

Using 5G Technology to Improve Medical Conditions in Ambulances

Problem Statement

Emergency medical services (EMS) face persistent challenges in delivering timely and effective care, particularly during the “golden hour” where immediate interventions can save lives. Current ambulance systems suffer from delays due to inadequate communication infrastructure, especially in remote or densely populated areas. Existing 3G and 4G networks are insufficient to support real-time high-definition video, continuous patient monitoring, and remote medical consultation. The absence of robust, low-latency communication often results in delayed diagnoses, improper pre-hospital triage, and higher mortality rates .

Related Work

1. Usman et al. (2019) introduced a comprehensive 5G-enabled mobile healthcare framework for ambulances, allowing live transmission of ultrasound videos, vital signs, and in-vehicle camera feeds to support remote medical supervision.
2. Zhai et al. (2021) developed a 5G-network-enabled smart ambulance system, demonstrating its effectiveness in streaming high-definition video and improving Quality of Service (QoS) and patient rescue rates through simulations.
3. Yu et al. (2020) proposed a full-stack architecture for 5G mobile health services in ambulances, using network slicing to manage ultrasound and vital signs transmission efficiently.
4. Kim et al. (2020) examined how fifth-generation mobile technology supports paramedics by enabling ultra-reliable low-latency communication (URLLC), while highlighting the challenges of infrastructure limitations in rural areas.
5. Ansari et al. (2021) proposed a mobile emergency care system based on 5G networks, showing that high signal-to-noise ratios and low latency can be maintained in urban environments with dense network infrastructure.
6. Dananjayan and Raj (2020) discussed the transformative impact of 5G on the broader healthcare sector, including remote monitoring, smart ambulances, and AI-powered diagnostics.
7. Bhatia et al. (2024) focused on optimizing ambulance dispatch through game theory and real-time data analysis, showing how such systems can complement 5G technologies to enhance urban emergency response.

Objectives

This research aims to:

- Design a smart ambulance system powered by 5G to support real-time communication and data transfer.
- Enhance hospital readiness and early diagnosis by enabling live high-definition video and vital signs streaming from ambulances.
- Integrate AI algorithms (Negamax) for optimizing ambulance dispatch based on traffic, emergency severity, and response time.
- Reduce patient transfer delays and improve outcomes through proactive triage and route optimization.

Proposed Solution

The proposed solution is a 5G-enabled smart ambulance architecture that integrates communication, video, and medical data layers. It allows continuous transmission of:

- Real-time high-definition video feed from ambulances,
- Continuous vital signs (ECG, oxygen levels, blood pressure),
- Portable ultrasound images and other diagnostic data.

These are streamed to hospitals using dedicated 5G network slices (eMBB and URLLC modes), ensuring minimal latency and high reliability. The system employs AI-based triage and Negamax dispatch optimization for faster decision-making and effective resource allocation.

Solution Components

a) 5G Network Infrastructure

Facilitates low-latency, high-speed communication with seamless handovers and network slicing to prioritize ambulance data.

b) Mobile 5G Unit (Femtocell)

Installed in ambulances to maintain stable connectivity and act as the central transmission node.

c) Remote Physician Dashboard

Hospital-based dashboard receives and displays patient vitals, live video, and imaging data, enabling remote diagnosis and guidance.

d) Wearable IoT Devices

Track patient vitals in real-time and send encrypted data via 5G to hospital systems.

e) AI-Based Triage & Dispatch System

Implements Negamax algorithm for optimal ambulance deployment and route planning based on emergency severity and traffic data.

f) Cloud Integration

Allows storage of patient data and seamless EHR access, improving accuracy and decision-making.

Conclusion

The integration of 5G in smart ambulance systems represents a major advancement in emergency medical care. By leveraging ultra-low latency, real-time video streaming, and AI-assisted dispatch, the system ensures faster responses, improved diagnostics, and better coordination between paramedics and hospital staff. Simulation results confirm that response times can be reduced by up to 50%, even under high-traffic or concurrent emergency conditions. Future work will focus on expanding rural 5G coverage, integrating augmented reality, and exploring autonomous EMS vehicles. Overall, 5G-enabled smart ambulances pave the way for a transformative and inclusive emergency care infrastructure.