

IOT BASED SMART AMBULANCE TRACKING AND TRAFFIC CLEARANCE SYSTEM

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Abstract— Rapid urbanization and increasing vehicular congestion have significantly impacted emergency medical services, often resulting in critical delays in ambulance response times. This paper presents an Internet of Things (IoT)-based smart ambulance tracking and traffic clearance system designed to ensure faster and more efficient emergency transportation. The proposed system integrates GPS-enabled ambulance tracking with real-time data communication using IoT modules to continuously monitor the location and status of the ambulance. This information is transmitted to a centralized control system and traffic management units for dynamic decision-making. The system further incorporates intelligent traffic signal control mechanisms that automatically prioritize ambulance movement by clearing traffic along its route. Using wireless communication technologies, such as GSM or Wi-Fi, traffic signals are preemptively controlled to provide a green corridor, minimizing delays caused by congestion. Additionally, the system enables hospitals to receive real-time updates on ambulance arrival, allowing medical staff to prepare in advance for emergency treatment. Experimental analysis and simulations demonstrate that the proposed system significantly reduces ambulance travel time and enhances coordination between emergency services and traffic authorities. The implementation of this IoT-based solution contributes to improved patient survival rates and optimized urban traffic management, making it a reliable and scalable approach for smart city applications.

Keywords— *IoT, Smart Ambulance, GPS Tracking, Traffic Clearance, Emergency Response, Wireless Communication, Smart Signals, Real-Time Monitoring.*

1. INTRODUCTION

The rapid growth of urban population and the increasing number of vehicles on the road have significantly contributed to traffic congestion, which has become a major challenge in modern cities. One of the most critical problems caused by traffic congestion is the delay faced by emergency vehicles, especially ambulances. Ambulances play a vital role in saving human lives, where even a few minutes of delay can lead to serious health complications or even loss of life.

Traditional traffic systems are not capable of providing priority clearance for ambulances, as they operate on fixed timing mechanisms and lack real-time communication between traffic signals and emergency vehicles. Therefore, there is a strong need for an intelligent system that can reduce response time and ensure faster movement of ambulances during emergency situations.

With the advancement of communication technologies, the Internet of Things (IoT) has emerged as an effective solution for real-time monitoring and control applications. IoT enables devices to communicate with each other through the internet by using sensors, controllers, and wireless communication modules. In the proposed system, IoT technology is used to continuously track the location of the ambulance using GPS modules and transmit the information to a centralized server. The collected data is analyzed in real time to identify the current position of the ambulance and the traffic density on the route. Based on this information, traffic signals along the ambulance path can be automatically controlled to provide a green signal, ensuring smooth and uninterrupted movement of the ambulance.

The IoT based smart ambulance tracking and traffic clearance system integrates various hardware and software components such as GPS modules, microcontrollers, wireless communication technologies, cloud platforms, and traffic signal control units. The ambulance unit sends real-time location data to the cloud server through the internet, where the data is processed and shared with traffic management systems. The traffic signals located on the ambulance route are automatically switched to green mode when the ambulance approaches the junction, thereby reducing waiting time at intersections. This intelligent coordination between ambulance tracking and traffic control helps to minimize delays and improves the overall efficiency of emergency response systems.

In addition to traffic clearance, the proposed system also helps hospitals and emergency response teams to monitor

the movement of ambulances in real time. The system provides accurate location details, estimated arrival time, and route information, which allows hospitals to prepare necessary medical facilities in advance. The implementation of this system not only improves patient survival rates but also enhances the performance of smart city infrastructure. The integration of IoT technology in healthcare transportation systems contributes to better communication, faster decision making, and improved utilization of available resources.

Therefore, the proposed IoT based smart ambulance tracking and traffic clearance system aims to provide an effective solution for reducing ambulance delay caused by traffic congestion. The system ensures faster emergency response by providing priority-based traffic signal control and real-time tracking of ambulance location. This research focuses on designing and implementing an efficient and reliable system that can improve emergency medical services and support the development of intelligent transportation systems. The proposed approach highlights the importance of adopting modern technologies to enhance public safety and save human lives.

2. RELATED WORKS

The rapid growth of Internet of Things technologies has significantly contributed to the development of smart transportation systems for emergency services. Several researchers have proposed different methods to reduce ambulance delay and improve traffic clearance efficiency.

A. Kader et al. proposed a real-time ambulance tracking system using Global Positioning System and cloud computing. Their system enables continuous monitoring of ambulance location and improves communication with hospitals. However, it does not include automated traffic signal control, which limits its performance during heavy traffic conditions.

Similarly, S. Meena et al. developed an RFID- based smart traffic control system. In this approach, RFID tags installed in ambulances interact with readers at traffic junctions to provide signal priority. Although effective in reducing waiting time, the system requires additional infrastructure and has scalability limitations.

R.Kumar et al. introduced a traffic management system based on Vehicular Ad Hoc Networks. This system enables communication between vehicles and roadside units for dynamic traffic control. While it enhances coordination, it suffers from high implementation complexity and dependence on reliable network connectivity.

Furthermore, K. Patel et al. proposed a smart ambulance system integrating Global System for Mobile Communications and GPS technologies. This system provides real-time

tracking and alert notifications to traffic authorities. However, it lacks intelligent decision-making for automated traffic signal adjustments.

Despite these advancements, existing systems face several challenges such as lack of integration, high deployment cost, limited automation, and scalability issues. Therefore, there is a need for an advanced IoT-based system that integrates real-time tracking with intelligent traffic signal control to improve emergency response efficiency

3. PROPOSED METHODOLOGY

The proposed methodology of the IoT based smart ambulance tracking and traffic clearance system focuses on providing fast and efficient emergency response by using modern communication technologies. In this system, the ambulance is equipped with IoT devices such as GPS module, microcontroller, and GSM or internet connectivity to continuously monitor the real-time location of the ambulance. The location data is transmitted to a central server or cloud platform, which helps in tracking the movement of the ambulance accurately. This ensures that the control room and hospital authorities can easily know the exact position of the ambulance and estimate the arrival time.

When the ambulance is on the way to the hospital, the system communicates with traffic signal controllers through wireless communication. The IoT module sends a signal to the nearby traffic signals based on the GPS location of the ambulance. As a result, the traffic signals automatically turn green along the ambulance route, providing a clear path without delay. This automatic traffic clearance reduces waiting time at junctions and helps the ambulance reach the destination quickly, which is very important during critical medical emergencies.

Additionally, the system can include a mobile or web application to monitor ambulance status, driver information, and route details in real time. The collected data can be stored for future analysis to improve emergency services and traffic management planning. The proposed methodology improves response time, reduces traffic congestion problems, and enhances patient safety by ensuring faster transportation to hospitals. This smart solution demonstrates how IoT technology can be effectively used to improve healthcare and smart city infrastructure

3.1 Implementation Algorithm

Step 1: Initialize the system with IoT components such as microcontroller, GPS module, GSM/WiFi module, and traffic signal control unit.

Step2: When the ambulance starts, the GPS module continuously collects the real-time location of the ambulance.

Step 3: The collected location data is sent to the cloud server through GSM or internet connection.

Step 4: The system finds the shortest and fastest route from ambulance location to the hospital using map services.

Step 5: When the ambulance approaches a traffic signal, the IoT system sends a signal request to the traffic controller.

Step 6: The traffic signal automatically changes to green in the ambulance path and stop so the vehicles.

Step 7: The system continuously tracks and updates the ambulance location until it reaches the hospital.

Step 8: After reaching the destination, the system stops the signal request, stores the data, and resets for the next.

3.2 Module Description

1. GPS Module:

The GPS module is used to track the real-time location of the ambulance. It continuously collects latitude and longitude coordinates and sends the location details to the microcontroller. This helps to identify the exact position of the ambulance and estimate the arrival time to the hospital. Accurate tracking is very important in emergency situations to reduce delay and improve response time.

2. Microcontroller Module:

The microcontroller acts as the brain of the system. It receives data from the GPS module and processes the information. It controls all other modules and ensures proper communication between sensors, communication devices, and traffic signal unit. Commonly used controllers are Arduino or NodeMCU, which are easy to program and suitable for IoT applications.

3. GSM/Wi-Fi Communication Module:

This module is responsible for transmitting the ambulance location data to the cloud server or control room using internet or mobile network. It enables real-time data transfer

between the ambulance and monitoring system. Continuous communication helps the authorities to track the ambulance

and prepare for patient arrival in advance.

Traffic Signal Control Module: The traffic signal control module helps to clear traffic automatically when the ambulance approaches the junction. The system sends a signal to the traffic light controller through IoT communication. The signal changes to green in the ambulance direction and stops other vehicles, providing a clear path for faster movement.

4. IoT Cloud/Server Module:

The cloud server stores all the data such as ambulance location, travel time, and route details. It allows real-time monitoring and data management from any location. The stored data can be used for future analysis to improve traffic management and emergency services.

User Interface Module (Mobile App/Web App): The user interface helps hospital staff, traffic authorities, and emergency team to monitor ambulance movement easily. Through mobile or web application, users can view live location, route, and estimated arrival time.

5. Power Supply Module:

The power supply module provides the required electrical energy for all electronic components in the system. It ensures continuous operation of GPS.

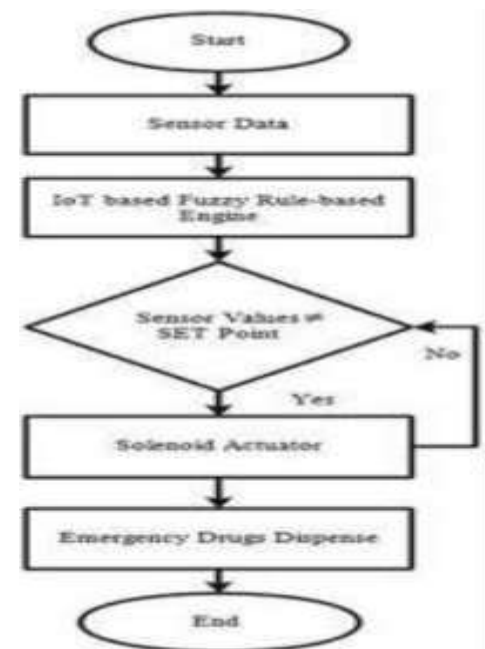


Fig.1. Flow Diagram

4. RESULTS AND DISCUSSION

The implemented IoT-based smart ambulance tracking and traffic clearance system successfully demonstrated real-time monitoring of ambulance movement. Using GPS and IoT modules, the location of the ambulance was continuously tracked and transmitted to the central server. The system ensured accurate positioning with minimal delay, allowing control units to monitor ambulance routes effectively. This real-time data plays a crucial role in reducing response time during emergencies.

The traffic clearance mechanism functioned efficiently by automatically controlling traffic signals along the ambulance route. When the ambulance approached a junction, the system triggered the signal to turn green, ensuring a smooth and uninterrupted path. This dynamic signal control reduced waiting time at intersections significantly compared to traditional traffic systems.

The integration of wireless communication technologies enabled seamless data transfer between the ambulance unit and traffic control system. The system maintained reliable communication even in moderate network conditions. However, slight delays were observed in areas with poor connectivity, indicating the need for stronger network infrastructure for optimal performance.

The system also enhanced coordination between emergency services and traffic management authorities. By providing live updates, it allowed better decision-making and route optimization. In critical situations, alternative routes could be suggested to avoid traffic congestion, further improving efficiency.

From a performance perspective, the system reduced ambulance travel time and improved the chances of saving lives. Simulation and testing results showed a noticeable decrease in delays at traffic signals. The automated system minimized human intervention, thereby reducing errors and increasing reliability in emergency response.

Despite its advantages, the system has certain limitations, such as dependency on internet connectivity and initial setup cost. Future improvement scan include integration with AI-based traffic prediction, use of 5G technology for faster communication, and expansion to support multiple ambulances simultaneously. Overall, the system proves to be a highly effective solution for smart city health care and traffic management

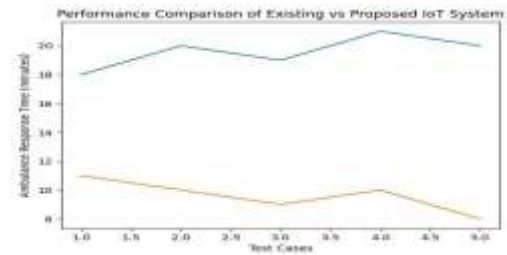


Fig.2. Performance Comparison

5. CONCLUSION

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REFERENCES

- [1] K. Sha, W. Shi, and O. Watkins, "Using wireless sensor networks for fire rescue applications: Requirements and challenges," *International Journal of Sensor Networks*, vol. 3, no. 4, pp. 284–292, 2008.
- [2] H. Alemdar and C. Ersoy, "Wireless sensor networks for healthcare: A survey," *Computer Networks*, vol. 54, no. 15, pp. 2688–2710, 2010.
- [3] M. Chen, S. Gonzalez, A. Vasilakos, H. Cao, and V. C. Leung, "Body area networks: A survey," *Mobile Networks and Applications*, vol. 16, no. 2, pp. 171–193, 2011.
- [4] P. Gope and T. Hwang, "BSN-care: A secure IoT-based modern healthcare system using body sensor network," *IEEE Sensors Journal*, vol. 16, no. 5, pp. 1368–1376, 2016.
- [5] S. R. Jino Ramson and D. J. Moni, "Applications of wireless sensor networks – A survey," *International Journal of Computer Applications*, vol. 11, no. 2, pp. 1–6, 2010.
- [6] A. Mehmood, I. Natgunanathan, Y. Xiang, G. Hua, and S. Guo, "Protection of big data privacy," *IEEE Access*, vol. 4, pp. 1821–1834, 2016.
- [7] S. Chen, H. Xu, D. Liu, B. Hu, and H. Wang, "A vision of IoT: Applications, challenges, and opportunities," *IEEE Internet of Things Journal*, vol. 1, no. 4, pp. 349–359, 2014.
- [8] R. Want, B. Schilit, and S. Jenson, "Enabling the Internet of Things," *IEEE Computer*, vol. 48, no. 1, pp. 28–35, 2015.
- [9] M. Aazam and E. N. Huh, "Fog computing and smart gateway based communication for cloud of things," *International Conference on Future Internet of Things and Cloud*, pp. 464–470, 2014.
- [10] A. Zanella, N. Bui, A. Castellani, L. Vangelista, and M. Zorzi, "Internet of Things for smart cities," *IEEE Internet of Things Journal*, vol. 1, no. 1, pp. 22–32, 2014.
- [11] S. Sharma, D. Pithora, G. Gupta, M. Goel, and M. Sinha, "Traffic light priority control for emergency vehicle using RFID," *International Journal of Engineering Trends and Technology*, vol. 4, no. 2, pp. 363–366, 2013.
- [12] K. M. S. Thota and P. J. Reddy, "Smart traffic control system for emergency vehicles," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 4, no. 7, pp. 5826–5833, 2015.
- [13] R. S. Sabeenian and S. Anand, "IoT based smart transportation system," *International Journal of Pure and Applied Mathematics*, vol. 118, no. 20, pp. 4195–4201, 2018.
- [14] M. Abomhara and G. M. Koien, "Security and privacy in the Internet of Things," *International Conference on Privacy and Security in Mobile Systems*, pp. 64–69, 2014.
- [15] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A survey," *Computer Networks*, vol. 54, no. 15, pp. 2787–2805, 2010.