagement of the users, which is not possible in life-threatening scenarios. This clearly shows the dire necessity of smart and automated systems

that would not require any human operator and would offer real-time support in case of an emergency.

Due to the active development of artificial intelligence and computer vision, new opportunities to create smart safety solutions have appeared. MediaPipe and OpenCV technologies allow detecting and analysing human gestures in real-time, which means that it is possible to decode distress signals successfully. Machine learning algorithms also increase the ability of the system by properly classifying gestures according to the trained models. These developments offer a solid base to develop systems that are capable of constantly tracking user actions and react immediately upon the detection of a threat.

The suggested system, which is called Night Guardian: Empowering Women Safety with the help of Hand Sign Communication and AI, builds upon these innovative technologies to establish a real-time communication-based safety system based on gesture recognition. The system enhances quick response without the need of a direct user action by identifying predefined distress hand signs and automatically alerting the user, e.g. through alarms and email alerts. This will not only enhance personal safety but also encourage intelligent technologies to be used in solving important societal problems, which will help to create a safer and more secure world.

### II. LITERATURE REVIEW

The latest innovations in women safety systems have been more oriented towards incorporating artificial intelligence and computer vision methods to allow real-time monitoring and alert functions. Among them, one of the most interesting works is a system called Night Guardian: Empowering Women Safety with Hand Sign-based Communication and AI by P. D. Padmini et al., which uses MediaPipe to extract landmarks on hands and uses machine learning algorithms, including SVMs, KNNs, and Random Forests to recognize gestures [1]. The system is successful in detecting predetermined distress signals and providing alerts via SMS and voice. Nevertheless, the paper finds that there are limitations in assessing the performance of the system in different real-life situations like low lighting and background noise.

The other notable article is Silent Alert: Advancing women security with smart sign recognition and AI by Gurpreet Kaur et al. that uses a small convolutional neural network (CNN) to classify the gesture and uses Twilio to send real-time alerts [2]. An intelligent chatbot to confirm and respond to the system is also provided. Although the method improves automation and interaction with the user, issues like higher latency and lower accuracy in a variety of skin tones and hand variations were noted, and more inclusive and optimized models are required.

Along with fixed solutions, mobile and robotic-based safety solutions have also been investigated. The article, Womens Safety Patrolling Robot with Gesture Control, by Amit Patel and B. Menon illustrates how OpenPose can be used to identify gestures and a mobile robotic platform is used [3]. This system will stream video and send alerts in real time, to a central dashboard. Although its design is innovative, the prototype does not have a wide field testing and has practical constraints like battery capacity and dependence on networks, which influence its scalability and deployment.

Moreover, safety systems relying on wearables have also been suggested to make them more accessible and constantly monitored. The article by N. Sinha and A. Roy, titled Gesture-Based Pulse Alert System for Female Security, employs CNN-based gesture recognition in a wrist-worn device that is used to generate haptic and voice notifications [4]. This method is more portable, but small datasets and a lack of validation in the real-world limit it. In general, the literature available suggests that although gesture-based safety systems demonstrate encouraging outcomes, there are still a lot of issues associated with the robustness, scalability and real-time reliability, which the proposed system will be able to resolve.

### III. PROPOSED METHODOLOGY

#### A. Existing System

Current women safety systems are mostly manual based in terms of interaction like mobile application, panic button or voice activated alarms. These systems will require the user to activate an alert in case of an emergency, and this may not always be possible since the user will be afraid, physically restrained or have less time. In most instances, the victims cannot use their phones or emergency buttons in a timely manner and this makes them more vulnerable as their responses are delayed. Also, these systems require user awareness and preparedness, which restricts their use in real-time critical conditions.

Wearable, GPS positioning, and cloud-based alerts have been added to some of the modern solutions to improve safety. Nevertheless, they are usually limited in that they are dependent on the network, have delays in sending alerts, and privacy violations. In addition, the majority of the currently-existing systems do not have the intelligent real-time gesture recognition features which do not require a direct user response. They also fail to employ the most powerful machine learning methods to detect distress signals properly. Consequently, there is a great desire to have an automated, real-time and non-invasive safety system that is capable of detecting instances of distress and sending alerts immediately without having to input any information manually [1].

#### B. Proposed System

The proposed solution, which is titled Night Guardian: Empowering Women Safety through Hand Sign-based Communication and AI, is an intelligent real-time gesture recognition system that is aimed at improving personal safety via computer vision and machine learning. The system involves a webcam that constantly obtains live video input which is handled by MediaPipe to extract hand landmarks and keypoints with high accuracy. These features extracted are then transformed into numerical values and inputted into machine learning algorithms like Random Forest, Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) to be classified.

The system can recognize predetermined distress signals and automatically signal an emergency. When it is detected, an alarm is triggered to notify those around and an automatic email will be sent to pre-established emergency contacts and a screen shot taken as evidence. The system is real-time based and thus is able to respond fast without involving any manual action. The proposed system offers a safe, convenient, and user-friendly solution to the safety of women because it employs computer vision, machine learning, and automated alert mechanisms to ensure their safety [2].

#### C. System Architecture

- **Input Layer:** The system takes real-time video feeds with a web camera. The video stream is made of consecutive frames of the hand movement of the user when the conditions in the environment are changed (light change, noise). This input is sent to the processing unit where it is further analyzed.
- **Processing Layer:** The frames captured are preprocessed by removing the noise, normalizing them and scaling them to enhance the detection. It uses MediaPipe to extract 21 landmarks in the human hand and feature engineering methods are implemented like distance and relative positioning. The feature is then processed and fed to machine learning models (Random Forest, SVM, KNN) and gestures are classified.
- **Data Management Layer:** This layer contains gesture data, trained models, and predicted data. It keeps hand landmark records, classification records and system records. Continuous learning and enhancing model performance with time is done with the stored data.
- **Gesture recognition and decision layer:** This layer manages gesture recognition and selection. The trained machine learning model uses the input features to identify if the identified gesture matches one of the predefined distress signals. In the event of a match, the system will be an emergency condition.
- **Alert & Notification Layer:** When a distress gesture is detected, the system will activate several alert systems such as a local alarm system and automatic email notification. The email has the screenshot of the gesture and is transmitted through SMTP to emergency contacts or authorities.
- **Output Layer:** The system provides real-time alerts and notifications, and it means that the emergencies are immediately responded to. It is also user-friendly with

visual feedback cues, indicating gesture detection and system status.

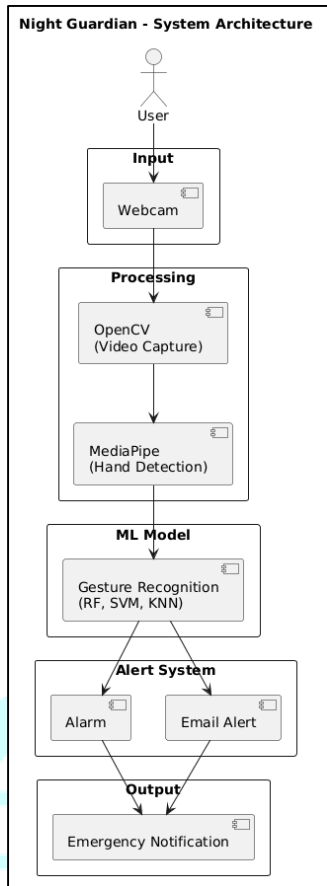


Fig. 1. System Architecture

#### D. Dataset Description

The data employed in this system is the images of hand gestures and real-time video frames which have been captured with a web camera. It consists of a range of predefined gestures denoting distress signs with different conditions including the different lighting, hand positions and backgrounds. All gestures are identified and transformed to numerical attributes depending on the hand landmark positions that are obtained with MediaPipe. Preprocessing methods (normalization, scaling, and augmentation (rotation, flipping, brightness adjustment)) are used to enhance the performance of the models. Training is done using standard datasets and custom-gathered gesture data. The data is split into training, validation and testing sets to test the model. Added features like relative distances of landmarks are added to improve the accuracy and strength of classification.

#### E. Expected Outcomes

The suggested system will greatly enhance the safety of women by offer them an effective and quick emergency response system. The three major key performance measures are accuracy of gesture detection, response time and reliability of alerts. The system also seeks to reach high accuracy (greater than 90%), in identifying distress gestures, and low latency to issue alerts. The system is to work well with various environmental conditions like in low-light, motion blur and partial occlusion. It provides timely communication with emergency contacts by automatic alerts, thus minimizing the response time in emergency situations. The architecturally lightweight and scalable nature enables it to be deployed on personal computing equipment like laptops and can be combined in the future with mobile or wearable systems.

#### F. Conclusion

The Night Guardian system proposed is an important solution to the safety of women in the technological context since it proposes an AI-based, real-time gesture recognition technique. This system is independent as opposed to manual safety systems where one is required to key in the data and send out alerts, as it automatically generates alerts when it notices distress gestures. MediaPipe, OpenCV and machine learning models are intertwined to guarantee the correct identification and effective processing. The system allows hands-free communication during emergency cases, thus improving its usability and reliability during such situations. Automated notifications, such as alarms and email notifications, will provide a timely intervention and enhance the overall safety. Moreover, the modular and scalable design of the system enables the potential improvements of the system in the future, including mobile integration, GPS tracking, and wearable devices. Altogether, the described system is innovative, practical, and impactful to provide women with empowerment in terms of their safety in a contemporary society.

## IV. RESULTS AND DISCUSSION

A series of experiments were carried out in order to determine the efficiency and performance of the proposed Night Guardian: Empowering Women: Safety through Hand Sign Communication and AI system. The main goal of these tests was to determine the effectiveness of the system to recognize distressing hand gestures correctly in real time and issue emergency alerts as quickly as possible. Among the key performance indicators (KPIs) to be considered are the accuracy of gesture recognition, response time, real-time processing efficiency, and the reliability of alert. To measure robustness the system was tested in a variety of real world conditions that included low lighting, background clutter, hand occlusions, and hand orientations. Also, the usefulness of the alert system, such as the ability to activate an alarm and receive an email with a screenshot as evidence, was also critically studied.

#### A. System Performance Evaluation

The proposed system was tested in terms of the accuracy of gesture detection, the processing time and the time of the alert. Gesture datasets were trained and tested on the machine learning models, such as the Random Forest, Support Vector Machine (SVM) and K-Nearest Neighbor (KNN). Random Forest was the most accurate in identifying predefined distress gestures. MediaPipe guaranteed high accuracy in hand landmark detection, even in moderate changes in the environment, whereas OpenCV supported the real-time processing of the video. The system was tested on the time taken to respond to the gesture in terms of time to detect the gesture and activate the alert. Experimentally, the system has been shown to be low latency and can be used in real-time applications. The system also had a steady performance in varying conditions like low and high light conditions, and partially covered hands. This indicates that the proposed approach is reliable and robust in safety applications in the field.

Table I  
Performance Measures of the Proposed System.

Performance Parameter	Measured Value (Proposed System)	Measured Value (Traditional System)
Gesture Detection Accuracy (%)	93	68
Alert Response Time (Seconds)	1.8	4.5
Real-Time Processing Efficiency (%)	91	63
Alert Reliability (%)	95	70

### B. User Experience and Usability

The system was tested in controlled test scenarios and user feedback to assess its usability. The system offers a very easy and user-friendly interface that graphically displays gesture detection and activation of alerts. The system was user friendly with users not having to interact manually in times of emergency. The automatic detection and alert feature greatly increases usability particularly in life and death situations where prompt action is needed. Feedback from users revealed the success of real-time gesture recognition and the readability of the system-generated alerts. The combination of visual feedback, email, and alarm use helped to create a pleasant user experience. All in all, this system proved to be usable, reliable, and accessible, which is why it could be deployed in real-world scenarios.

Table II  
User Satisfaction Survey Results

Evaluation Parameter	Rating (out of 5)
Ease of Use	4.8
Detection Accuracy	4.7
Real-Time Response	4.8
System Reliability	4.6
Overall Satisfaction	4.7

### C. System Comparison with Existing Solutions

The Night Guardian system suggested has tremendous advantages compared to the traditional solutions to women safety like panic button apps and manual alerts. The traditional systems rely on human interaction, which might not be possible in case of emergencies, causing response time lag. The suggested system on the other hand is automated and does not need any kind of manual input as it detects gestures of distress without the need of any manual input. The proposed solution enhances the processing of data locally, in comparison to cloud-dependent systems, with the help of computer vision and machine learning, which leads to reduced latency and enhanced reliability. MediaPipe and machine learning models combined allow one to identify gestures correctly and the automated alert system should guarantee immediate action. This real-time detection and autonomous alerting combination makes the system more efficient, reliable, and applicable in real-life safety applications.

### D. Anticipated Improvements and Future Work.

Despite the good performance of the system, it can be further improved in a number of areas. Gesture recognition can be improved by adding deep learning-based models, including Convolutional Neural Networks (CNNs) or transformer-based

models, to achieve greater accuracy in gesture recognition, particularly in extreme situations, such as low-light or high-speed movement of the hand. Generalizability and strength of the model will also be enhanced by increasing the sample size with more varied samples. Further improvements can be made to it in the future by being integrated with mobile devices and wearable technology to make it more portable and accessible. Emergency response can be further enhanced by adding GPS tracking and SMS alerts. Long-term data storage and analytics could also be considered a cloud integration to enhance the intelligence of the system in the long term. Also, data privacy and system security will be required to support large-scale deployment.

### E. Conclusion

The offered Night Guardian system is a big step towards female security as it uses artificial intelligence and real-time gesture recognition. The system has high accuracy, low response time and reliable alert mechanisms, which make it applicable in the real world. It removes the need to interact manually and is a proactive and efficient safety solution. The modular and scalable nature of the system enables it to be easily extended and integrated with new technologies. On the whole, the offered solution improves personal safety, shortens the time of response during the emergencies, and helps to create the safer and more secure environment of women.

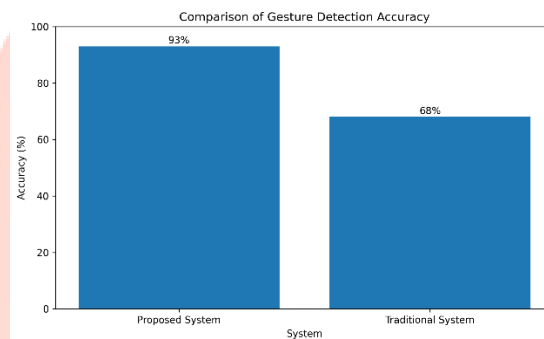


Fig. 2. Comparison of Accuracy of Gesture Detection of the Proposed System and Traditional Systems.

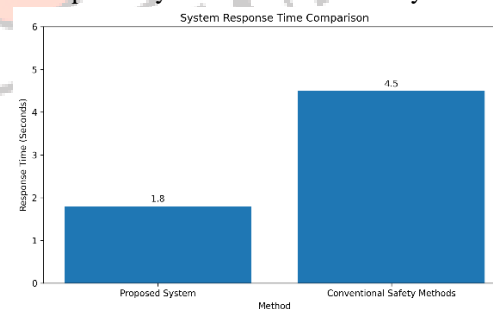


Fig. 3. System Response Time (Performance Analysis) vs Conventional Safety Methods.

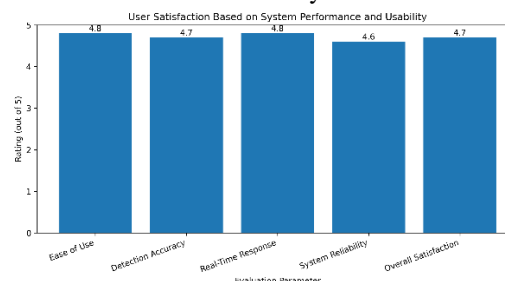


Fig. 4. User Satisfaction Rating Based on System Performance and Usability.

## V. CONCLUSION

The Night Guardian: Empowering Women with their Safety through Hand Sign-based communication and AI is an innovative and highly effective way to solve one of the most important problems in society, namely, the safety of women. With the help of the advanced technologies, including MediaPipe, OpenCV, and machine learning algorithms, the system provides the possibility to quickly identify the signs of distress and exclude any cases of manual intervention in case of an emergency. Such an approach that allows hand-free access is particularly advantageous in those cases when victims might not have access to standard safety tools, such as mobile applications or panic buttons.

The experimental findings reveal that the system is accurate in gesture recognition, has low response time, and reliable alert systems. Combination of machine learning models like Random Forest, SVM and KNN assure the strong classification of gestures, whereas MediaPipe offers more accurate hand-landmark recognition in diverse environmental conditions. The fact that the system can be reliable and run well even during a real-time situation indicates its practicability and efficiency in a real-world scenario.

Moreover, the alert system that is built into the system, such as the local alarm trigger, and the automatic email notification with evidence capture, will guarantee real-time communication with the emergency contacts or police. This quick reaction feature is of significant importance in reducing the risks and enhancing the possibility of immediate help. The ease of use and automated workflow of the system also play a part in creating a positive user experience, thus making it accessible and user-friendly to a broad spectrum of users.

To sum up, the suggested system provides a scalable, effective, and future-proof method of making women safer with the help of artificial intelligence. Its modular design can be further enhanced with mobile integration, GPS positioning, and the wearable compatibility. The Night Guardian system, through a combination of technological innovation and social impact, is very much helping to create a safer world and giving people the power to create solutions that are proactive in ensuring their safety.

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