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SOS Detection: Distress Signal Recognition

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Abstract
In emergency situations where individuals cannot verbally call for help, there is a critical need for a reliable and efficient non-verbal communication system. This project proposes a real-time SOS gesture recognition solution using advanced computer vision techniques to address this need. The system utilizes MediaPipe for precise hand gesture detection and OpenCV for robust image processing to identify a predefined SOS gesture sequence, specifically an open hand followed by a fist. Upon detecting the SOS gesture, the system captures an image of the individual, overlays a timestamp in the bottom-right corner for context, and promptly sends an email alert with the captured image to a predefined recipient using SMTP (Simple Mail Transfer Protocol). This ensures that the alert is dispatched quickly and reliably. The solution is designed to ensure real-time processing and minimal latency, making it highly responsive in critical situations. Additionally, its ease of deployment and adaptability make it suitable for a wide range of applications, including personal safety, medical emergencies, and security systems. By providing a silent and effective method for signaling distress, this system enhances safety and offers peace of mind in various high-risk environments.

Keywords: *SOS Gesture Recognition, Computer Vision Techniques, Media Pipe, Hand Detection, OpenCV image Processing, SMTP Email Alert.*

1. Introduction
The SOS Detection System project utilizes MediaPipe's hand-tracking framework and OpenCV for image processing to develop a robust, non-verbal method for signaling distress, specifically tailored for security applications. By recognizing an SOS gesture sequence (fingers outstretched with the thumb tucked across the palm, followed by a fist with the thumb inside) and employing a frame-based transition mechanism, the system ensures accurate detection and minimizes false positives. Upon successful detection, the system captures a timestamped image and sends it via email using SMTP (Simple Mail Transfer Protocol) to a designated recipient, providing timely emergency alerts. This innovative solution is particularly valuable in high-risk environments where vocalizing a call for help is not feasible, such as during a home invasion or in a high-risk job. By enabling a silent alarm, it ensures a rapid response without alerting potential threats, thereby enhancing security and providing an additional layer of safety and peace of mind for users.

1.1. Importance of the work
This project enhances personal safety by providing a real-time SOS gesture detection system using computer vision and machine learning. It enables users to silently signal for help through a predefined hand gesture, with immediate image capture and email alerts. The system ensures reliability through accurate hand landmark detection and sequence recognition, making it a valuable tool for emergency response and future gesture-based applications [1-3].

1.2. Objective
The SOS Detection System project is designed to detect a predefined SOS hand gesture sequence using MediaPipe's hand-tracking framework, capture and timestamp an image of the individual using OpenCV

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for image processing, and send an alert email to a predefined recipient via SMTP (Simple Mail Transfer Protocol) for timely emergency alerts. This system ensures accurate and real-time distress signal recognition, providing an additional layer of security and peace of mind in high-risk environments where vocalizing a call for help is not feasible.

1.3. Project Description and Features

The SOS Detection System project is designed to create a robust, non-verbal method for signaling distress, specifically tailored for security applications. Utilizing MediaPipe's hand-tracking framework for accurate gesture recognition and OpenCV for image processing, the system detects a predefined SOS hand gesture sequence—fingers outstretched with the thumb tucked across the palm, followed by a fist with the thumb inside—employing a frame-based transition mechanism to minimize false positives. Upon successful detection, the system captures and timestamps an image of the individual and sends an alert email via SMTP (Simple Mail Transfer Protocol) to a predefined recipient, ensuring timely emergency alerts. This innovative solution is particularly valuable in high-risk environments where vocalizing a call for help is not feasible, such as during a home invasion or in high-risk jobs. By enabling a silent alarm, the system ensures rapid response without alerting potential threats, enhancing security and providing an additional layer of safety and peace of mind for users. Additionally, the system's scalability and potential to recognize additional gestures make it a versatile tool for various applications, including healthcare and accessibility. With its efficient real-time operation, the SOS Detection System stands out as a significant advancement in providing reliable and silent distress signaling, showcasing the powerful integration of computer vision and machine learning techniques to enhance user safety and security [4-7].

1.4. Social Impacts

- Non-Verbal Aid: The SOS Detection System provides a non-verbal way for individuals with speech or mobility impairments to seek help in emergencies, significantly improving their safety and independence. By recognizing specific hand gestures, it ensures that individuals who cannot communicate verbally or physically press a panic button still have a reliable method to signal distress and receive timely assistance.
- Inclusive Method: The system offers an inclusive communication method for individuals who struggle with traditional emergency alert systems, such as the elderly or those with disabilities. By enabling gesture-based alerts, it ensures that all individuals, regardless of their physical or cognitive abilities, can effectively communicate distress and receive the necessary help, thereby enhancing their overall well-being and security.
- Efficient Alerts: Eliminating the need for physical panic buttons or verbal calls, the SOS Detection System makes emergency alerts more efficient and accessible in various environments. Whether in a high-risk job, during a home invasion, or in other scenarios where making a verbal call is not feasible or safe, this system provides a silent and immediate method to alert designated recipients, ensuring a rapid response and enhancing security.

1.5. Challenges

The SOS Detection System faces limitations such as variability in individuals' gesture performance, which can complicate recognition; challenges in maintaining accuracy amid occlusion and clutter in real-world environments; the need for minimal latency and efficient processing on devices with limited computational power; continuous adaptation to new lighting conditions; privacy concerns with image capture and transmission requiring robust encryption and data handling practices; and the difficulty of distinguishing SOS gestures from everyday hand movements to avoid false alerts. Addressing these limitations is crucial to ensure the system's reliability and effectiveness [8].

2. Literature Survey

Gesture recognition for SOS signals has emerged as a vital tool in ensuring personal safety, especially in high-risk environments. The integration of advanced hand-tracking frameworks, such as MediaPipe, and image processing tools like OpenCV, has enabled the

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development of robust systems that accurately identify distress gestures in real time. By recognizing specific SOS hand gestures and incorporating frame-based transition mechanisms, these systems minimize false positives and ensure precise detection. The captured and timestamped images are sent via SMTP to designated recipients, providing timely emergency alerts. This approach is particularly beneficial for individuals with speech or mobility impairments, offering a non-verbal and efficient method of seeking help. The adaptability of such systems to various lighting conditions and backgrounds further enhances their reliability. Additionally, the inclusion of machine learning techniques allows these systems to learn and improve over time, making them indispensable in applications ranging from personal security to accessibility.

2.1. Methodology used

The SOS Detection System uses MediaPipe's hand-tracking framework and OpenCV for image processing to detect a predefined SOS hand gesture sequence. It ensures accurate and real-time distress signal recognition with a frame-based transition mechanism to minimize false positives. Upon detection, the system captures and timestamps an image, sending an alert email via SMTP to a predefined recipient. This provides an efficient non-verbal method for signaling distress, enhancing security and ensuring timely emergency response in high-risk environments.

2.2. Merits

- **Minimized False Positives/Negatives:** Utilizes a frame-based transition mechanism to accurately recognize the SOS gesture sequence, reducing the chances of false alarms.
- **Automated Alerts:** Automatically captures a timestamped image and sends an emergency alert via email, ensuring timely response and intervention.
- **Scalability:** Can be expanded to recognize additional gestures, making it versatile for various applications beyond security, including healthcare and accessibility.

2.3. Limitations

- **Lighting and Background Variability:** The system may struggle to accurately detect gestures in extreme lighting conditions, such as very bright or very dark environments. Complex or cluttered backgrounds can also interfere with the accuracy of gesture recognition
- **Gesture Ambiguity:** Users may unintentionally perform gestures that resemble the SOS sequence, leading to false positives. This can be particularly challenging in situations where hand movements are common and varied.
- **Hardware Requirements:** The system relies on a camera with sufficient resolution and frame rate to capture clear and detailed hand movements. Poor camera quality can hinder the effectiveness of gesture recognition.

2.4. Future Work

The future work for the SOS Detection System focuses on enhancing gesture recognition accuracy through advanced machine learning, adapting to various environmental conditions, and optimizing hardware for better real-time processing. Privacy and security measures will be strengthened, along with user training and customization options to improve accessibility. Integration with existing security infrastructure and scalability to handle larger user bases will be prioritized. Continuous evaluation and user feedback will drive ongoing improvements, ensuring the system remains a reliable and versatile tool for distress signal recognition in high-risk environments.

3. Requirements

3.1.Hardware Requirements

- Processor: Ryzen 5
- RAM: 8GB
- Hard Disk: 512GB SSD

3.2.Software Requirements

- Operating System: Windows 10
- Programming Language: Python – v3.9

3.3.Libraries

- OpenCV (Open Source Computer Vision Library) for Python
- Mediapipe Framework
- SMTP (Simple Mail Transfer Protocol) library for sending mail, Figure 1 & Figure 2.

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4. System Design

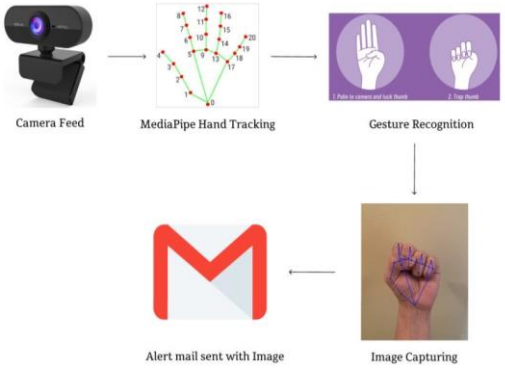

Figure 1 System Design

5. Result

Figure 2 Results

Conclusion

In conclusion, this project presents a comprehensive SOS detection system that leverages advanced hand gesture recognition techniques for effective emergency alert generation. By implementing state-of-the-art models and integrating with real-time communication systems, it enhances the promptness and reliability of distress signal recognition. Future work will focus on improving the accuracy of gesture recognition, expanding the system's adaptability for various environments, and enhancing user accessibility for individuals with disabilities. Ultimately, this project aims to significantly bolster emergency response systems and ensure timely assistance for those in need in a variety of critical situations.

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