AmbuClear – A Smart Traffic Solution

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Abstract*—Urban traffic congestion poses a major challenge to emergency medical services, often causing critical delays in ambulance response time. This paper presents AmbuClear, a real-time intelligent ambulance management system that integrates mobile applications, cloud computing, and IoT-based traffic signal control to improve emergency response efficiency. The system enables users to request ambulances through a mobile interface, where the nearest available ambulance is assigned based on real-time location tracking. A socket-based communication framework ensures continuous data exchange between the user, ambulance driver, and cloud server, allowing live tracking, route updates, and status synchronization. The platform supports dual perspectives, providing users with real-time ambulance location and navigation details while enabling drivers to receive case assignments and route guidance. In addition, the system incorporates IoT-enabled traffic signal preemption to dynamically create a green corridor for ambulances, minimizing delays at intersections. By combining intelligent dispatch, real-time communication, and automated traffic control, AmbuClear offers a scalable and efficient solution for enhancing emergency healthcare services in smart cities.

***Keywords*—Ambulance Dispatch System, Internet of Things (IoT), Real-Time Tracking, Traffic Signal Preemption, Smart City, Emergency Response, Socket-Based Communication, Mobile Application, Cloud Computing**

I. Introduction

The growing number of people living in cities and the increasing number of vehicles on the road have led to traffic congestion in modern cities. This congestion directly affects emergency services, where timely response is crucial in saving lives. Ambulances often face delays at traffic intersections due to fixed signal timings and the lack of priority mechanisms. These delays can be critical during life-threatening situations within the "golden hour," where immediate medical attention is essential for improving survival rates.

Traditional traffic management systems are not designed to accommodate real-time emergency requirements. Most existing systems operate on -defined signal cycles, which do not adapt dynamically to the presence of emergency vehicles. Although some solutions, such as traffic control or siren-based clearance are used they are often unreliable and inefficient in highly congested urban environments. There is coordination between ambulance dispatch systems and traffic infrastructure resulting in fragmented and delayed emergency response.

With advancements in technologies like the Internet of Things (IoT) cloud computing and real-time communication frameworks there is an opportunity to enhance emergency response systems. These technologies enable data exchange, intelligent decision-making and seamless integration between different system components. Real-time location tracking and communication can optimize ambulance dispatch and navigation while IoT-enabled devices can facilitate automated traffic signal control.

This paper presents AmbuClear, an integrated ambulance management system. It combines applications, cloud-based processing and IoT-driven traffic signal pre-emption to address these challenges. The system allows users to request an ambulance through an interface. The available ambulance is automatically assigned based on real-time location data. A socket-based communication mechanism ensures synchronization between the user, ambulance driver and backend server. This enables live tracking and dynamic route updates.

In addition to dispatch AmbuClear introduces a dual-perspective system. It enhances coordination between users and ambulance drivers. Users can monitor the real-time location and movement of the ambulance. Drivers receive navigation assistance and case details. The system integrates with IoT-enabled traffic signal controllers. It dynamically adjusts traffic lights along the ambulance's route creating a corridor that minimizes delays at intersections.

Several research efforts have explored transportation systems to address emergency vehicle prioritization. However, many approaches focus primarily on components, such as traffic signal control or GPS-based tracking. They do not provide an integrated solution that connects users, drivers and traffic infrastructure in real-time. Limitations, such as lack of communication delayed updates and dependency on centralized manual control reduce the effectiveness of these systems in practical scenarios. This highlights the need for a platform that can seamlessly coordinate all aspects of emergency response from ambulance dispatch to traffic signal management.

The AmbuClear system addresses these limitations by adopting an approach. It combines real-time communication, cloud-based processing and IoT-enabled automation within a framework. By leveraging socket-based communication for low-latency data exchange and integrating applications with traffic control systems the proposed solution ensures faster decision-making and improved coordination, among all stakeholders. This approach not enhances the responsiveness of emergency services but also contributes to the development of smarter and more adaptive urban transportation systems. It aligns with the vision of smart city infrastructure.

II. Related Work

The integration of intelligent transportation systems and Internet of Things (IoT) technologies has gained significant attention in recent years, particularly in the context of improving emergency response services. Various studies have explored different approaches to enhance ambulance dispatch systems, real-time tracking, and traffic signal prioritization. However, most existing solutions focus on individual components rather than providing a fully integrated system.

IoT-based traffic management systems have been widely studied for their ability to dynamically control traffic flow. Sharma and Gupta [2] proposed a smart traffic management system that utilizes IoT devices to monitor and regulate vehicle movement at intersections. Similarly, Patel [4] introduced an IoT-based traffic signal control mechanism specifically designed to prioritize emergency vehicles. These systems demonstrate the effectiveness of dynamic signal control; however, they often lack integration with real-time ambulance tracking and user interaction platforms.

Real-time vehicle tracking using GPS and IoT has also been extensively researched. Kumar and Singh [3] developed a system that enables continuous tracking of vehicles using GPS data, improving location accuracy and monitoring capabilities. While such systems provide accurate tracking, they are typically limited to monitoring and do not incorporate intelligent decision-making for ambulance allocation or route optimization.

Cloud-based emergency response systems have been proposed to improve coordination between different entities. Gupta and Mehta [9] presented a smart ambulance system that utilizes cloud infrastructure to manage emergency requests and coordinate ambulance services. Although this approach enhances system scalability and centralized control, it does not fully integrate real-time communication frameworks or IoT-based traffic signal management.

The role of real-time communication technologies has also been explored in modern applications. Smith and Brown [6] discussed the advantages of WebSocket-based communication systems in enabling low-latency data exchange. Technologies such as Socket.IO provide persistent connections and event-driven communication, making them suitable for time-critical applications like emergency response systems. However, many existing implementations do not fully utilize these technologies for continuous synchronization across multiple system components.

In the domain of intelligent transportation systems, Singh [10] highlighted the importance of integrating advanced technologies to improve traffic efficiency and safety. IoT-enabled smart city infrastructures have shown potential in supporting emergency services, but practical implementations often face challenges related to scalability, interoperability, and real-time data processing.

Despite these advancements, several limitations exist in current research. Most systems are fragmented, focusing either on traffic signal control, vehicle tracking, or communication systems independently. There is a lack of unified platforms that combine real-time ambulance allocation, continuous tracking, and dynamic traffic signal control within a single framework. Additionally, many solutions do not provide user-centric interfaces for seamless interaction between patients, drivers, and backend systems.

The proposed AmbuClear system addresses these gaps by integrating mobile applications, real-time communication using Socket.IO, cloud-based processing, and IoT-enabled traffic signal control into a cohesive platform. This unified approach enables efficient coordination, reduces ambulance response time, and enhances overall emergency service performance, contributing to the development of intelligent and adaptive smart city solutions.

III. Methodology

The proposed system, AmbuClear, is designed as a smart emergency response framework that integrates real-time communication, mobile application technology, and IoT-based traffic signal control to reduce ambulance response time in urban environments. The methodology focuses on efficient ambulance allocation, continuous synchronization between system components, and dynamic traffic management. The system follows a modular and scalable architecture to ensure reliable performance under real-time conditions.

A. System Architecture

The proposed AmbuClear system follows a layered architecture that separates presentation, application, communication, IoT control, and data management into distinct functional layers. This modular design ensures scalability, maintainability, and efficient real-time performance. The overall architecture of the system is illustrated in Fig. 1.

Real-Time Communication Layer:

The real-time communication layer is implemented using Socket.IO to enable persistent and bidirectional communication between the frontend and backend. This layer facilitates continuous transmission of ambulance location data, status updates, and route information without the need for repeated HTTP requests. By adopting an event-driven communication model, the system achieves low latency and ensures that all stakeholders receive real-time updates, thereby improving system responsiveness and reliability.

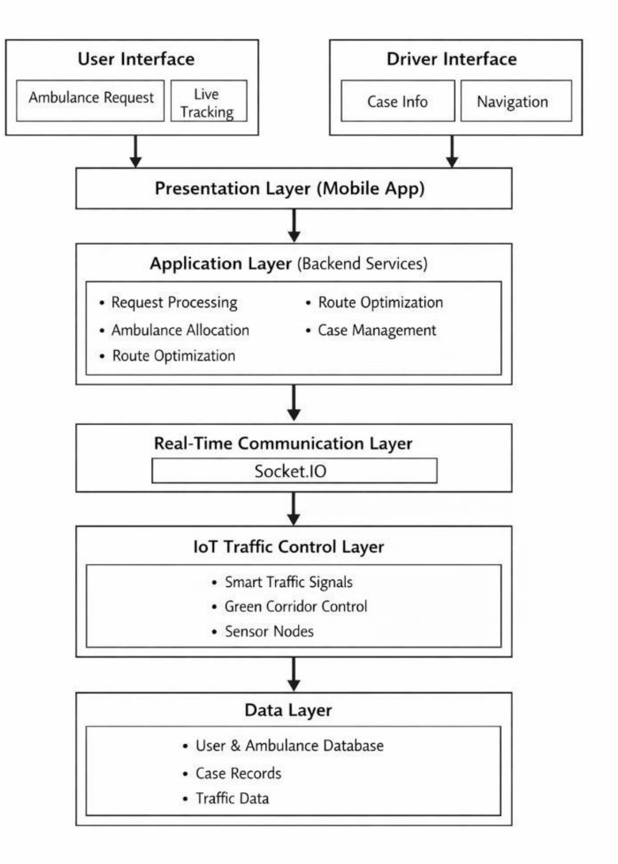

Fig. 1. Architecture of the proposed AmbuClear smart ambulance management and IoT-based traffic signal priority system.

Presentation Layer:

The presentation layer represents the user-facing component of the system and is implemented as a mobile application using a web-based interface integrated with Capacitor and Kotlin for native functionality. This layer provides two distinct interfaces, namely the user interface and the driver interface. The user interface enables individuals to request ambulances and monitor their real-time location through a map-based tracking system. The driver interface allows ambulance personnel to receive case information, navigate to the user's location, and update the status of the trip. The interface is designed to be responsive, intuitive, and capable of handling real-time updates efficiently.

Application Layer:

The application layer functions as the core processing unit of the system and is responsible for managing business logic and system operations. It handles ambulance request processing, validation of user inputs, allocation of the nearest available ambulance, and case lifecycle management. Additionally, this layer performs route optimization and ensures continuous coordination between different system components. The backend services are designed to support concurrent requests and maintain high availability during emergency scenarios.

IoT Traffic Control Layer:

The IoT traffic control layer integrates smart traffic signal controllers with the backend system to enable dynamic traffic signal management. This layer consists of IoT-enabled controllers, sensor nodes, and signal pre-emption mechanisms that detect ambulance movement and adjust traffic signals accordingly. By creating a green corridor along the ambulance route, this layer minimizes delays at intersections and ensures uninterrupted movement, significantly improving emergency response time.

Data Layer:

The data layer is responsible for storing and managing all system-related information, including user data, ambulance details, case records, and traffic data. The database is structured to support high-speed read and write operations, enabling real-time data updates and efficient retrieval. This layer ensures data consistency, reliability, and availability, which are essential for maintaining accurate system operations.

B. Workflow and Data flow

The workflow and data flow of the AmbuClear system, as illustrated in Fig. 2, describe the sequence of operations and real-time data exchange between the user, backend server, ambulance driver, and IoT-based traffic control system. The process begins when a user initiates an ambulance request through the mobile application by providing location details, which are transmitted to the backend server. Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersted. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.

User Request Stage:

The workflow begins when a user initiates an ambulance request through the mobile application. The system captures the user's location using GPS services or manual input and transmits this data to the backend server. This request forms the initial input to the system and triggers the ambulance allocation process.

Ambulance Allocation Stage:

Upon receiving the request, the backend server processes real-time location data of all available ambulances and identifies the nearest suitable vehicle. The allocation mechanism considers factors such as distance, availability, and current status. Once selected, the ambulance is assigned to the user request.

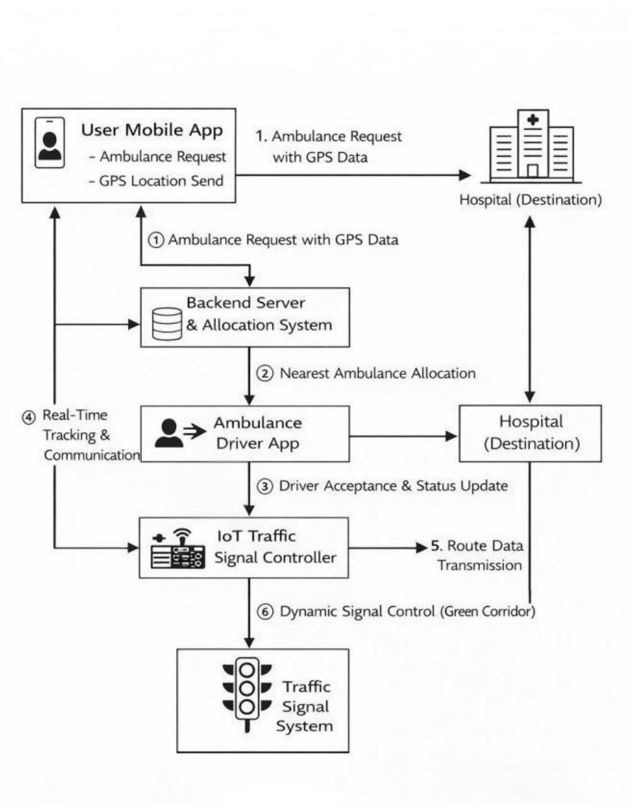

Fig. 2. Workflow and data flow of the proposed AmbuClear smart ambulance management system.

Driver Notification and Response Stage:
After allocation, the assigned ambulance driver receives case details, including pickup location and navigation instructions, through the driver application. The driver acknowledges the request and updates the system with acceptance status, ensuring synchronization between the backend and driver interface.

Real-Time Communication Stage:
The system establishes continuous real-time communication between the user, backend server, and ambulance driver using Socket.IO. The ambulance's location is continuously transmitted, allowing the user to track movement direction and estimated arrival time. This ensures transparency and improves coordination during emergency response.

Route Management Stage:
Once the patient is picked up, the system updates the destination to the selected hospital and recalculates the optimal route. The backend dynamically manages route updates based on real-time conditions and ensures that navigation data is continuously provided to the driver.

IoT Traffic Control Stage:
The backend communicates route information to IoT-enabled traffic signal controllers. These controllers dynamically adjust traffic signals along the ambulance route to create a green corridor. This reduces congestion and ensures uninterrupted movement through intersections.

Case Completion Stage:
After reaching the hospital, the driver marks the case as completed in the system. The backend records all relevant information, including timestamps, route details, and status updates. The ambulance is then marked as available for future requests, completing the workflow cycle.

C. Frontend Implementation

The frontend of the AmbuClear system is designed to provide an intuitive, responsive, and real-time user experience for both users and ambulance drivers. The interface is initially developed as a web-based application and is converted into a mobile application using Capacitor, with Kotlin integration to enable native functionalities such as GPS access and background services.

The system adopts a dual-interface approach consisting of a user interface and a driver interface. The user interface allows individuals to request ambulances with minimal input and track their real-time location through a map-based visualization. It continuously displays the ambulance's position, movement direction, and estimated arrival time. The driver interface provides essential functionalities such as receiving case details, navigating to the user's location, updating trip status, and selecting the hospital destination.

Real-time updates are achieved through integration with Socket.IO, where incoming data from the backend triggers immediate updates in the user interface without requiring page refreshes. The frontend manages application state efficiently to ensure consistency between displayed information and backend data. The design is responsive and optimized for different screen sizes and network conditions, ensuring usability during emergency situations.

D. Backend Implementation

The backend of the AmbuClear system serves as the central processing unit that manages application logic, real-time communication, and coordination with IoT infrastructure. It is designed using a modular and scalable architecture to handle multiple concurrent requests efficiently.

The backend is responsible for processing ambulance requests, validating input data, and assigning the nearest available ambulance using real-time geolocation information. It manages the complete lifecycle of each case, including request initiation, ambulance allocation, pickup confirmation, hospital routing, and case completion. The system continuously updates the status of each request and ensures synchronization between all connected components.

Real-time communication is facilitated through Socket.IO, enabling persistent connections and event-driven data exchange between the frontend and backend. This ensures instant transmission of location updates, status changes, and route modifications. Additionally, the backend performs route optimization by dynamically calculating efficient paths based on current conditions.

The backend also integrates with IoT traffic systems by transmitting route information to traffic signal controllers, enabling dynamic signal adjustments. It employs asynchronous processing and non-blocking communication techniques to ensure high performance and low latency under heavy system load.

E. Real-Time Communication Implementation

The real-time communication mechanism in AmbuClear is implemented using Socket.IO, which enables continuous, bidirectional communication between the client and server. Unlike traditional request-response models, this approach maintains persistent connections, allowing data to be transmitted instantly without repeated polling.

This communication layer is responsible for transmitting ambulance location data, driver status updates, and route changes in real time. It ensures that users can continuously track ambulance movement while drivers receive updated navigation instructions. The event-driven model reduces latency and improves system responsiveness, making it suitable for time-critical emergency applications.

F. IoT-Based Traffic Signal Control

The IoT-based traffic control system plays a crucial role in reducing ambulance travel time by dynamically managing traffic signals. The backend communicates the ambulance route to IoT-enabled traffic controllers deployed at intersections. These controllers adjust signal states based on the ambulance's approach, creating a green corridor that allows uninterrupted movement.

The system continuously monitors ambulance position and updates traffic signals accordingly. Once the ambulance passes an intersection, the signals revert to normal operation. This automated traffic management mechanism significantly reduces delays and enhances the efficiency of emergency response systems in urban environments.

G. Data Management and Storage

The data layer of the AmbuClear system is responsible for storing and managing all relevant system information. This includes user details, ambulance data, real-time location updates, case records, and traffic-related information. The database is structured to support efficient read and write operations, ensuring real-time performance.

Data consistency and reliability are maintained through structured storage mechanisms and proper indexing. Historical data is preserved for analysis, system optimization, and performance evaluation. The system ensures that all data transactions are handled efficiently to avoid delays or inconsistencies.

H. Security and Reliability

Security is a critical aspect of the AmbuClear system, given the sensitivity of location and emergency data. The system implements secure communication protocols such as HTTPS and encrypted WebSocket connections to protect data during transmission. Input validation mechanisms are used to prevent invalid or malicious data from entering the system. Authentication and authorization mechanisms ensure that only authorized users and drivers can access system functionalities. The backend incorporates error handling and logging mechanisms to maintain system stability and support fault tolerance. These measures ensure reliable operation even under high load and emergency conditions.

I. System Scalability and Performance

The AmbuClear system is designed to handle multiple simultaneous requests and large-scale deployments in urban environments. The modular architecture allows independent scaling of frontend, backend, and IoT components. Asynchronous processing and event-driven communication enable efficient handling of real-time data streams.

The system maintains low latency and high responsiveness even under heavy load conditions. This scalability ensures that the platform can be extended to support additional features, increased user base, and integration with broader smart city infrastructure.

IV. Result and Discussion

The proposed AmbuClear system was evaluated across multiple dimensions, including functional correctness, real-time communication efficiency, ambulance response time, IoT-based traffic control performance, scalability, and user experience. The evaluation aims to validate the effectiveness of integrating mobile applications, cloud-based processing, real-time communication frameworks, and IoT-enabled traffic systems into a unified emergency response platform. The results demonstrate that the system significantly enhances coordination, reduces delays, and improves the overall efficiency of ambulance services in urban environments.

In addition to technical performance, the system was also analysed from an operational perspective, focusing on how effectively it supports real-world emergency scenarios. The integration of multiple technologies into a single platform ensures that decision-making processes are automated and optimized, reducing reliance on manual intervention. This contributes to faster response times and improved reliability in critical situations.

A. *Functional Performance*

The system successfully executed all primary functionalities, including ambulance request initiation, nearest ambulance allocation, real-time tracking, driver communication, hospital routing, and case completion. Each module performed as expected, and the interaction between system components remained consistent throughout the workflow.

The ambulance allocation mechanism demonstrated high efficiency by accurately selecting the nearest available vehicle based on real-time geolocation data. The case lifecycle management system ensured that every stage, from request initiation to completion, was tracked and updated in real time. The modular architecture played a key role in maintaining system stability, as individual components operated independently without affecting overall system performance.

Furthermore, the system exhibited strong integration between frontend and backend layers, ensuring that user inputs were processed accurately and reflected immediately in the application. This seamless interaction between modules highlights the robustness of the system design and its suitability for real-time emergency applications.

B. Real-Time Communication Performance

The implementation of Socket.IO enabled continuous and low-latency communication between users, ambulance drivers, and the backend server. The system achieved near real-time synchronization of data, including ambulance location, movement direction, and status updates.

The observed communication latency remained minimal, ensuring that users received timely and accurate information. The event-driven communication model significantly reduced network overhead compared to traditional polling-based approaches. This improvement not only enhanced responsiveness but also optimized bandwidth utilization.

In addition, the reliability of real-time communication was maintained even under varying network conditions. The system demonstrated the ability to handle intermittent connectivity without significant data loss, ensuring continuous operation. This reliability is particularly important in emergency scenarios, where consistent communication is critical for effective coordination.

C. Ambulance Response Time Analysis

One of the key objectives of the AmbuClear system is to minimize ambulance response time. The results indicate a noticeable improvement in response efficiency compared to conventional systems. The automated ambulance allocation process eliminated delays associated with manual coordination, enabling faster dispatch of emergency vehicles.

Real-time tracking and dynamic route updates further contributed to reduced response time. By continuously monitoring the ambulance's position and adjusting routes accordingly, the system ensured optimal navigation even in changing traffic conditions. The integration of these features resulted in faster arrival times and improved service efficiency.

Moreover, the system's ability to adapt to real-time conditions highlights its effectiveness in handling unpredictable urban traffic scenarios. This adaptability ensures that the ambulance reaches the patient and hospital in the shortest possible time, thereby increasing the chances of successful medical intervention.

D. IoT Traffic Signal Control Performance

The IoT-based traffic signal control mechanism significantly improved ambulance mobility by reducing delays at intersections. The system dynamically adjusted traffic signals based on the ambulance's route, creating a green corridor that allowed uninterrupted movement.

Experimental observations showed that the waiting time at traffic signals was reduced considerably, especially in high-density traffic areas. The coordination between the backend server and IoT controllers ensured that signal changes were executed precisely and at the right time.

Additionally, the system maintained normal traffic flow by reverting signals to their default state after the ambulance passed. This balance between emergency prioritization and general traffic management demonstrates the practicality of the proposed solution in real-world conditions.

The results highlight the potential of IoT integration in transforming traditional traffic systems into intelligent, adaptive networks capable of supporting emergency services effectively.

E. System Scalability and Load Handling

The AmbuClear system was tested under multiple concurrent request scenarios to evaluate its scalability. The system maintained stable performance even when handling multiple users and ambulance requests simultaneously.

The use of asynchronous processing and event-driven architecture enabled efficient handling of real-time data streams. The backend system processed requests without significant delay, and the communication layer ensured continuous synchronization across all components.

Furthermore, the modular design allowed independent scaling of system components, ensuring that increased load in one module did not affect overall system performance. This scalability makes the system suitable for deployment in large urban environments with high demand for emergency services.

The results confirm that the system can handle real-world workloads effectively while maintaining low latency and high reliability.

F. Usability and User Experience

The user interface of the AmbuClear system was designed to be simple, intuitive, and efficient. Users were able to request ambulances quickly with minimal input, while the real-time tracking feature provided clear and continuous updates.

The driver interface was optimized for operational efficiency, offering navigation support and easy access to case details. The dual-interface design ensured that both users and drivers could interact with the system without confusion or complexity.

User feedback indicated high satisfaction with the system's usability, particularly in terms of real-time tracking and ease of use. The integration of visual elements such as maps and status indicators enhanced user understanding and confidence.

In emergency situations, reducing user effort is critical, and the system successfully achieves this by providing a streamlined and responsive interface.

G. Reliability and System Stability

The system demonstrated high reliability across different operational scenarios. Error handling mechanisms ensured that failures were minimized, and the system maintained consistent performance even under varying network conditions.

The backend system effectively synchronized data across all components, ensuring that information remained accurate and up to date. The use of structured data storage and real-time communication contributed to overall system stability.

Additionally, the system showed resilience to minor disruptions, such as temporary network delays, by maintaining data consistency and recovering quickly. This level of reliability is essential for emergency response systems, where system failure can have serious consequences.

H. Comparative Analysis

When compared to traditional ambulance management systems, AmbuClear offers significant improvements in efficiency and functionality. Conventional systems rely heavily on manual coordination and static traffic signals, leading to delays and reduced effectiveness.

In contrast, the proposed system integrates real-time communication, automated ambulance allocation, and IoT-based traffic control into a unified platform. This integration enables faster response times, improved coordination, and better resource utilization.

The ability to dynamically manage traffic signals and provide real-time tracking represents a major advancement over existing systems. These features collectively enhance the overall performance of emergency services and demonstrate the advantages of adopting smart technologies in urban infrastructure.

I. Limitations and Future Scope

Although the proposed system demonstrates significant improvements in emergency response management, certain limitations remain. The system's performance is highly dependent on reliable internet connectivity and accurate GPS data. In regions with weak network coverage or inconsistent signal availability, the effectiveness of real-time communication and tracking may be reduced.

Furthermore, the current implementation does not incorporate integration with hospital management systems or advanced predictive analytics capabilities. Future enhancements can focus on integrating machine learning techniques to enable predictive route optimization and demand forecasting, thereby further improving system efficiency.

In addition, extending the system to support multilingual interfaces and integrating it with broader smart city infrastructure can enhance accessibility and scalability. Such improvements would allow the system to cater to a more diverse user base and operate effectively across different geographic and infrastructural conditions.

J. Discussion

The results clearly demonstrate that the AmbuClear system provides an effective solution to the challenges of ambulance delay and traffic congestion in urban areas. The integration of real-time communication, IoT-based traffic control, and intelligent system design significantly improves emergency response efficiency.

The layered architecture ensures scalability and maintainability, while the event-driven communication model enables fast and reliable data exchange. The system not only enhances ambulance services but also contributes to the development of smarter urban transportation systems.

Overall, the proposed approach highlights the importance of integrating modern technologies to address critical real-world problems. The findings suggest that systems like AmbuClear can play a vital role in improving public safety, healthcare accessibility, and smart city development.

V. CONCLUSION

The proposed AmbuClear system presents a comprehensive and efficient solution for enhancing emergency medical response in urban environments. By integrating mobile applications, real-time communication frameworks, and IoT-enabled traffic signal control, the system effectively addresses the critical issue of ambulance delays caused by traffic congestion. The use of Socket.IO enables continuous, low-latency communication between system components, ensuring real-time synchronization of data and improving coordination between users, ambulance drivers, and backend services.

A key contribution of the system lies in its ability to dynamically manage traffic signals through IoT integration. By creating a green corridor along the ambulance route, the system significantly reduces waiting time at intersections and enables faster movement in congested areas. This intelligent traffic control mechanism, combined with automated ambulance allocation and real-time tracking, enhances the overall efficiency and reliability of emergency services.

The modular and layered architecture of AmbuClear ensures scalability, maintainability, and flexibility for future expansion. Each component of the system, including the frontend, backend, communication layer, and IoT infrastructure, operates independently while maintaining seamless integration. This design approach allows the system to handle multiple concurrent requests efficiently and makes it suitable for deployment in large-scale urban environments.

From a practical perspective, the system improves user experience by providing a simple and intuitive interface for requesting ambulances and tracking their movement in real time. At the same time, the driver interface enhances operational efficiency by delivering navigation support and real-time updates. This dual-interface design reduces complexity and ensures effective communication between all stakeholders involved in emergency response.

The experimental evaluation confirms that the system achieves reliable performance under real-time conditions, with minimal latency and stable operation across different scenarios. The integration of event-driven communication and asynchronous processing ensures efficient handling of data streams, while the IoT-based traffic control mechanism demonstrates measurable improvements in travel time. These results validate the feasibility of implementing such integrated systems in real-world applications.

Furthermore, the proposed system contributes to the broader vision of smart city development by demonstrating how modern technologies can be leveraged to solve critical urban challenges. The integration of IoT, real-time communication, and intelligent system design highlights the potential for creating adaptive and responsive infrastructure that supports public safety and healthcare services. This approach can be extended to other domains such as fire services, police response systems, and disaster management.

Despite its effectiveness, the system has certain limitations, including dependence on network connectivity and the absence of advanced predictive analytics. Addressing these limitations through future enhancements such as machine learning-based route prediction, demand forecasting, and integration with hospital management systems can further improve system performance and applicability.

In addition, future work can focus on incorporating multilingual support, improving mobile application optimization, and expanding the system to integrate with broader smart city ecosystems. These enhancements will enable the system to operate effectively across diverse environments and cater to a wider population.

In conclusion, AmbuClear represents a significant advancement in intelligent emergency response systems. By combining real-time communication, IoT-based traffic management, and scalable system architecture, the proposed solution improves ambulance response time, enhances coordination, and contributes to safer and more efficient urban environments. The findings of this work establish a strong foundation for future research and development in smart healthcare and transportation systems.

AmbuClear also leverages real-time data to improve emergency response efficiency. It enables analysis of traffic patterns and ambulance demand across different areas. This helps in better planning and optimal allocation of emergency resources. The system can evolve to support predictive deployment of ambulances in high-demand zones

Measuring Parameters:

Parameter	**Existing Models (Traditional / Partial Systems)**	**AmbuClear Proposed Model**
System Approach	Fragmented (separate tracking, traffic, or dispatch systems)	Fully integrated unified platform
Ambulance Allocation	Manual or semi-automated	Fully automated using real-time location
Real-Time Tracking	Limited or delayed updates	Continuous live tracking using Socket.IO
Smart City Compatibility	Not fully aligned	Designed for smart city infrastructure
User Experience	Basic and sometimes confusing	Intuitive, responsive, real-time interaction
Reliability	Affected by manual dependency	High reliability with automated workflows
IoT Integration	Rare or standalone implementations	Fully integrated IoT traffic control system
Latency	High latency (polling-based systems)	Low latency (event-driven communication)

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