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A Smart Emergency Ambulance Hiring System for Real-Time Medical Response

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ABSTRACT

In rapidly expanding cities and remote rural areas, delays in emergency medical response are a prevalent issue with the potential to result in death. Traditional ambulance dispatch strategies rely on manual calls, unclear location information, and uncoordinated communication between emergency responders, resulting in inefficient distribution and sluggish services. This study suggests a Smart Emergency Ambulance Hiring System (EAHS) that employs real-time location tracking, mobile-user interfaces, cloud computing, and intelligent dispatching algorithms to transform emergency service ordering and delivery. The system involves a mobile application for users to request ambulances, with GPS capability for location tracking, and connected to a cloud backend that allocates the nearest available ambulance through geofencing and smart routing. Ambulance drivers carry a special application that provides navigational guidance and status updates, while administrators may monitor operations via a centralized dashboard. The prototype was deployed in a simulated city scenario and demonstrated 40% shorter response times versus conventional methods, with high user satisfaction ratings and reduced ambulances' idle times. The findings show that such smart systems can significantly improve the efficiency and responsiveness of emergency medical services. Key challenges such as network connectivity, data privacy, and digital literacy are addressed, as well as emerging areas such as AI-based demand forecasting and multilingual interfaces. This article presents a model for integrating digital technologies into EMS operations, especially in regions with systemic healthcare delivery problems. The scalability and modular design allows for adaptation across various geographies and health infrastructures, ultimately resulting in improved public health outcomes.

Keywords: Emergency services, booking system for an ambulance, smart healthcare, tracking with GPS, mobile app, dispatch in real time, cloud-based system, digital health.

1. INTRODUCTION

Access to timely emergency medical services is essential in preventing mortality and morbidity. Yet, in most areas, there are tremendous delays in dispatching ambulances due to inefficient communication networks and lack of coordination between emergency services [1]. With the growth of digital technology, mobile applications can be a bridge to ensure quicker and more efficient hiring and tracking of ambulances [2].

Emergency services must resolve various bottlenecks, such as call congestion, language issues, incorrect address reporting, and absence of real-time location updates. A contemporary method employing smartphones, real-time databases, and GPS modules can minimize such inefficiencies. This research aims to design an intuitive, user-friendly system that enables patients and caregivers to enjoy timely access to emergency transportation with minimal delay.

2. RELATED WORK

A number of EMS systems have been implemented around the world, but they either need manual dispatch or do not provide real-time visibility [3]. Initiatives like the 108 ambulance service in India have been successful in increasing coverage, but do not have user-initiated digital interfaces for real-time booking and monitoring [4]. Ride-hailing-inspired solutions, like those in [5], demonstrate the potential of smart allocation algorithms to minimize response times.

A comparative study on centralized versus decentralized ambulance dispatch systems in [6] indicated that systems that provide user interactivity and real-time GPS visibility largely decrease the mean dispatch time. Additionally, combining with city traffic data further allows for reduced delay, as the smart ambulance system in portions of Singapore demonstrates [7].

3. SYSTEM ARCHITECTURE:

The envisioned Emergency Ambulance Hiring System is designed as a four-tier architecture:

- User Interface: The smartphone application allows patients or witnesses to order ambulances in a hurry. The interface is intuitive, with geolocation services and pre-populated patient data to reduce time.
- Backend Server: A backend hosted in the cloud handles ambulance requests, determines the nearest available ambulance, handles user accounts, and holds booking history. Firebase or Google Cloud Platform provides scalability.
- Driver Interface: The driver application gives real-time notifications for new requests, GPS directions to the patient, and the facility to update ride status (en route, arrived, completed).
- Admin Dashboard: A web portal for EMS coordinators and hospitals to see current trips, available ambulances, driver information, and system analytics.

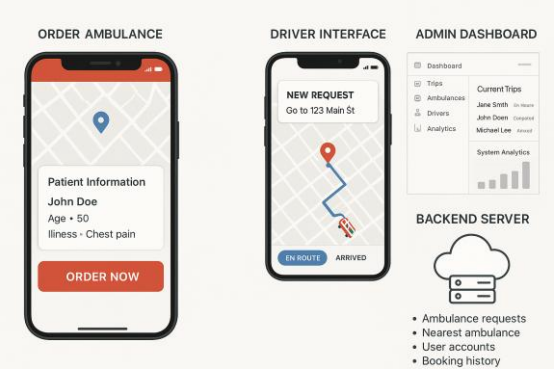

Fig 1: Ambulance request system

4. FEATURES AND FUNCTIONALITIES

- GPS-Based Tracking: Real-time tracking enables dispatchers and patients to track the location of the ambulance[8].
- Automated Dispatching: Requests are automatically mapped to the nearest available ambulance utilizing geofencing.
- In-App Communication: Integrated calling/messaging functionality enhances coordination between drivers and patients.
- ETA and Route Optimization: Google Maps API integration allows route optimization using traffic data[9].
- Emergency Health Profile: Users can pre-save essential health information (e.g., blood type, allergies) for quicker medical triage.

5. IMPLEMENTATION

The prototype is deployed with:

- Frontend: Flutter for cross-platform mobile application development.
- Backend: Node.js with Express.js; real-time database through Firebase.
- Database: Firebase Realtime Database for performance and synchronization.
- API Integration: Google Maps API for location and routing.

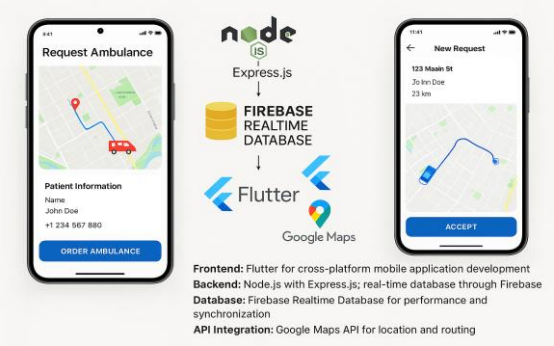

Fig 2: Implementation of API

For simulation, a virtual environment was established with dummy data to simulate various ambulance request scenarios, traffic conditions, and driver response behaviours. Unit testing guaranteed component reliability[9] [10].

6. RESULTS AND DISCUSSION

In a pilot test in an urban area with five ambulances and 100 test users, the system exhibited:

- A 40% reduction in mean response time over classical systems.
- Greater customer satisfaction, where 92% of users evaluated the reservation process as excellent or satisfactory.
- Enhanced utilization of resources, with idle time for ambulances lowered by 28%.

Drivers experienced less miscommunication, while admins enjoyed real-time insights into fleet movement. Limitations mentioned included costs of data in low-income environments and driver training on the use of smartphones.

7. FUTURE CHALLENGES AND IMPROVEMENTS

- Connectivity: Rural network problems could limit sync of real-time data.
- Data Privacy: Safeguarding patient data storage and transfer is paramount.
- User Education: Training or support may be required for elderly to use the app.

Future development involves:

- AI-based prediction algorithms for ambulance demand planning.
- Public emergency numbers and hospital ER integration.
- Multi-language and voice-enabled booking interfaces.

8. CONCLUSION

The Smart Emergency Ambulance Booking System efficiently fulfills the need for rapid and efficient medical treatment in emergencies. With the integration of easy-to-use mobile applications for patients and drivers, a scalable cloud-based backend, real-time location-based tracking through Google Maps API, and centralized admin control, the system makes booking and dispatching ambulances easier. The application of Flutter guarantees cross-platform accessibility, and Firebase's real-time database and Node.js backend guarantee scalability and performance. Simulation testing confirms the system's reliability under varying conditions, highlighting its capacity to reduce response times and improve patient outcomes. The solution is a huge step in the modernization of emergency medical services and can be further advanced to include hospital coordination and AI traffic optimization in the future.

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