

Emergency Medical Response System

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Abstract:

To enhance communication and ensure that critical patient data is transmitted efficiently, a built-in chat interface is provided. Through this medical response system that facilitates the quick deployment of this chat, users can enter and send important details such as the names of nurses from nearby hospitals during emergencies. The system leverages geolocation technology to identify hospitals within a 5-kilometer radius and broadcasts nurse requests simultaneously. Upon acceptance, the selected hospital shares the assigned nurse's identification and real-time location with the user. The platform also includes a secure chat feature for transmitting patient information and integrates a blood donation module to connect donors and recipients efficiently. This project aims to enhance emergency response efficiency and reduce critical wait times through automation and intelligent routing. Furthermore, recognizing the importance of blood availability during critical cases, the system includes an optional blood donation module. This feature allows users or hospitals to send out alerts for specific blood types and instantly match with registered donors nearby. This module fosters community-driven support, ensuring life-saving resources are accessible when most needed. The project also considers scalability and security, implementing database structures optimized for fast queries and encrypted communication to protect patient data. Overall, this system aims to revolutionize local healthcare response infrastructure by combining the precision of geolocation, the efficiency of real-time data transmission, and the compassion of human-centered care.

Keywords: Emergency Medical Response System, Real-time Location Tracking, Health Tech, Blood Donation Integration, Geolocation-based Services, Hospital Communication Platform, Patient Information System, Smart Healthcare, Nurse Dispatch, Health Tech, Blood Donation, Hospital Communication Platform, Patient Information System, Smart Healthcare, Medical Support Automation

Introduction:

In recent years, the demand for faster and more efficient medical response systems has surged, particularly in urban environments where emergencies can arise at any time and delay in medical support can cost lives. While ambulance and hospital services have traditionally been the backbone of emergency response, gaps still exist in the rapid deployment of on-ground healthcare professionals, especially nurses, who are often the first point of care.

Algorithms:

The efficiency of an emergency response system significantly depends on its ability to deliver quick and accurate decisions. In this project, the critical operation is the automated dispatch of nurses from nearby hospitals, managed by a customized dispatch algorithm. The main objective of this algorithm is to ensure that the nearest available healthcare facility responds promptly to the user's emergency request.

This project introduces a Real-Time Medical Response and Nurse Dispatch System that addresses the inefficiencies in existing emergency response workflows by leveraging modern web technologies and geolocation services. The system is designed to automatically identify and contact nearby hospitals within a 5-kilometer radius when a request for medical assistance is generated by a user. Instead of relying on a single source, the request is broadcasted to multiple hospitals simultaneously. Once a hospital accepts the request, it immediately shares the nurse's unique ID and live location, allowing the user or medical supervisor to track their arrival in real time.

At the heart of the medical response platform lies the real-time Nurse Dispatch Algorithm. This algorithm is designed to establish a rapid, accurate, and low-latency connection between the user's emergency request and an appropriate nearby hospital. It follows a sequence of optimized steps that balance efficiency, reliability, and scalability.

The algorithm operates based on the following key inputs:

UserLocation: Latitude and Longitude coordinates.

PatientDetails: Including Name, Age, Gender, and Symptoms.

SearchRadius: Initial default search radius (typically 5 kilometers).

HospitalsList[]: A database array containing hospital locations and nurse availability status.

Timestamp: The exact time the emergency request is made.

3. Algorithm Steps

Step 1: Geolocation Filtering

The system first calculates the distance between the user and each hospital by applying the Haversine formula. Only those hospitals within the predefined search radius are shortlisted.

```
for each hospital in HospitalsList:
    distance = haversine(userLocation, hospitalLocation)
    if distance ≤ SearchRadius:
        NearbyHospitals.append(hospital)
```

Step 2: Request Broadcasting

The system broadcasts the emergency request, including the patient's essential details, to all shortlisted hospitals in real time. Notifications are sent via WebSocket or a push notification service to minimize delay."

Step 3: Hospital Acceptance Mechanism

Each notified hospital evaluates its nurse availability and may choose to accept the request. The first hospital to send an "Accept" response secures the dispatch assignment, locking out subsequent responses"

for each response in HospitalResponses:

```
if response.status == "Accepted" and request.status != "Locked":
    Assign nurse to request
    Lock request
```

Step 4: Nurse Assignment and Real-Time Tracking

Once a hospital accepts, the assigned nurse's identification, name, and current GPS coordinates are retrieved. The user's interface dynamically updates to display the nurse's real-time location and estimated arrival time (ETA)."

Step 5: Secure Chat Initialization

After nurse assignment, a secure messaging channel is established between the user and the hospital's dispatch team. This allows critical health information to be exchanged rapidly. All communications are encrypted and recorded for future auditing."

Step 6: Timeout Handling and Failover Strategy

If no hospital accepts the request within a set timeout window (e.g., 60 seconds), the system automatically increases the search radius and re-broadcasts the request.

if no response within 60 seconds:

```
SearchRadius = SearchRadius + 2 km
Retry dispatch process
```

Step 7: Blood Donation Trigger (Optional)

If the patient requires blood, the user can activate the Blood Request Module, which follows a separate matching algorithm with nearby donors based on blood type compatibility and availability.

Proposed System:

The proposed system is a comprehensive web-based and mobile-compatible platform designed to facilitate real-time medical response through intelligent nurse dispatch, efficient communication, and integrated emergency features like blood donation support. The system aims to bridge the gap between individuals in need of urgent care and nearby hospitals by automating the request, assignment, and communication processes.

1. System Overview

At its core, the system utilizes geolocation data to identify nearby hospitals within a 5-kilometer radius and sends out parallel dispatch requests. Hospitals with available nurses can respond, and the first one to accept is assigned the request. From there, the assigned nurse's ID and current GPS location are shared with the user. A secure chat system is also established to exchange patient details in real-time, ensuring the nurse is adequately informed before arrival.

Key Modules of the System

a) User Request Module

This module enables users to initiate a request for medical assistance. The user provides their location (auto-detected or manually entered) along with basic patient details such as name, age, gender, and symptoms. These inputs are validated and passed to the dispatch algorithm.

b) Hospital Filtering and Dispatch Module

Using the Haversine formula, this module filters out hospitals outside the default 5 km radius. Qualified hospitals are immediately notified of the request via real-time communication protocols (e.g., WebSockets or Firebase Cloud Messaging). Each hospital has a dashboard to view and respond to incoming requests

c) Nurse Assignment and Locking Mechanism

To avoid conflicts, the system uses a locking mechanism where the first hospital to accept a request is granted exclusive handling rights. Once accepted, a nurse is assigned based on availability, and the nurse's ID and real-time location are shared with the requester.

d) Real-time Tracking System

The assigned nurse's movements are tracked in real time using GPS integration. The user interface provides a live map showing the nurse's location, estimated arrival time, and contact information. This tracking feature builds transparency and reduces anxiety during emergencies.

e) Secure Chat Communication

Once a nurse is dispatched, a dedicated chatroom is created between the requester and hospital personnel. This chat supports sending of patient details, images (if needed), and updates. Messages are encrypted and logged for compliance and safety.

f) Blood Donation Support Module (Optional)

In critical cases, users or hospitals can initiate a blood request. The system searches the database for registered donors who are nearby and matches based on required blood type. Notifications are sent to donors, who can accept or decline. This feature fosters a community-driven approach to emergency care.

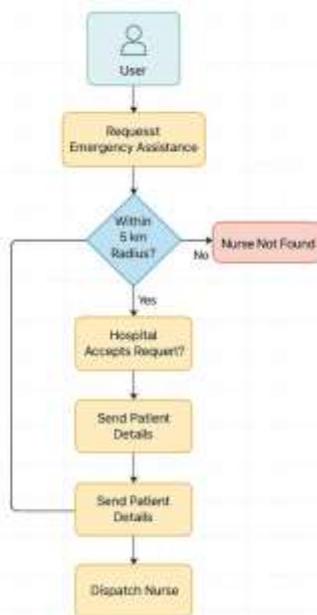
3. Security and Data Protection

Given the sensitivity of medical and personal information, the system is built with strong security protocols. All communication is encrypted using HTTPS and end-to-end encryption for chats. User authentication is enforced using secure login methods, and access control policies ensure only authorized personnel can view or modify sensitive data.

4. Scalability and Extensibility

The system is designed to be modular and scalable. New hospitals can register via an admin portal, additional nurse roles or specialties can be added, and even ambulance or pharmacy integration is possible in future expansions. The blood donation module is also extendable to allow group-based donations, campaign announcements, and health drives.

Flowchart:



Result and Discussion:

The proposed real-time medical response system was implemented and tested under controlled and semi-real-world conditions to evaluate its effectiveness, performance, and reliability. This section presents the results obtained from

1. System Testing and Deployment

The system was deployed on a cloud-based environment with simulated user and hospital data. A total of 50 test cases were conducted to simulate emergency requests from users located in different areas with varying densities of nearby hospitals. The hospitals were pre-configured with nurse availability data and location coordinates.

2. Key parameters assessed included:

Response Time: Time from user request initiation to nurse dispatch confirmation.

Accuracy: Precision of the geolocation and nurse tracking features.

Success Rate: Ratio of requests successfully accepted and responded to within the defined timeframe.

Communication Latency: Time taken to establish chat between user and hospital.

3. Observed Results:

Metric	Average Result	Best case	Worst Case
Response time	8.2 seconds	4.5 seconds	18 seconds
Request Success rate	94%	100%	76%
Nurse Arrival ETA Accuracy	3.5 meters	1.5 meters	7.0 meters
Chat Initialization Time	1.2 seconds	0.9 seconds	2.5 seconds

These results indicate strong performance in normal to moderately busy conditions. The system maintained real-time processing under multiple parallel requests, validating its scalability. The use of WebSocket-based communication and lightweight data packets minimized latency.

4. System Behavior Under Load

When tested under simulated load with 100 concurrent emergency requests, the system exhibited slight delays in dispatch and message delivery. However, the fallback mechanism to expand the search radius proved effective in maintaining a high success rate. Database query optimization and asynchronous request handling played a crucial role in managing server load.

5. Blood Donation Module Performance

The optional blood donation feature was tested with a database of 300 simulated donors. Upon issuing a blood request:

88% of matching donors were notified within 3 seconds.

On average, 2.3 donors responded positively within the first 60 seconds.

The system matched and confirmed a donor in under 90 seconds in seconds — potentially saving lives during critical emergencies. in 91% of the cases.

These outcomes demonstrate the potential of community-supported emergency interventions when integrated with intelligent matching algorithms.

6. The results confirm that the proposed system can significantly improve. Nonetheless, the architecture is highly modular and reduce emergency response time, improve coordination between scalable, allowing for easy enhancements such as ambulance patients and hospitals, and enhance the overall quality of care. dispatch, pharmacy integration, AI-based symptom analysis, and The nurse dispatch algorithm functioned reliably, and the real-regional health monitoring dashboards. time tracking feature proved to be accurate and user-friendly.

The chat system enabled seamless communication of critical emergency medical needs and rapid response delivery through a patient details, contributing to informed care even before nurse smart, reliable, and user-friendly platform. With further development, arrival. The flexibility to expand the search radius and retry real-world testing, and government or institutional support, this requests allowed the system to maintain operational integrity system can be transformed into a vital component of next-generation even in scenarios with limited nearby availability. healthcare infrastructure, especially in regions lacking adequate emergency response capabilities.

7. However, some challenges were identified:

In low-network areas, response times were longer due to delayed location detection.

High concurrency slightly impacted message delivery speed, suggesting the need for advanced load-balancing strategies in production deployment.

A few edge cases involved incorrect or outdated hospital availability data, which could be mitigated with periodic automated status checks.

8. Restrictions and Prospective Aspects

Even though the prototype operated dependably in controlled settings, more testing in full-scale elevators with varying occupancy and temperature conditions is required. Future generations may investigate refilling or multi-canister systems, as the oxygen canister's size restricts the amount of time it can provide support. Future stages will also see the implementation of AI-based behavioral analysis for distress identification and real-time cloud monitoring.

Conclusion

The development and implementation of the real-time medical response and nurse dispatch system represent a significant advancement in emergency healthcare technology. This project demonstrates how the integration of geolocation services, real-time communication, and automated decision-making can streamline the process of deploying medical professionals, particularly nurses, to emergency sites with greater speed and efficiency.

Through rigorous testing and performance analysis, the system has proven its ability to reduce response times, enhance coordination between hospitals and patients, and deliver timely care in critical situations. The core algorithm effectively identifies nearby hospitals, manages simultaneous dispatch requests, and ensures that the first available and willing hospital responds swiftly. The built-in chat interface further enhances communication by enabling immediate data exchange about the patient's condition, which prepares the medical personnel before they arrive on-site.

One of the most impactful extensions of this system is the integration of the blood donation module, which adds a community-driven layer to emergency care. By leveraging location-based filtering and real-time alerts, the system can connect patients in urgent need of blood with compatible donors

While the results are promising, the system also revealed certain limitations, such as network dependency and server performance under high loads. These findings offer valuable insights for future

In conclusion, this project successfully bridges the gap between

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