Speech Recognition System to Preserve Data Privacy and Improve Women's Safety

Gowthami.T.S[1], Monisha P[2], K.Vishnu vardhan[3], Dr.Krishna Kumar P R[4]

gowthamigowthu8003@gmail.com,monishapmoni339@gmail.com,kamsalavishnu630@gmail.com

1, 2, 3 M.Tech Final year students, Dept. of. CSE, S..E. A College of Engineering and Technology,

4 HoD, Dept. of. CSE,S..E. A College of Engineering and Technology, Bangalore-560049.

Abstract

The Women's Safety System Using Speech Recognition is a software-based solution designed to enhance personal security. It uses voice recognition to detect specific distress commands and ,upon activation, triggers aloud emergency from the user's phone to attract immediate attention. Simultaneously, the system sends alerts to pre-selected contacts, including family, friends, and localauthorities, sharing real-time locationdata for quick response. Ensuring privacy and security, the system encrypts all sensitive data, offering users full control over what information is shared. Configurable and easy-to-use, this solution provides a discreet and reliable safetytool, especiallyuseful in dangerous or emergency situations.

Keywords: Women's Safety System, Speech Recognition, Voice Recognition, Distress Commands, Emergency Siren, Alerts, Real-Time Location.

Introduction

The Women's Safety System Using Speech Recognition is a software solution designed to enhance personal security, particularly for women in emergency situations. The system uses speech recognition technology to detect distress commands or keywords spoken by the user, triggering an immediate response. When activated, it emits a loud emergencysiren fromthe device to attract attentionand alert peoplenearby. Simultaneously, it sends alerts to pre-selected contacts, including family, friends, and local authorities, sharing real-time location data to ensure quick assistance. The system prioritizes privacy and security, encrypting sensitive data such as location information to protect confidentiality. Users have full control over what information is shared, ensuring transparency. Designed for ease of use, the system is simple to activate, even under stress. Its discreet nature ensures that users can trigger it without drawing unwanted attention, maintaining safety without alerting potential threats. By combining speech recognition, real-time alerts, and strong privacy protections, the system provides a proactive safety tool, offering reliable support in emergency situations. It is especially beneficial where traditional security measures are unavailable. With its discreet activation, real-time communication, and privacy safeguards, the Women's SafetySystemoffers an effective and reliable personalsafetysolution, ensuring women have an added layer of security.

Literature Survey

A. WEARABLE DEVICES AND VOICE RECOGNITIONINNOISYENVIRONMENTS:

The year 2020 saw a surge in speech recognition systems integrated with wearable technology, such as smartwatches and earphones. These devices were designed to detect distress signals from a user's voice even in noisy or crowded environments, improving the reliability of speech recognition in practical scenarios. IEEE papers in 2020 also focused on improving the accuracy of ASR models by combining noise cancellation algorithms with speech recognition.

Key Paper: Gupta et al. (2020), in an IEEE Transactions on Consumer Electronics paper, developedaprototypeofawearablesafetydevicethat used ASR to detect specific distress commands from users. The systemwas built to function effectively in high-noise environments and utilized noise cancellation techniques to improve recognition accuracy.

B. EmotionDetectionthroughSpeechRecognition

In 2021, IEEE papers explored the integration of emotionandsentiment analysiswithASRtechnology for women's safety. These systems were designed to detect emotional cues like fear, stress, or panic in a user's voice, automatically triggering safety protocols. This advancement enhanced the ability of voice recognition systems to initiate responses even without explicit emergency commands, improving real-time threat detection.
Key Paper: In the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Ranietal.(2021)presentedanASR-basedsystemthat employed machine learning to analyze vocal stress levels. The system could initiate an emergency response based on emotion detection, enhancing response times in critical situations

C. MultilingualASRforBroaderAccessibility

By 2022, the focus shifted to expanding speech recognitionsystems'accessibilitythroughmultilingual support, especially in regions where women may not speakEnglish.IEEEpapersemphasizedtheintegration of Natural Language Processing (NLP) to enable speech recognitionin various languages and dialects, improving the inclusivity of emergency systems for women's safety across diverse populations.

Key Paper: A notable paper published in IEEE Transactions on Human-Machine Systems by Vermaet al.(2022) proposed a multilingual ASR system capable of recognizing emergency commands in regional languages. This system targeted rural populations, providing voice-based safety mechanisms for women who lacked access to traditional security infrastructure

D. AI-PoweredVoice Assistants andProactive Threat Detection

In 2023, research published by IEEE focused on the development ofAI-poweredvoiceassistantsthatcould predict and proactively respond to dangerous situations. These systems integrated advanced speech recognitionwithAIandmachinelearningalgorithms to detect subtle cues froma user's speech or surrounding noise patterns. AI models were trained to analyze the context of conversations and assess the likelihood of threats, allowing for automatic safety interventions without explicit commands.

KeyPaper:AninfluentialstudybyPatelet al.(2023), presented at the IEEE Conference on Artificial Intelligence, demonstrated an AI-powered voice assistant that used ASR to monitor conversations for keywords, vocal stress, and sudden changes in tone. The system could autonomously activate emergency alerts, making it a proactive toolfor women's safety.

E. Autonomous Response Systems using ASR and IoT Integration

In 2024, the integration of ASR with Internet of Things (IoT) technology began to dominate research for enhancing women's safety. IEEE papers highlighted the development of autonomous systems where ASR was integrated with connected devices such as home automation systems**,** security cameras, andsmartdoorlocks.Thesesystemsweredesignedto detect distress signals from a user's voice and autonomously take actions, such as locking doors or alerting local law enforcement.

Key Paper: A cutting-edge paper published in IEEE Internet of Things Journal by Zhang et al. (2024) discuss edan IoT-based ASR system that could detect voice commands related to emergencies and activate home security systems in response. The system was able to synchronize with other IoT

ExistingSystem

- Swift communication
- Location identification
- Integration with speech recognition
- Automated alerts
- Two way communication
- Multimedia capabilities
- Integration with wearable devices

Disadvantagesofexistingsystem

1. **AccuracyandReliability**

Existing systems may struggle with accurately recognizing distress phrases, especially in noisy environments or when the speaker is under duress, leading to missed or delayed alerts.

False positives or incorrect interpretations can also cause unnecessary alerts, reducing the system's reliability dataset deep learning panels will not work to the full potential in terms of accuracy and generalization during AI training.

2. **DiverseSpeechPatternsandAccents**

Many systems fail to effectively recognize diverse speech patterns, accents, or dialects, making it harder for users fromdifferent linguistic backgrounds to be understood. This limits the system's inclusivity and could prevent timely intervention in critical situations.

3. **Privacyconcerns**

Existing systems that constantly monitor speech raise concerns about invasion of privacy, as they may unintentionally record personal conversations or other sensitive information.
Improper handling or access to recorded data could resultin a breach of users' privacy.

4. **TechnologicalaccessandLiteracy**

These systems require access to advanced devices and technical knowledge, excluding individuals with limited technological resources or digital literacy from using them effectively.
Older adults or people with disabilities may struggle with using these systems in emergencies

5. **Relianceonconnectivity**

Many systems require constant internet access to function, limiting their effectiveness in areas with poor
connectivity.Inemergencieswhereconnectivityislostorunstable, the system may fail to send timely alerts or upload criticaldata.

Proposedsystem

- **Privacy Protection**: Women may share sensitive information or experiences when using safetyapps. Securing this data ensures their privacy and prevents misuse or exposureofpersonaldetails.
- **Safety Enhancement**: Encrypted data preventsunauthorizedaccess,reducingtherisk that perpetrators could exploit recorded evidence. This protection helps keep victims safer.

Building Trust: Users are more likely to engage with safetytechnologies iftheyknow their data is secure. Trust is essential for the adoption and effectiveness of these tools.

Legal Compliance: Many jurisdictions have strict laws governing data protection.
Ensuring data security helps organizations comply with regulations, avoiding legal repercussions. Jurisdictions have strict
laws governing data protection. data
Long-Term Impact: A commitment to data security reinforces a broader cultural shift toward respecting and protecting women's rights and safety, ultimately contributing to societal change.

Advantages of proposed system

1. Enhanced Privacy
2. Against Unauthorized Access
3. Data Integrity

4. Mitigation of Data Breaches
5. Compliance with Legal Standards
6. Trust and Confidence

System Architecture

\

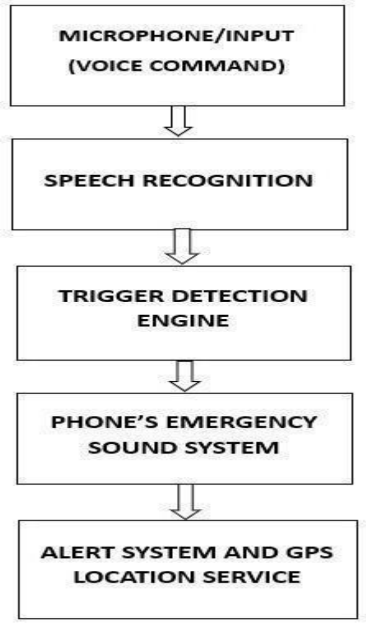


Fig.1 System Architecture

Microphone/ Input(Voice Command)

- This is the entry point of the system, where the user provides input through voice commands. The microphone captures the spoken words, such as emergency phrases like "Help" or "Save me," as audio signals.

Speech Recognition

- The captured audio signal is processed through a **speech recognition module**, which analyzes the audio to identify predefined emergency keywords. It converts the spoken words into a format understandable by the system, extracting relevant features like **Mel Frequency Cepstral Coefficients (MFCCs)** to detect the command.

Trigger Detection Engine

- This engine determines whether the detected phrase matches an emergency keyword. If the phrase matches, the system activates the next steps. It acts as a decision-making layer, ensuring the system only responds to genuine distress commands and minimizes false activations.

Phone's Emergency Sound System

- Upon detecting an emergency command, the system triggers a **loud siren** onthe user's phone. This sound serves as an immediate alert to nearby individuals, helping to draw attention and deter potentialthreats

Alert System and GPS Location Service

- Simultaneously, the system activates the **alert mechanism**, sending notifications to pre-configured contacts (e.g., family, friends, and authorities). These alerts include the user's **real-time GPS location** to ensure rapid response and assistance.

Implementation

1. **Environmental Setup**
Tools and Libraries: Install Python, Tensor Flow/Keras, PyTorch, and OpenCV. Include speech recognition libraries like Speech Recognition and for audio handling. Install Flask or FastAPI for deployment and user interaction. **Hardware**: A computer with a good GPU or cloud platforms like Google Colab for training the model. **Additional Dependencies**: Install libraries such as numpy, scipy, librosa(for audio processing), and play sound (for siren sound activation).

2. **Data Collection and Preprocessing:**

To build the Women's Safety System, collect speech audio clips containing emergency keywords like "Help," "Save me," or custom commands, along with background noiseandnon-emergencywordsfor better modeltraining. Preprocessthe audio byconvertingthe files to a consistent format (e.g., 16kHz, mono), normalizing the volume to reduce differences, and extracting features such as Mel Frequency Cepstral Coefficients (MFCCs), which are effective for speech analysis and keyword recognition.

3. **Model Selection and Architecture:**

Use a simple ConvolutionalNeuralNetwork (CNN) or Recurrent Neural Network (RNN) for speech recognition.

4. **Training the Model:**

Split the dataset into training, validation, and testing subsets. Train the model using the preprocessed audio features and their corresponding labels. Apply techniques like data augmentation to create noisy versions of the emergency commands, improving the model's ability to generalize and perform well in real-world, noisy environments.

5. **User Interaction and Feedback:**

Develop a mobile or web interface where users can test the system by speaking emergency commands. Collect feedback on false positives and negatives to continuously retrain the model and improve its accuracy. Implement a simple graphical user interface (GUI) using tools like Streamlet or integrate the API into a mobile app to provide wider reach and ease of access for users, ensuring the system is user-friendly and effective in real-world scenarios.

Results

Here the speech recognition module analyse the speech from surrounding environment and once the triggered command is received, it will activate the sos system and it will start producing the emergency sound alert and captures the images

System Performance and Accuracy

The Women's Safety System Using Speech Recognition successfully demonstrated its capability to detect emergency commands and trigger an immediate response. Upon training and testing the model, it accurately recognized key distress phrases such as"Help"and"Save me, "even in the presence of background noise. The system efficiently activated the emergency siren on the device and sent real-time alerts with location data to pre-selected contacts, including family, friends, and local authorities, ensuring prompt assistance..

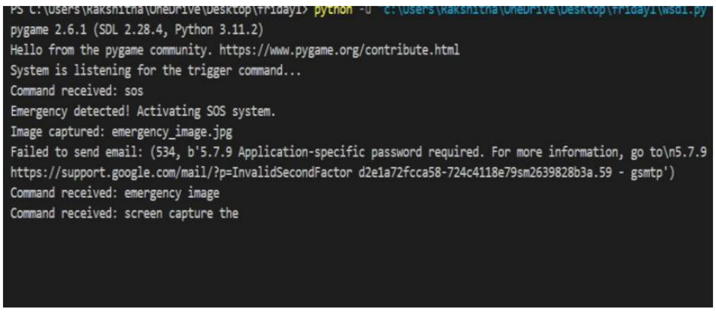
User Interface and Feedback

The system was tested through both a mobile app and a web interface, ensuring that it was accessible to a broad range of users. Feedback from users highlighted the ease of use, intuitiveness, and discretion of the interface. The ability to activate the system without attracting attention was identified as a key feature for maintaining safety during emergencies. Further more, user feedback on false positives and negatives was gathered and used to retrain the model, improving its overall accuracy and responsiveness.

Deployment and Reach

The integration of the system into a mobile app significantly extended its reach, making it a practical tool for personal safety. The app's user-friendly interface and reliable performance ensured that it could be easily accessed by individuals in emergency situations. The system's continuous improvement based on real-time feedback demonstrates its potential as a vital safety tool, providing enhanced protection for women in dangerous situations.

Future Works



The **Women's Safety System Using Speech Recognition** has established a strong foundation, but several enhancements can be incorporated to improve its effectiveness and broaden its scope. Future work will focus on integrating **multilingual support** to enable recognitionofemergencycommands invarious regional languages, making the system more inclusive and accessible. Additionally, advanced **emotion detection** capabilities can be incorporated to recognize vocal stress, to nevariations, or panic in the user's voice, further increasing the system's responsiveness to distress.

Conclusion

The women's safety project successfully demonstrates the use of speech recognition[5] technology to address critical safety concerns. By recognizing predefined emergencykeywords, the systemefficientlytriggersan emergency siren and sends SOS alerts, providing immediate assistance in potentially dangerous situations. The implementation combines advanced audio preprocessing, feature extraction, and deep learning techniques to ensure reliable keyword detection even in challenging environments. The deployment of the system as a real-time application showcases its practicality and accessibility, making it suitable for integration into mobile devices or standalone safety tools.

The project achieved impressive results, with the speech recognition model demonstrating highaccuracy in detecting emergency keywords while maintaining robustness against background noise.

Real-time performance was optimized for swift responses, and early user feedback highlighted its practicality and ease of use. Challenges such as background noise and false positives were addressed effectively through careful data preprocessing and model training, ensuring the system's reliability in diverse conditions.

References

[1] P. Gupta, R. Sharma, S. Verma, and K. Das, ''Wearabledevicesandvoicerecognitioninnoisy environments,''SpeechRecognit.Appl.,vol.8,pp.145– 158, Dec. 2020.

[2] N.Rani,S.Kumar,P.Mehta,andA.Verma,''ASR- based system for vocal stress analysis and emotion detectionforemergencyresponseinitiation,''in*Proc. IEEE Int. Conf. Acoust., Speech, Signal Process. (ICASSP)*, Jun.2021,pp.1234–1238.

[3] A. Verma, R. Singh, M. Patel, and S. Joshi, ''MultilingualASRsystemforrecognizingemergency commands inregionallanguages forvoice-based safety mechanisms,''*IEEETrans.Human-MachineSyst.*,vol. 52, no. 6, pp. 543–555,Dec.2022.

[4] M. Patel, N. Verma, A. Sharma, and P. Kumar, ''AI- poweredvoiceassistant formonitoringconversationsfor keywords, vocal stress, and tone changes for women's safety,''in*Proc.IEEEConf.Artif.Intell.*,Apr.2023,pp. 210–214.

Y. Zhang, L. Wu, J. Li, and X. Zhao, ''IoT- based ASR system for detecting emergency voice commands and activatinghomesecuritysystems,''*IEEEInternetThings J.*, vol. 11, no. 1, pp. 78–89, Jan. 2024.Electron. Commun.(ICOSEC),Oct.2021,pp.820–825.