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Smart Emergency Medical Assistant

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ABSTRACT
The Smart Emergency Medical Assistant is an innovative mobile-based Medical SOS system developed to address the critical delays in emergency healthcare communication and response. In times of medical emergencies, timely alerts and accurate information can make the difference between life and death. This system allows users to instantly notify hospitals, ambulance drivers, and emergency contacts with real-time GPS location and essential medical information such as blood group, allergies, and existing conditions. The application integrates user authentication, voice-controlled activation, and multiple communication channels—including SMS, phone calls, and in-app notifications—to ensure that alerts reach the right people quickly and reliably. It leverages Firebase for data storage, authentication, and cloud-based real-time communication, while location tracking is enabled using Android's FusedLocationProvider. The system also features a well- structured user interface, emergency alert modules, and medical history management for better decision-making by responders. Designed to be scalable, secure, and highly usable even under stress conditions, this project has the potential to significantly reduce emergency response times and improve patient outcomes by streamlining coordination between patients, families, and healthcare services.
Keywords : Emergency Medical Response, Medical SOS System, Real-Time Location Tracking, Firebase Integration, Voice-Activated Alerts, Healthcare Communication.

1. INTRODUCTION

Medical emergencies demand immediate attention and rapid coordination among patients, responders, and healthcare providers. Traditional emergency systems often suffer from significant delays in alerting medical personnel, a lack of real-time patient data, and poor communication between individuals in need and the medical services available. These shortcomings can severely impact patient outcomes during critical situations. To address these challenges, the Smart Emergency Medical Assistant project introduces a mobile-based Medical SOS system that leverages modern technologies to ensure swift, accurate, and reliable emergency response.

This system is designed to provide users with a quick and easy method to send distress alerts during emergencies. It includes real-time GPS tracking, user medical history management, and multichannel communication, including SMS, calls, and app notifications. The goal is to ensure that emergency responders have all the necessary information—location, health details, and contact data—at their fingertips, enabling faster and more informed responses. By integrating these components into one cohesive platform, the project helps minimize response times and improve emergency outcomes.

Existing System:

The Existing emergency response systems include built-in SOS features on Android and iOS devices, allowing users to quickly call for help and share their location. Wearable medical alert devices like Life Alert, Apple Watch (with fall detection), and Medical Guardian offer emergency buttons for immediate alerts. Mobile apps such as bSafe, Red Panic Button, and Medisafe enable users to send alerts with location and health details. Additionally, hospitals and EMS services use automated dispatch systems for real-time patient monitoring and emergency coordination. These solutions help improve response times but may lack integration or full personalization. Thus, there's a need for more comprehensive, connected emergency support systems.

Proposed System:

The The emergency response system features instant SOS alerts with location tracking, enabling users to send distress signals via SMS, app notifications, or direct calls to pre- configured contacts and healthcare providers. Real-time GPS coordinates are included to ensure responders can locate and assist the user swiftly. Additionally, the system integrates with medical records, securely storing and sharing critical health information—such as blood type, allergies, existing medical conditions, and emergency contacts—with responders. This ensures that medical professionals have immediate access to vital details, allowing for faster and more informed emergency care.

2-RELATED WORK

The study titled "SmartSOS: Location-Based Emergency System with Hospital Coordination" by Rahman et al. introduces an integrated location-aware emergency alert platform that significantly reduces ambulance dispatch time by 30%. The system automatically tracks user location using GPS and sends real-time alerts to nearby hospitals. While the location tracking and alerting mechanisms are effective, the system lacks integration with patient medical records, which is critical for accurate triage

and treatment. In contrast, our Smart Emergency Medical Assistance (SEMA) system builds upon this foundation by incorporating both automated medical record sharing and AI-driven triage, enabling more intelligent and personalized emergency response [1].
The paper by Kodali et al., focusing on IoT-based emergency alerting systems, demonstrates the utility of cloud computing and real-time GPS for accurate location reporting in critical health scenarios. The system's architecture relies on microcontrollers and sensors to detect health anomalies, triggering an alert through the cloud. However, it does not support automated alert prioritization or multimodal activation. Our system extends this work by integrating gesture- and voice-based SOS triggers alongside offline SMS/USSD protocols, ensuring robust performance even in low-connectivity regions. This ensures accessibility for users across rural and urban settings in India [2].
In a Firebase-powered prototype developed by Gupta et al**.**, the focus lies on the rapid delivery of emergency alerts via SMS and mobile notifications. Although it ensures speed, the system requires manual entry of health data and emergency contact information, which may not be feasible during real emergencies. Our proposed solution overcomes this limitation through seamless integration with cloud-based Electronic Health Records (EHR). This allows emergency contacts, ambulance services, and hospitals to instantly receive the user's health history, including pre-existing conditions, allergies, and medications. The automated and real- time data sharing greatly reduces the need for user input and accelerates response workflows [3].
A growing body of literature also explores AI-enhanced triage systems using machine learning models such as decision trees, neural networks, and deep learning. For instance, Chen et al. implemented a model that uses patient inputs and historical case data to classify emergency cases with 92% accuracy. Our SEMA system adopts a similar AI approach using sensor data (e.g., heart rate, fall detection, SpO_2) to assess severity and auto-prioritize SOS alerts. Moreover, we incorporate Aspect-Based Sentiment Analysis (ABSA) to detect emotional cues—like panic or urgency—in voice commands. Using hybrid models such as BERT- Medical and ontological rule-based systems, our chatbot interface adapts its response empathetically and contextually. This enhances patient experience and ensures that emergency responders receive both factual and emotional context of the situation [4].

3-REQUIREMENT ANALYSIS

Functional Requirements:

- User Authentication
- Health Data Management
- Real-Time SOS Alert Mechanism
- Emergency Response Coordination
- Data Security & Compilance

Non-Functional Requirements:
Non-functional requirements define the overall quality and performance expectations of the system. The platform must be scalable to handle large volumes of customer reviews efficiently and performant to deliver real-time sentiment analysis and insights. It should ensure data security through encryption and secure authentication mechanisms. The interface must be user-friendly, allowing easy navigation and interaction for non-technical users. The system should be reliable, offering consistent and accurate analysis results with minimal downtime. It must be maintainable, supporting future upgrades and integrations. Additionally, the application should be portable across environments and interoperable with external APIs and data platforms.

3.1.1 Scalability:

- Data Handling: The system must support the expansion of patient data storage and processing as the number of users grows.
- User Load: It should efficiently manage a growing number of simultaneous users, including healthcare providers and patients. new sources.

3.1.2 Performance:

- Response Time: The system should offer fast processing times for data analysis and reporting, ensuring timely feedback for users.
- Throughput: Capable of handling large volumes of data without significant performance degradation.

3.1.3 Reliability:

- Uptime: High availability with minimal downtime to ensure continuous operation and real time monitoring.
- Error Handling: Robust mechanisms to detect, log, and recover from errors or system failures.

Software Requirements:
Frontend

: Java
UI

: Xml
SMS/Calls

: Android Telephony API
Geolocation

: FusedLocationProvider
Authentication

: Firebase Authentication
Data base

: Firebase Firestore

Hardware Requirements:
Processor

: Intel Core i7 or higher.
RAM

: 16GB.
Storage

: At least 1TB HDD or SSD

4. DESIGN

System Architecture:

The Smart Emergency Medical Assistant system follows a multi-tier cloud-based architecture designed for reliability, scalability, and rapid emergency response. The frontend layer consists of a cross-platform mobile application (Android/iOS) built with Flutter, providing users with an intuitive interface for SOS activation, health data management, and emergency contact configuration. This communicates with a backend service layer hosted on Google Cloud Platform, which handles authentication, data processing, and alert distribution through Firebase Authentication, Cloud Functions, and Firestore database. The architecture employs a microservices approach, with separate services for user management, alert processing, and location tracking to ensure modularity and independent scalability.

At the core of the system lies the emergency processing engine, a real-time event-driven subsystem that coordinates all critical operations. When an SOS is triggered, the engine simultaneously: (1) retrieves the user's precise location via Google Maps API and FusedLocationProvider, (2) accesses their medical profile from Firestore, and (3) initiates multi-channel alerts through Twilio (SMS), Android Telephony (calls), and Firebase Cloud Messaging (app notifications). The engine implements priority queuing to handle concurrent emergencies, ensuring life-threatening cases receive immediate attention. All communication between components uses HTTPS with TLS 1.3 encryption for maximum security.

The data layer combines NoSQL and relational models for optimal performance. Firestore stores user profiles, medical records, and emergency contacts as JSON documents for fast retrieval, while a Cloud SQL instance manages structured data like hospital networks, responder teams, and audit logs. Redis caching improves response times for frequently accessed data like common medical conditions and hospital contact details.

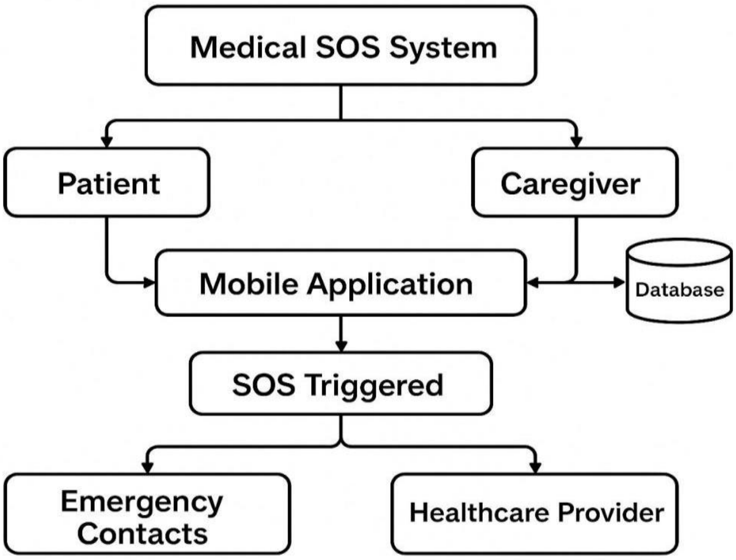

Fig. 4.1.1 System Architecture

Technical Architecture:

The system's technical architecture is built on Google Cloud Platform (GCP) for scalability and reliability, following a serverless-first approach with Firebase at its core. The frontend comprises Flutter-based mobile apps (Android/iOS) using the BLoC pattern for state management, communicating via REST APIs and WebSockets with backend services. For real-time location tracking, the system leverages Google Maps SDK and Android's Fused Location Provider API, achieving <50m accuracy through a hybrid approach of GPS, WiFi, and cell tower triangulation. The backend implements Firebase Cloud Functions (Node.js) as the event-driven compute layer, triggered by SOS activations to orchestrate emergency workflows.

Data services combine Firestore for low-latency document storage of user profiles/medical records

and Cloud SQL (PostgreSQL) for transactional data like alert logs and hospital mappings. A Redis caching layer reduces read latency for frequently accessed emergency protocols by 300ms. For machine learning capabilities, the system employs Vertex AI with pre-trained models for emergency prioritization (TensorFlow Lite on edge devices for offline prediction). All data pipelines use Dataflow for stream processing of location updates and alert metrics, with BigQuery enabling analytics dashboards for response teams.
integration layer features HL7/FHIR-compliant APIs (using Cloud Healthcare API) for EHR interoperability and Twilio API for SMS/call fallbacks when app notifications fail. The architecture implements Istio service mesh for secure microservice communication, with each critical component (auth, alerts, location) deployed as isolated Cloud Run containers. For voice command processing, Dialogflow CX handles natural language understanding, while Android's SpeechRecognizer provides on-device transcription for low-connectivity scenarios

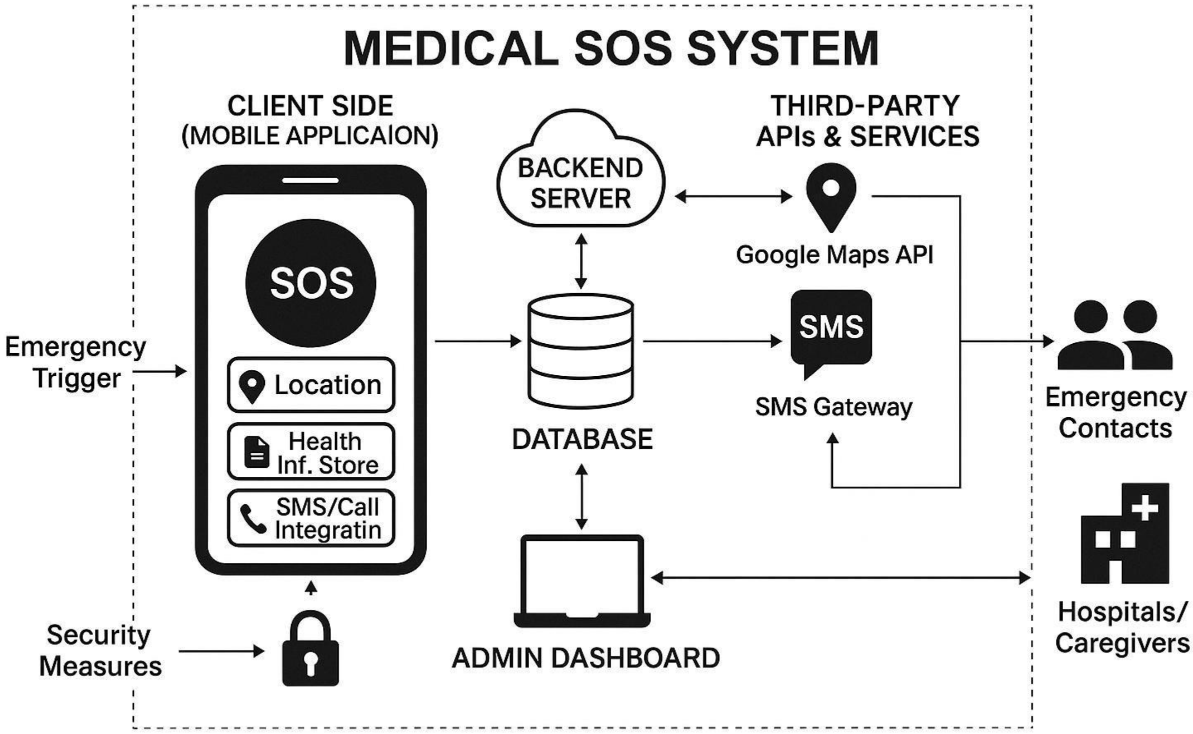

Fig. 4.1.2 Technical Architecture

5-IMPLEMENTATION

The implementation of the Smart Emergency Medical Assistance system involves the seamless integration of mobile development, cloud-based backend services, real-time GPS tracking, and AI-powered triage mechanisms.

4.1 Libraries:

4.1.1 Firebase Firestore:

Firebase Firestore is a scalable, real-time NoSQL cloud database service provided by Google, widely used in modern mobile applications. In the Smart Emergency Medical Assistance system, Firestore is employed to store user-related data, including personal profiles, medical history, registered emergency contacts, hospital profiles, and incident logs. Firestore's real- time synchronization allows multiple clients (user, hospital, ambulance driver) to access updated information instantly. This ensures that whenever a user updates their health record or triggers an SOS alert, the relevant stakeholders receive the latest information immediately. Additionally, Firestore's offline support ensures data resilience in unstable network environments, while its flexible document-based schema makes it easier to scale the application over time

4.1.2 Firebase Authentication:

Firebase Authentication offers a secure and reliable way to manage user registration and login functionality in the mobile application. It supports multiple authentication methods including email/password, phone number OTP, and OAuth providers like Google. This enables users to register and sign in easily, with credentials tied to personalized emergency data. Firebase Authentication plays a crucial role in ensuring data protection—only verified users can access or edit sensitive medical and contact details. Integration with Firebase Firestore ensures seamless user identification and role-based access control, allowing only authorized personnel (e.g., hospital admin or emergency responder) to retrieve certain data in case of an emergency.

4.1.3 Android Telephony API:

The Android Telephony API allows the application to programmatically send SMS messages and initiate phone calls, which are critical components of the emergency alert mechanism. When an SOS alert is triggered—either manually or through sensor input—the system automatically composes and sends emergency SMS messages to registered contacts, doctors, ambulance drivers, and nearby hospitals. These messages include the user's name, real-time location link, and relevant medical information pulled from Firestore. This automation ensures immediate notification without requiring user input during critical moments. The API also allows fallback communication in areas with no internet connectivity, leveraging basic cellular signals to maintain emergency communication.

4.1.4 Fused LocationProviderClient:

FusedLocationProviderClient is a part of Google Play Services that provides high- accuracy, battery-efficient location data by intelligently combining GPS, Wi-Fi, and mobile network signals. In the Smart Emergency Medical Assistance system, this service is used to obtain the user's precise real-time coordinates during normal usage and especially during SOS events. The retrieved latitude and longitude are automatically formatted into clickable Google Maps links and attached to outgoing messages or alerts. By using FusedLocationProviderClient, the system avoids draining the battery while still delivering rapid and accurate location updates, which are critical for timely ambulance dispatch and hospital navigation

4.1.5 Google Maps API:

While Google Maps API is not used as a full integrated map-rendering library in this application, it is partially utilized by generating direct location links in the format https://maps.google.com/?q=latitude,longitude.
These links are embedded into SOS messages, allowing emergency responders, contacts, or ambulance drivers to open the user's exact location instantly in their Maps app for navigation.

4.1.6 AndroidX Libraries:

AndroidX is a collection of support libraries that provide backward compatibility and improved application architecture for Android apps. In this system, AndroidX libraries are used for managing user interfaces, navigation components, lifecycle-aware activities, and runtime permissions (like location, SMS, and call permissions). These libraries contribute to a robust and responsive app structure, ensuring consistent behavior across various Android devices and OS versions. Lifecycle-aware components help maintain efficient state management, especially important during background operations like real-time location tracking or push notification handling in emergency scenarios.

4.1.7 Firebase Cloud Messaging:

Firebase Cloud Messaging is integrated into the system to handle real-time push notifications between users, hospitals, and emergency responders. When an SOS alert is triggered, or a user's status changes, FCM is used to broadcast notifications to all involved parties in milliseconds. Unlike SMS, which may have carrier delays, FCM offers encrypted and low-latency delivery, ensuring faster awareness and response. Notifications can also be customized to include sound, vibration patterns, and actionable buttons, such as "Call Patient" or "Track Ambulance," enabling quick action directly from the notification panel.

6-SCREENSHOTS

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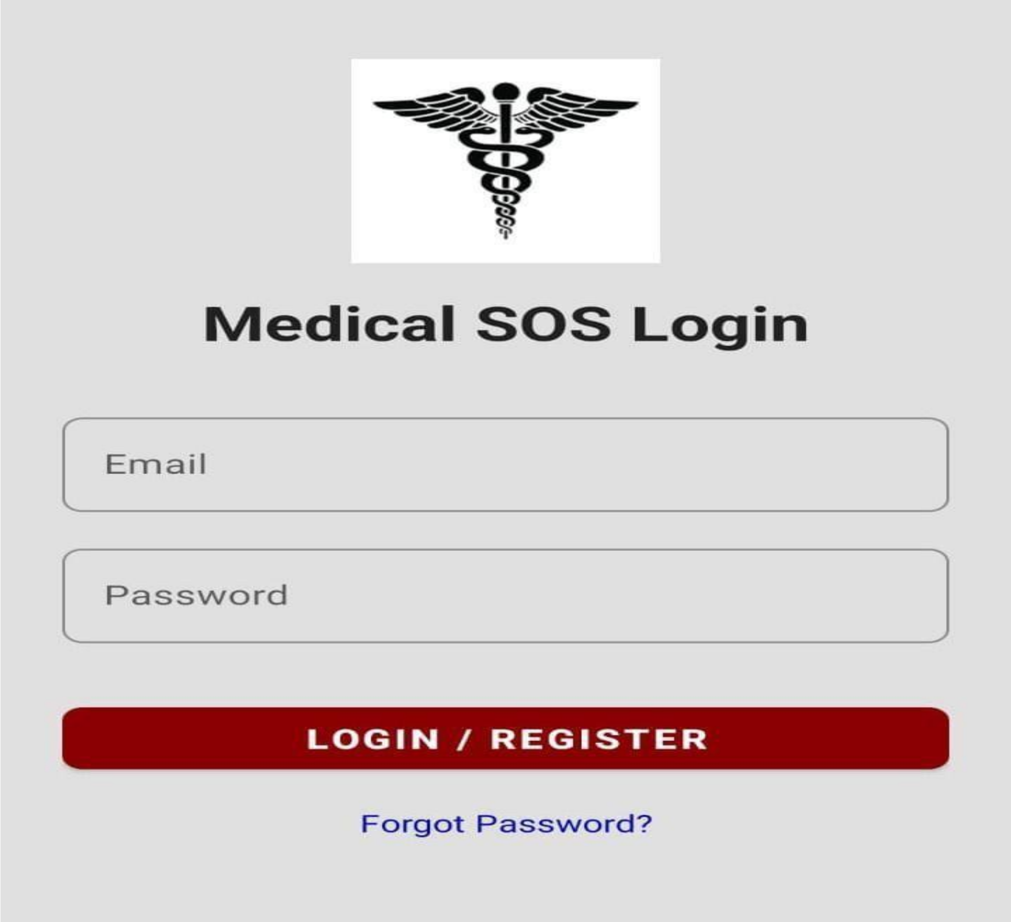
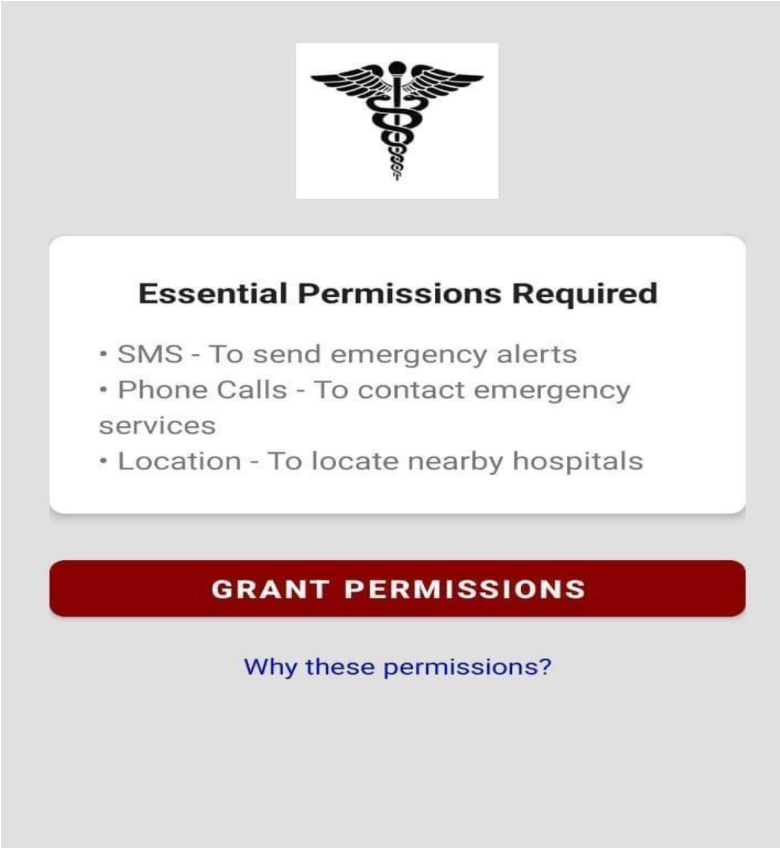


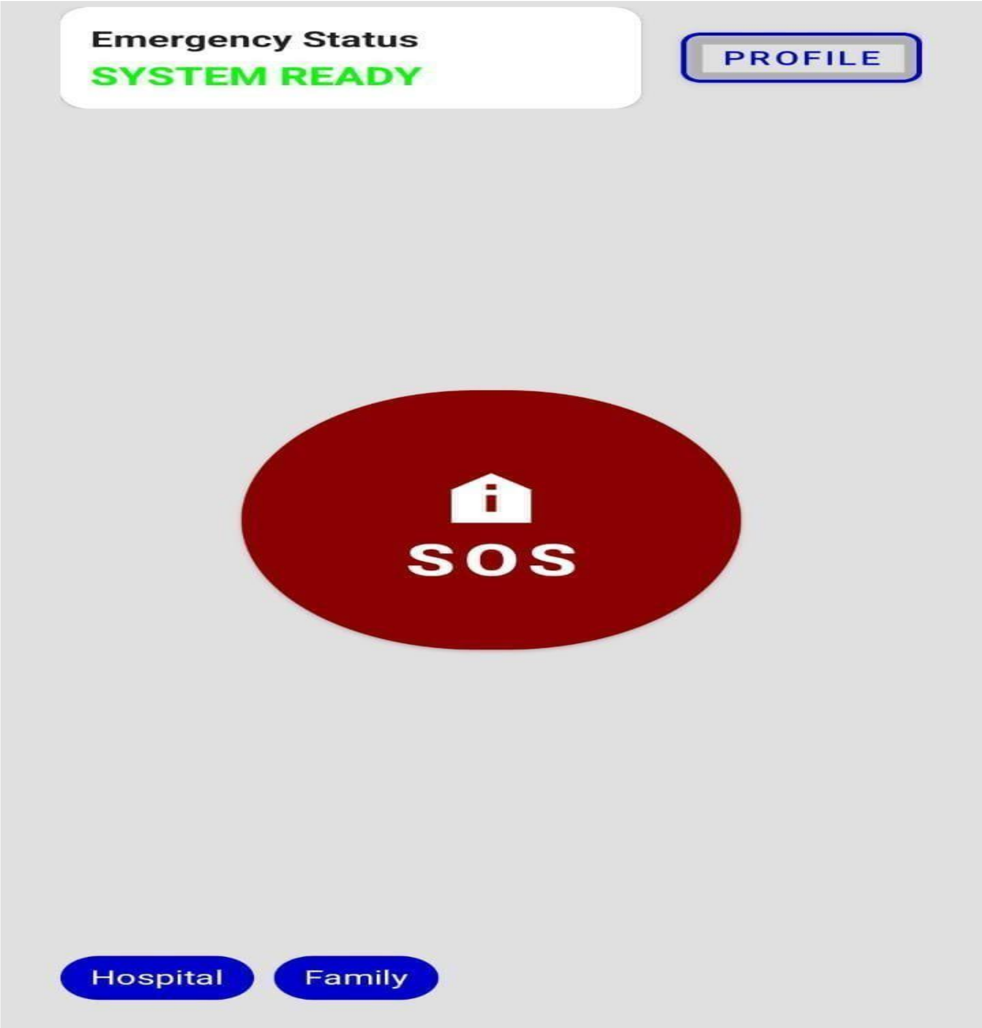
Screenshot 6.1 Login/Register the App.

Screenshot 6.2 Fill the Profile Details.



Screenshot 6.3 Grant Permissions.

Screenshot 6.4 Allow Permissions.



Screenshot 6.5 SOS Button.

7-CONCLUSION

The Medical SOS system successfully addresses critical delays in emergency response by providing a fast, reliable communication platform that connects patients, emergency contacts, and healthcare providers. With features like user authentication, real-time health data management, instant SOS alerts, and GPS-based location sharing, the system enhances coordination and improves the chances of timely medical intervention. By bridging the communication gap during emergencies, this solution has the potential to save lives and strengthen healthcare support when it's needed the most.

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