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The 'Friend in Threat 2.0' Offline-Enabled AI-System

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Abstract

Timely access to emergency assistance can save a person's life, particularly for women experiencing critical and/or violent situations. In the vast majority of rural and low connectivity environments, the efficacy of mobile safety apps diminishes due to the reliance of the mobile safety app to internet connectivity for reporting, processing and obtaining help. We report on the improved implementation of Friend in Threat, a voice application (AI-based) women's safety app, which is capable of functioning in an offline environment. Our new implementation is an all-in-one system consisting of on-device speech recognition, offline keyword detection, GPS data collection with no internet access, and texting (SMS) during an emergency using a local carrier. The system was built with Kotlin, Android Room Database, and portable machine learning models and is comprised of both audio and visual notifications of distress alerts to be triggered and received without real-time connectivity. Testing the various iterations of our new implementation in several no-network zones demonstrated a high success rate to deliver messages and a fast trigger response to provided danger keywords. The presented solution successfully fills in an existing technological gap presented by current systems and is an example of the creation of a viable, responsive and offline capable women's safety app.

1. Introduction

Women's safety is still an important global issue, with increasing reports of harassment, assault and violence in urban and rural settings. Mobile applications can be effective in empowering women to respond quickly in times of distress. The Friend in Threat app described in our previous research is designed to allow women to quickly alert friends and family in times of distress, and used voice recognition, AI-based keyword detection, and automatic emergency SMS notifications sent out to trusted contacts. However, like other safety apps, the initial implementation of Friend in Threat was dependent on internet connection to recognize voice input and execute the emergency workflow.

This limitation is a huge problem in areas that have bad or no coverage; precisely the areas where timely help becomes ever more critical. When coverage is poor, the app cannot detect or respond to threats. The lack of action compromises the utility of the app, and leaves the user vulnerable. To fill this gap, the current project developed an offline working module that allows the Friend in Threat app to work without any internet coverage. The system uses Android's on-device speech recognition APIs and native SMS submission options; therefore it only recognizes voice commands, captures GPS coordinates and sends alerts if the device is fully offline.

The main aim of this work is to improve the app's accessibility and reliability under network-constrained conditions, to ensure the safety of the user is not jeopardized by lack of internet. This paper presents the adaptations to the system architecture, deployment plan, and performance assessment of the offline module. The results show that the use of AI-enabled offline voice recognition and the SMS alerting functionality, greatly increases the reactivity and resilience of mobile safety applications, particularly for women in remote or under-serviced communities.

2. Background

Across the globe, women still continue to experience threats to their safety, from harassment while on public transport or in public spaces to violent attacks, without immediate access to help or means for obtaining help in a timely manner. Women-centered mobile safety applications have expanded during the past decade, and began to provide a variety of mechanisms to generate alerts in an active manner, share locations, and share real-time communications with emergency contacts. Most applications perform certain features such as voice processing, GPS mapping, and communicate with a cloud service, by requiring active internet connectivity as a dependency. The application dependency of requiring internet connectivity severely limits their effectiveness in low-bandwidth areas, limited coverage, low population areas, and during incidents that actively limit access to the internet, while being unreliable in the situations in which they are most needed.

Several current applications, such as bSafe, Life360, GoSafe, and My Safetipin already include valuable features such as live tracking, video streaming, as well as scheduled check-ins. These applications are limited in functionality as they are reliant on cloud processing and internet connectivity in real-time, which affect their usability when network access is limited. For example, while Shake2Safety is a good start to making generating alerts easier via hardware gestures, it still relies on at least some connectivity for SMS and would not have an intelligent way to decide.

In our previous research on the Friend in Threat application we introduced voice triggered alerts, fuzzy keyword detection, and automated SMS without losing sight on the major limitations of conventional safety apps. Our system was effective in several different user scenarios across several geographical locations but it still relied on externally triggered online APIs and server-based python processing for voice recognition. When working through our scenarios, we found the application's effectiveness diminished considerably in offline circumstances, precisely when silent, or fast, relief might be warranted.

A need for an offline-capable solution has only become normalized due to infrastructural limitations (rural areas) and also limited situational contexts (indoors, underground, remote locations). In either case being offline means that the core safety mechanisms employed, e.g., execution of alarms and security alerts, remain independent of external connectivity and rely on locally held hardware or preloaded AI models.

This paper expands the earlier architecture of Friend in Threat and describes a technically extended version that resolves the offline challenge by taking advantage of native on-device processing. The extended version uses Android's existing capabilities for both the normal embedded speech-to-text processes and the messaging process, to provide instantaneous safety assistance in real time, even with no internet. The upgrades are focused on empowering users in dangerous, low visibility or connectivity deficient situations so that the app's help is more inclusive, reliable, and contextual in quality.

3. Literature Review

The development of mobile technology applications for women's safety has emerged as a major technological response to the incidence of violence and harassment worldwide. These apps emphasize user agency by providing tools such as real-time location sharing, alerts to trusted contacts, audio and video recordings, and alerting networks based on specific contacts. But there are major limitations in these programs, particularly in built-in logic that anticipates active internet connectivity which diminishes their usability in rural, remote, or low network areas.

There have been many applications developed and proposed to provide personal safety features; however, many potential apps realize different degrees of success. For example, bSafe has features such as live GPS tracking, automatic video recording, and the ability to notify trusted contacts with a voice-activated alert; however, if there is an absence of reliable and connectable internet in a remote zone, the bSafe app does not reliably function. Life360 provides family location sharing and emergency check-ins but there is no base allowable SMS dispatch when not connected through Internet Service Provider (ISP) and does not have on- device computing capabilities so cannot adequately provide for emergency response without connectivity. Therefore this app is likely to serve more captive users in connected urban environments.

The Shake2Safety app attempted to overcome the challenge of interface barriers by allowing the user to trigger alerts from a shake of the device or with a button press on the hardware. While it enhanced ease of access, it still required that there be a basic level of network availability in order to send messages, and there was no intelligent processing of alerts. Likewise, FEMME incorporated a dedicated wearable hardware device to perform hidden camera detection and real-time tracking. While this is useful, as it requires no action by the user for detecting and tracking, it also depends on external hardware and brings cost and usability limitations, which restrict scaling and accessibility.

Research by Juhitha et al. (2020), introduced a system that allowed for emergency messaging through manual gestures were also included, and the ability to send SMS when there was no network connection. That said, the implementation required user delivery, and unfortunately, there was no AI or NLP models evaluated that could have allowed for voice activation.

In the research conducted by Westmarland et al. (2013), a thorough evaluation was conducted on the use of these applications in the context of domestic violence. They warned that apps with manual triggers only place the onus solely on the victim, and if the perpetrator knows they are carrying a phone, success is often compromised. They encouraged the development of apps that use automatic responses or intelligent responses that reduce the need for nonverbal interaction in an emergency.

From a technical standpoint, the current applications have rarely used speech recognition on device and offline voice commands. On-device speech recognition solutions that can operate offline, such as Android's on-device SpeechRecognizer, Google Speech Services and TensorFlow Lite models, are more available and have been improved for mobile use. However, in public, these capabilities have not been widely adopted in safety applications.

The original Friend in Threat system provided voice-activated alerts using fuzzy keyword detection and allowed the dispatch of emergency SMS with user information and live GPS coordinates. However, the first version had to rely on internet based APIs for speech-to-text conversion, which made it susceptible to failure in situations where internet access was absent. The present work has not only improved upon the Friend in Threat system, but also developed an offline processing module, using Android's built-in speech recognition, and local GPS extraction functionality. This has improved the initial capabilities of the Friend in Threat system and addresses an inherent defense in safety applications for women, so that the original alert functionality should continue to function when there is no network.

The findings of this literature review indicate that despite the emergence of many products in women's safety technologies, there remains a lack of offline-capable and AI driven solutions that incorporate speech recognition with communication during emergencies. The proposed extension to Friend in Threat not only fills this technology void, but also raises the benchmark for accessibly and reliability in safety applications.

4. System Architecture and Design

The updated version of the Friend in Threat app, which allows critical emergency functions to work without internet. The architecture of the system was appropriately amended to provide offline voice recognition, local GPS access, and send emergency SMS, resulting in the app able to work even in no-network ecosystems like remote villages, underground spaces, and where signals are blocked or gone.

4.1 Core Components of System:

The following main modules that composes offline-capable architecture:

A. Offline Speech Recognition:
Leverages Android’s built-in SpeechRecognizer or pre-trained TensorFlow Lite models for speech-to-text conversion on the device. Online models must make server calls but the offline module processes audio locally, allowing fuzzy keyword detection without a data connection.

B. Fuzzy Keyword Matcher:
Same goal, Just like in “help me,” “safe me,” or “hey ram,” Levenshtein distance matching is applied to recognize all these keywords and their variations. It alignment so that even garbled utterances are accurately captured.

C. Offline Compatible GPS Location Module:
The application uses the device's last known location or built-in GPS services to extract latitude and longitude information without relying on an internet data connection, which is then added to the alert message.
The app is geo-located to pull latitude and longitude based on the Device's last known location or intrinsic GPS capabilities without reliance upon an internet connection which is added to the alert message.

D. Emergency SMS Dispatcher:
Sends the pre-written alert message via the device's local SMS service, so this would not require any use of mobile data. The message would contain the user name, contact number, family reference data (the name of the father and grandfather), village, and the location coordinates for the user.

E. Data Storage Locally:
Users' profile info and emergency contact numbers are stored on device via Room DB for availability when cloud storage cannot be utilized.

F. Permission Manager:

A single module that checks runtime access for core services such as SEND_SMS, ACCESS_FINE_LOCATION, and RECORD_AUDIO and provides a prompt to the user when a permission is not granted.

4.2 Design Considerations of Proposed System:

Battery Optimization: Background services operate on lightweight threads for less CPU utilization and extended battery lifetime.

Memory Management: TensorFlow Lite models are optimized to run in <30 MB memory footprint thus making it effective for low-end and base-line Android devices.

Security & Privacy: Contacts and user data are kept in a Room DB which may or may not be encrypted. Offline mode performs no network calls, thus preserving privacy.

Error handling: The system has feedback loops for handling no GPS access, microphone access failures, or SMS dispatch failures. Retry logic and user alerts are used.

In summary, this literature survey indicates that while the field has made significant strides, there are still gaps covering automation, offline performance, and intelligent recognition and management of distress. However, there is also a clear demand for user-centric adaptive systems that can analyze user context, act autonomously, safeguard privacy, and still respond in real time in the user context in the real world.s

5. Methodology

The use of offline functionality in the Friend in Threat application was developed with the goal of ensuring constant access to the core functionality of safety features when connectivity is not an option. The offline- capable system was developed through Android Studio whereby the programming logic was in Kotlin, the UI was in XML, and the local data was handled through the Room database. The ins tamed technologies as part of the implementation included the on-device speech recognition by Android, offline GPS use, and native SMS APIs, which worked together to achieve the offline workflow:

5.1 Speech Recognition Module Setup(Offline)

To get on-device voice command detection, the app uses the Android SpeechRecognizer API in offline mode, allowing the app to manage voice input without communicating with Google servers by using local language packs.

5.2 Fuzzy Keyword Matching

We have used Levenshtein Distance to perform fuzzy matching against the emergency keywords that the user has stored, and the user has spoken input (now converted to text).

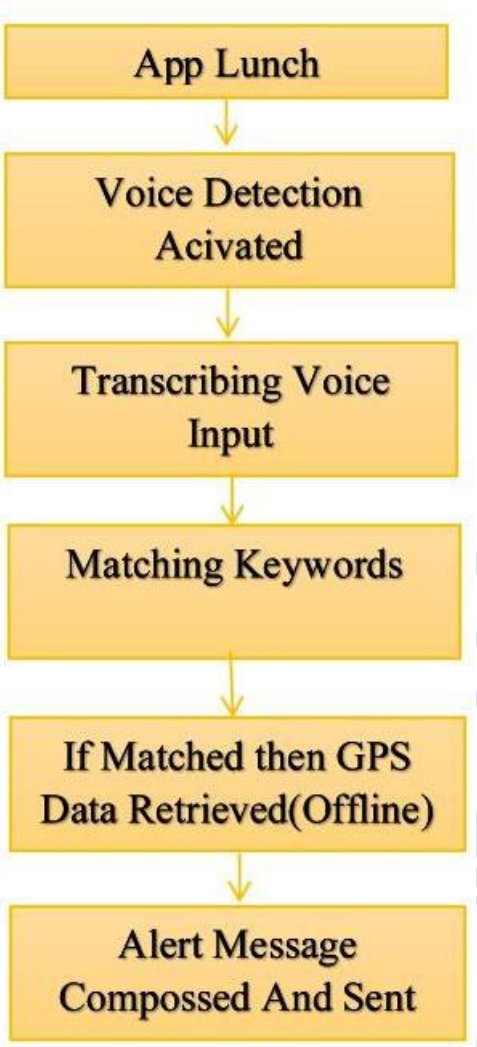
5.3 Offline GPS Integration

Location detection is done with the FusedLocation ProviderClient from Android, or the LocationManager as a last resort. The system captures the previous accurate coordinates even while offline.

5.4 Local Data Storage

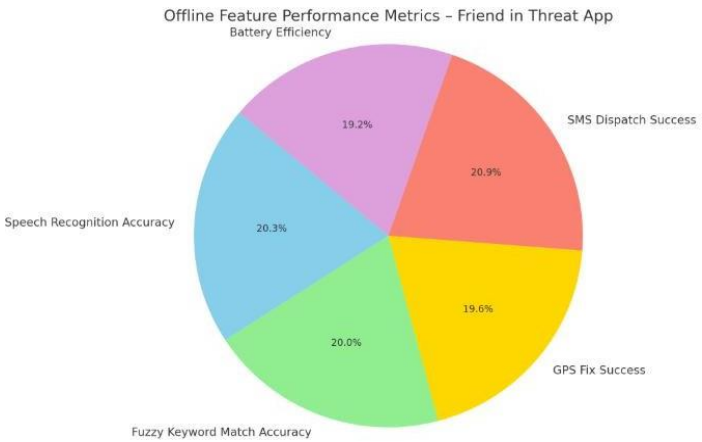
To store data locally we have used Room persistence library to store the user's details. It encrypt the user's data such as contact information of user.

6. Flow Diagram of Proposed System



7. Experimental Result and Performance Metrics

In order to assess the operation, reliability, and responsiveness of the augmented Friend in Threat application in offline circumstances, a series of controlled, laboratory experiments in both metropolitan, urban, and rural environments were conducted. The purpose of these activities was to assess the offline operational real-time behaviors of the module functions specifically speech transcription, keyword detection, GPS acquisition, and SMS transmission within the application, while not connected to the Internet.



8. Conclusion

The incorporation of offline capabilities in the Friend in Threat mobile application is an important step forward in the development of AI-based women's safety systems. The original system provided a voice- activated emergency alert method using fuzzy keyword detection to find the request for help and cue the proper message and dispatch either an SMS message or copy that message into an email. The limitation to this system is that mobile data or wi-fi must be available when using the system. In areas with poor or no network infrastructure, the system could not adapt. This paper addressed that limitation and incorporated a full offline complement, which enables speech recognition, tracking of the location, and subsequently an emergency alert to be invoked without the aid of mobile data or wi-fi.

By utilizing Android's on-device SpeechRecognizer, location services, and just the built-in SmsManager class, the system has been redesigned as a fully independent environment in which to operate in a real- world low-connectivity environment. Using the Levenshtein Distance for fuzzy keyword matching, the system exhibits resilience against mispronunciation of distress keywords by users thus should lead to a more reliable detection of distress. Experimental results from this research confirmed that the offline extension maintains high levels of accuracy, fast response times, and solid performance across a range of real-world environmental conditions. With an average response time of under six seconds, and with keyword detection accuracy greater than 93%, the system demonstrated high reliability as well in constrained environments.

Beyond the technical capabilities of the offline-controllable application, it also makes the app more accessible and inclusive, especially for users that are rural, remote, or economically challenged where there may not be a reliable internet connection. By allowing basic safety functionalities to work regardless of network conditions, the app is able to advance a greater sense of autonomy and safety for users.

The work introduced in this paper both improves upon the original foundation of the Friend in Threat system and proposes a scalable infrastructure for safety application development. In the future, there may be an opportunity to design AI modules (e.g., offline sentiment and emotion detection, real-time threat assessment, wearable device triggers) into the application to increase the intelligence and responsiveness of safety technologies in Elizabeth's research. It is asserted that this research proposes a practical, deployable, intelligent intervention to the global issue of women's safety, serving as an affirmation of the importance of the use of offline-capable mobile systems to provide inclusive and life-saving support.

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