



Voice-Automated Emergency Response System

**Prof. Dr. Jeyaprabha T J¹, Haresh Krishna G S², Harinee V T³,
Balasaraswathy B⁴**

¹Associate Professor, ECE, Sri Venkateswara College of Engineering

^{2,3,4}UG Student, ECE, Sri Venkateswara College of Engineering

Abstract

During emergencies, personal safety depends on fast and reliable SOS communication and response. Traditional methods such as phone calls, mobile applications, and panic buttons have the limitation of delayed triggering due to the involvement of manual operation of the device by users. Since time is the key factor in determining the effectiveness of such SOS devices, they are considered disadvantageous. To overcome this, the proposed solution is a voice-triggered distress alert system that listens for specific distress keywords customized by the user during the initialization of the device. Upon detection of a keyword, the current location of the user is obtained using GPS and shared with the designated authority using a GSM module, providing timely assistance. Experimental results show that this system proves to be reliable and practical for prompt response during emergencies.

Keywords: Emergency communication systems, Voice-triggered distress detection, Speech recognition algorithms, GPS-based location services, GSM-enabled alerting, Real-time emergency response

Introduction

Personal safety is continually exposed to numerous emergency scenarios, including assaults, accidents, medical complications, and direct threats. In such high-stakes situations, the ability to contact rescue services without delay can be the decisive factor in reducing harm and potentially saving lives. However, amid the turmoil of an actual crisis, people often cannot seek help right away. Panic may take over, injuries may limit their ability to move and may make communication impossible. When every second counts, the real value of any safety system is defined by how quickly and reliably it can transmit a distress signal.

At present, most emergency alert systems still rely heavily on deliberate user input. We depend on phone calls, SOS functions on smartphones, or dedicated panic buttons. Although these options are widespread, each one demands that we consciously operate it. In a critical moment, searching for a phone, unlocking it, or opening the correct app can be completely unrealistic. Even a short delay in sending an alert can be dangerous. Countless safety reviews and incident reports show that slow emergency communication frequently worsens the impact of an incident, especially in isolated locations or high-risk settings.

This pressing shortfall has driven growing interest in the use of intelligent and assistive technologies to build safety solutions that require very little user input. In particular, hands-free emergency alert systems, most notably those triggered by voice, have gained attention as a compelling alternative. By allowing individuals to request assistance simply by uttering specific preset keywords, these voice-activated tools become especially valuable in situations where manual operation is impossible.



They are especially promising for at-risk groups such as women, older adults, children, and people with physical impairments.

However, despite these promising advances, many current safety systems still provide only limited automation or operate as standalone tools. In many cases, automatic distress detection is not fully integrated with precise location tracking or consistently reliable alert delivery. Ongoing challenges such as false alarms and unreliable location data further hinder overall system effectiveness. Together, these gaps highlight the need for a more unified, end-to-end emergency alert solution, one that works autonomously while ensuring accurate and timely communication.

To directly address these challenges, our work presents an innovative voice-activated SOS alert system engineered for fast and reliable emergency communication. The system continuously monitors audio input, listening for distress keywords that the user specifies during the initial setup. As soon as a trigger word is detected, it automatically determines the user's current location via GPS and promptly sends an alert message to preselected authorities or emergency contacts using GSM communication. To avoid unintended activations, a brief cancellation period is provided. In essence, the proposed system is designed to substantially reduce response times, minimize user effort in critical situations, and significantly enhance overall personal safety.

The main contributions of this work are:

- Development of a voice-activated, hands-free SOS alert system specifically engineered to enhance personal safety.
- Integration of GPS and GSM modules to provide real-time, location-based emergency notifications.
- Experimental validation of the system to thoroughly evaluate its reliability and effectiveness in various emergency scenarios.

The remainder of this paper is structured as follows. Section 2 reviews related works on emergency alert systems and voice-based safety solutions. Section 3 presents the proposed system. Section 4 describes the system architecture and methodology. Section 5 outlines the experimental setup. Section 6 presents and analyzes the results. Finally, Section 7 concludes the paper and discusses future work directions.

Related Works

Emergency alert systems, which facilitate quick communication during critical incidents, are now an essential part of modern public safety frameworks. Their responsiveness and dependability have been significantly improved by technological advancements. This review summarizes existing systems, highlights key findings and constraints, and suggests promising directions for further study.

The advent of Information and Communication Technologies (ICT) has transformed emergency management systems by improving communication and operational efficiency.[1] discuss the utilization of ICT for effective emergency management networks, emphasizing the need for real-time data processing and participatory sensing. They also suggest that integrating Geographic Information Systems (GIS) can enhance situational awareness during emergencies, which is crucial for timely dissemination of alerts. This aligns with the findings of [2], who highlight the role of communication technologies in automatic accident detection and underscore the importance of real-time assistance in emergencies.

Research also highlights several challenges in implementing effective emergency alert systems.[3] conducted a survey on wireless communication technologies for public safety and identified issues

such as interoperability, reliability, and network coverage. These challenges can hinder the performance of alert systems, particularly in rural or underserved areas.

Speech recognition combined with location services can significantly improve emergency response by enabling timely and context-aware alerts. Recent work has improved keyword detection and emotion recognition using hybrid models such as CNN and BiLSTM architectures, which effectively process critical speech segments and support rapid decision-making by responders. These approaches also reduce computational complexity to meet real-time constraints in high-stress environments [4].

Location-based services, particularly those utilizing GPS technology, are integral to personal safety applications in emergency response. These services allow real-time tracking of individuals, which is crucial in time-sensitive situations. By integrating GPS data with emergency alert systems, responders can accurately locate individuals in distress, facilitating quicker interventions [5]. The seamless integration of location data with emergency alert systems enhances the efficiency and effectiveness of response efforts.

Taken together, these findings point to two practical priorities for future work:

- On-device, low-power keyword detection with low false alarm rates.
- Hybrid location strategies that combine GPS with network- and sensor- based fallbacks.

Proposed System

The proposed voice-activated distress alert system is designed to enable fast, effective, and reliable communication of the user's location to concerned authorities. This solution integrates a keyword detection algorithm with GPS and GSM modules to transmit an SMS containing the user's location in real time to predefined contacts such as police or nearby hospitals.

The overall workflow of the proposed system is shown in Fig. 1.

This work presents a compact, hands-free SOS alert system that combines on-device keyword detection with location acquisition and automated alert transmission. The design emphasizes low cost, ease of deployment, and rapid response. A spoken distress keyword initiates an automated sequence

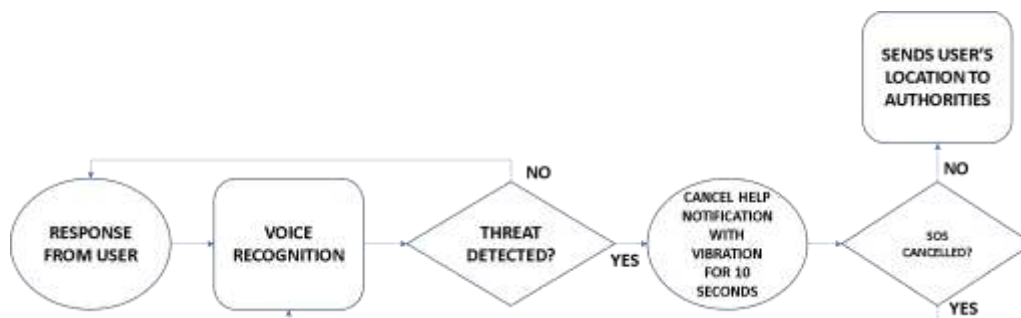


Figure 1: Overall Workflow

that acquires the user's position, issues a cancellable alert notification, and transmits location and status information to predefined contacts or authorities.

The overall functional block diagram is illustrated in Fig. 2. The system adopts a modular architecture that prioritizes rapid detection, user safety, and operational resilience in real-world emergency scenarios.

A layered approach is followed, where sensing, local decision-making, and external communication are

separated into distinct but tightly integrated subsystems. This separation clarifies responsibilities, simplifies testing, and enables incremental upgrades without disrupting core safety logic.

Critical decision processes such as keyword recognition, confirmation logic, and immediate user feedback are maintained locally on the device to ensure timely alert initiation.

The communication layer is responsible for acquiring geo-location, composing concise alert payloads, and reliably transmitting them to predefined contacts or services while reporting transmission status back to the user.

Practical considerations such as low latency, low power consumption, and fail-safe mechanisms (such as cancellation windows) are incorporated into the design to reduce false activations and maximize the likelihood of successful alert delivery.

Finally, the system accounts for real-world constraints such as indoor GPS degradation, intermittent GSM coverage, and noisy acoustic environments, and includes fallback strategies and logging mechanisms to support post-incident analysis and iterative improvements.

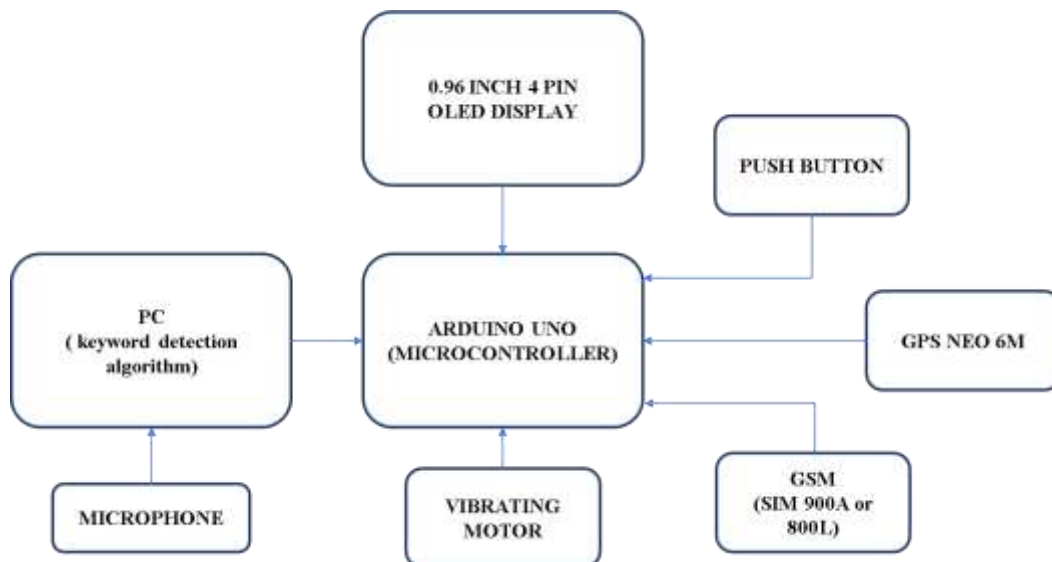


Figure 2: Overall Functional Block Diagram

Architecture and Methodology

System Architecture

The circuit diagram simulated in Cirkuit Designer illustrates a compact, layered SOS device in which sensing, local processing, and communication are clearly separated. The sensing layer captures audio through a microphone and provides immediate user feedback via an OLED display and a vibration motor. The local processing layer, implemented using an Arduino-based Python keyword recognizer, performs keyword detection, confirmation logic, and manages the cancellable alert workflow. The communication layer acquires position from the Neo-6M GPS module and transmits alerts via a SIM800L/SIM900A GSM module. The overall system architecture is shown in Fig. 3.

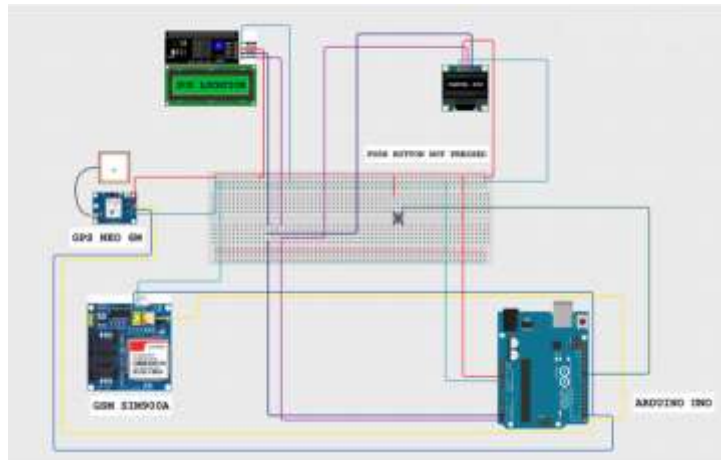


Figure 3: System architecture using Cirkuit Designer

Sensing and User Interface

Audio Capture. A low-power microphone front end continuously samples ambient sound. Basic pre-processing techniques such as gain control, bandpass filtering, and voice activity detection are applied to reduce noise and focus on relevant audio segments.

User Feedback. A compact OLED display and vibration motor provide immediate, multimodal feedback when a trigger is detected. The display presents concise status messages (e.g., “Cancel SOS”), while vibration offers tactile confirmation for users who may not be able to view the display.

Manual Control. A physical push button enables the user to cancel an alert or manually trigger a test alert. These controls provide an additional confirmation mechanism and improve accessibility.

Local Processing and Control

Keyword Detection. Keyword detection is implemented using a lightweight Python-based recognizer and evaluated on a local processing host during prototype development. Continuous audio is preprocessed using voice activity detection and short-time framing. Extracted feature segments are passed to the recognizer for keyword matching. The implementation utilizes standard speech recognition libraries with a compact matching routine optimized for low latency and resource efficiency.

To reduce false activations, detection is gated using short-term confirmation across consecutive frames along with a configurable confidence threshold. Upon confirmed detection, the controller initiates a cancellable alert window and proceeds only if the alert is not aborted. This prototype demonstrates feasibility and provides a migration path toward embedded or TinyML implementations [6]. The output of the keyword detection algorithm is shown in Fig. 4.

```
Listening...
Recognized speech: lemon switch
User's voice detected.
Distress signal detected. Sending alert...
Listening...
```

Figure 4: Keyword detection algorithm output

Alert Workflow Management. Once a keyword is detected, the controller initiates a short, configurable cancellation window. During this period, the device displays a cancellation prompt and waits for user input. If no cancellation occurs, the system proceeds with location acquisition and alert transmission.

Communication and Notification

Location Acquisition. The Neo-6M GPS module is used to obtain latitude, longitude, and timestamp information. If a fresh GPS fix is unavailable within a specified time, the system uses the last known coordinates along with a flag indicating reduced accuracy.

Transmission. A GSM modem (SIM900A or SIM800L) transmits the alert via SMS. The system monitors transmission status and retries using a simple backoff strategy in case of network issues. Feedback is provided to the user via the display and vibration.

Alert Composition. The alert message includes a human-readable notification, GPS coordinates, timestamp, and device identifier. The format is optimized for SMS compatibility and simple backend integration, as shown in Fig. 5.



Figure 5: GSM initiated SMS of user's location sent to Authorities

Fault Handling and Fallback Strategies

False Activation Mitigation. False triggers are minimized through multi-frame confirmation and a user-controlled cancellation window. A manual cancel button provides an immediate override.

Location Fallback. If GPS data is unavailable, the system attaches the last known coordinates along with an accuracy indicator. Future improvements may include cell-ID or Wi-Fi-based positioning.

Transmission Resilience. The system incorporates retry mechanisms and stores failed messages for later transmission. Failures are reported to the user and logged for analysis.

Experimental Setup

To validate the proposed voice-activated distress alert system, a series of experiments were conducted in a controlled environment replicating emergency scenarios. The experimental setup was designed to evaluate latency, accuracy, and the ability to cancel alerts in case of false triggers. Fig. 6 shows the prototype when an actual alert is triggered, while Fig. 7 illustrates the cancellation scenario.



Figure 6: Alert sent scenario

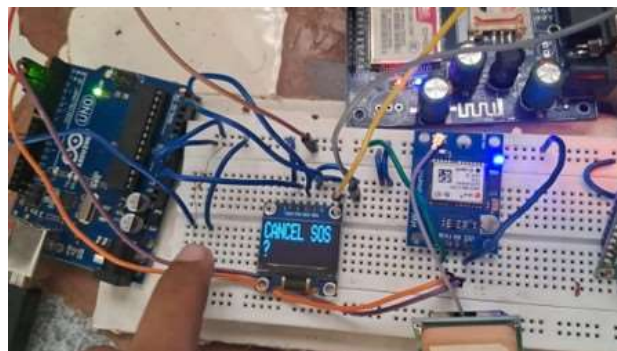


Figure 7: Alert cancelled scenario

Testing Environment

Prototype execution

- The bench-top prototype was implemented using an Arduino Uno, Neo-6M GPS module, GSM SIM900A/SIM800L module, and microphone connected to a development host.
- The Python-based keyword recognizer was executed on the host system and monitored in real time to detect customized keywords.
- Upon detection, the alert workflow was triggered through the prototype logic.

Test scenarios

- Scripted utterances: clear keyword, shouted keyword, and muffled keyword.
- Unscripted scenarios: interrupted speech, overlapping conversations, accidental activations, and rapid cancellation attempts.
- Each scenario was repeated across multiple users and device placements to capture variability.

Observation protocol

- Detection outcomes were recorded after each trial using a structured log including trial ID, speaker, environment, placement, recognizer result (match/no match), and workflow execution.
- Qualitative observations such as misrecognitions, false triggers, and perceived delays were also documented.

Performance Metrics

The following metrics were used to evaluate system performance:

- **Detection latency:** Measured as the time taken by the system to respond after a spoken keyword, indicating responsiveness.
- **True positive rate:** The proportion of correctly detected keyword utterances, representing detection reliability.
- **False positive rate:** The frequency of incorrect activations during non-keyword speech or ambient noise, indicating robustness.
- **GPS fix time:** The time required to obtain valid location coordinates after a request.
- **SMS delivery success:** The success rate of message transmission based on GSM module responses.
- **Usability and user feedback:** Collected through user trials and a Google Forms survey (Fig. 8), capturing user experience and acceptance.

Do you believe a hands-free voice-activated emergency alert system could improve personal safety in real-life situations? (1-Strongly Disagree, 3-Neutral, 5-Strongly Agree)
14 responses

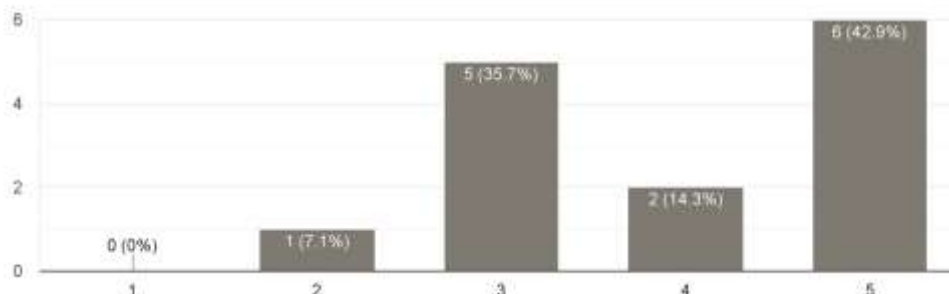


Figure 8: Survey response

Results and Observations

The proposed system was evaluated in a controlled experimental setup as described earlier. The performance metrics were measured across different conditions, providing insights into the system’s accuracy and reliability.

Experimental Results

Table 1 summarizes the performance evaluation of the proposed system. The selected performance metrics, including detection latency, true and false positive rates, GPS fix time, and SMS delivery success, provide a focused view of prototype feasibility and operational readiness. These metrics were primarily measured through live observations and manual trial logs, highlighting both the strengths and limitations of the current system.

Table 1: Performance evaluation of the system

Metric	Target	Observed Performance	Test Condition
Detection	la- <2000	1800	Short keyword;



tency (ms)			desktop Python recognizer, 50 trials
True positive rate (%)	>85	86	Controlled speech, 50 utterances
False positive rate (%)	<5	7	Ambient environment noise, 2 hours monitoring
GPS fix time (s)	<60	45	Outdoor open sky, cold start
SMS delivery success (%)	>90	90	Urban GSM network, 20 sends

The results indicate that the system performs reliably under controlled conditions, while also revealing areas for improvement. Future enhancements include porting the keyword recognizer to an embedded runtime, incorporating automated logging for reproducibility, expanding testing across diverse speakers and environments, and integrating hybrid positioning techniques to reduce dependency on GPS. These improvements will enable more robust evaluation and move the system closer to a deployable wearable solution.

Observations

From the experimental evaluation, the following observations were made:

- The prototype operated as a bench-top proof of concept.
- The Python-based recognizer reliably detected the configured keyword in most scripted trials.
- Detection performance degraded for muffled speech, heavy accents, and overlapping noise conditions.
- False activations were observed in noisy environments, although confirmation logic helped reduce their frequency.
- The GPS module provided accurate outdoor positioning but showed delays during cold starts and poor performance indoors.
- User feedback indicated that the system is useful, but raised concerns regarding false alerts and privacy.

Overall, the system demonstrates feasibility as a practical emergency response solution, with clear directions for improvement such as embedding the recognizer, enhancing noise robustness, implementing automated logging, and incorporating hybrid positioning strategies.

Conclusion and Future Work

This work demonstrates the feasibility of a low-cost, hands-free SOS prototype that integrates keyword-triggered alerting, GPS-based location detection, and GSM communication into a compact and efficient system. Experimental evaluation using a host-based Python recognizer confirmed that the end-to-end workflow, including keyword detection, cancellable alert prompting, location acquisition, and alert transmission, operates effectively under controlled conditions. The observed limitations primarily stem from the constraints of an early-stage prototype rather than fundamental design issues. Overall, the system establishes that simple hardware combined with local decision-making logic can deliver timely and actionable emergency alerts, while also providing baseline performance benchmarks



for future development [7, 8].

To transition from a proof-of-concept prototype to a field-ready wearable device, several enhancements are proposed. These include porting the keyword recognition module to an embedded runtime or TinyML-based implementation [9], integrating automated and synchronized logging mechanisms for reproducible performance evaluation, and redesigning the device form factor (e.g., wearable watch) to improve usability, microphone placement, and haptic feedback.

Further improvements involve enhancing acoustic robustness to handle noisy environments, adopting hybrid positioning techniques to reduce GPS dependency and improve location accuracy, and strengthening communication reliability through retry mechanisms and secure data transmission protocols [10]. Additionally, extensive field trials and large-scale user studies, combined with privacy-focused data handling practices, will be essential to evaluate real-world performance, minimize false activations, and ensure user acceptance before large-scale deployment.

Acknowledgments

The authors gratefully acknowledge the guidance and support of Dr. T.

J. Jeyaprabha, whose expert advice, critical feedback, and sustained encouragement were instrumental in shaping the direction and rigor of this work. Her insights significantly improved the quality and clarity of the project.

The authors also thank Sri Venkateswara College of Engineering for providing laboratory facilities, hardware resources, and access to development tools that enabled rapid prototyping and testing. Special thanks are extended to the departmental technical staff for their assistance during the prototype development and evaluation phases.

The authors are grateful to the students and volunteers who participated in the usability trials and completed the survey. Their valuable feedback and suggestions contributed directly to system refinement and performance evaluation. The authors also acknowledge the informal peer reviews and discussions with colleagues in the embedded systems and signal processing domains, which helped identify practical improvements and future research directions.

Finally, the authors express their sincere gratitude to their families for their patience, encouragement, and continuous support throughout the project.

References

1. Hu, Q., Kapucu, N., 2016. Information communication technology utilization for effective emergency management networks. *Public Management Review* 18(3), 323–348. <https://doi.org/10.1080/14719037.2014.969762>
2. Fogué, M., Garrido, P., Martinez, F.J., Cano, J.-C., Calafate, C.T., Manzoni, P., 2012. Automatic accident detection: Assistance through communication technologies and vehicles. *IEEE Vehicular Technology Magazine* 7(3), 90–100. <https://doi.org/10.1109/MVT.2012.2203877>
3. Baldini, G., Karanasios, S., Allen, D., Vergari, F., 2014. Survey of wireless communication technologies for public safety. *IEEE Communications Surveys & Tutorials* 16(2), 619–641. <https://doi.org/10.1109/SURV.2013.082713.00034>
4. Mustaqeem, M., Sajjad, M., Kwon, S., 2020. Clustering-based speech emotion recognition by incorporating learned features and deep BiLSTM. *IEEE Access* 8, 79861–79875.



<https://doi.org/10.1109/ACCESS.2020.2990405>

5. Aloudat, A., Michael, K., 2011. Toward the regulation of ubiquitous mobile government: A case study on location-based emergency services in Australia. *Electronic Commerce Research* 11, 31–74. <https://doi.org/10.1007/s10660-010-9070-0>
6. O’Shaughnessy, D., 2024. Review of methods for automatic speaker verification. *IEEE/ACM Transactions on Audio, Speech, and Language Processing* 32, 1776–1789. <https://doi.org/10.1109/TASLP.2023.3346293>
7. Emergency SOS Button Using GPS & GSM Functionality, 2025. *International Journal for Multidisciplinary Research*. Available at: <https://www.ijfmr.com/papers/2025/2/38763.pdf>
8. A review on emergency alert system wearable device for women safety, 2021. *International Journal of Creative Research Thoughts*. Available at: <https://ijcrt.org/papers/IJCRT2106057.pdf>
9. Tiny machine learning for IoT-enabled embedded systems: A review, 2025. In: *Emerging Trends in IoT and Embedded Systems*. Springer Nature. Available at: https://link.springer.com/chapter/10.1007/978-3-031-93448-3_6
10. Advances in small-footprint keyword spotting: A comprehensive review of efficient models and algorithms, 2025. *arXiv preprint*. Available at: <https://arxiv.org/pdf/2506.11169>