

Smart Emergency Corridor Creation Using IoT-Based Traffic Control System

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Abstract- Rapid urbanization and the increasing number of vehicles on road networks have led to severe traffic congestion in urban and metropolitan areas. One of the major challenges arising from this congestion is the delay faced by emergency vehicles, particularly ambulances, while navigating through traffic intersections. Such delays can significantly affect emergency response times, reduce the efficiency of medical services, and negatively impact patient survival rates. Conventional traffic management systems operate on fixed signal timings and lack the ability to dynamically prioritize emergency vehicles during critical situations. To address this issue, this paper presents a Smart Emergency Corridor Creation Using IoT-Based Traffic Control System that enables real-time ambulance tracking and automated traffic signal management. The proposed system integrates GPS technology, ESP32 microcontrollers, and LoRa communication modules to establish seamless communication between ambulances and traffic signal controllers. The ambulance continuously transmits its location data, allowing the system to identify its route and predict its arrival at upcoming intersections. To determine the most efficient emergency route, the system employs Dijkstra's shortest path algorithm, which dynamically computes the optimal path from the ambulance's current location to the destination hospital by evaluating real-time traffic density and junction distances. This computed route is communicated through a dedicated mobile application that provides role-based access to three user categories — Ambulance Driver, traffic administrator, and hospital personnel. The driver interface displays the optimal navigated route and upcoming signal status in real time, the admin interface enables centralized junction monitoring and manual override capability, and the hospital interface provides live ambulance ETA and incoming patient alerts. Based on this information, traffic signals are automatically adjusted to provide a green corridor, ensuring uninterrupted movement of the ambulance. Additionally, the system incorporates a centralized monitoring platform that facilitates real-time tracking, traffic analysis, and decision-making. The proposed solution aims to reduce ambulance travel time, minimize delays at intersections, improve emergency response efficiency, and enhance overall traffic management. Experimental implementation and testing demonstrate the effectiveness of the system in creating a reliable and intelligent emergency traffic control mechanism. The proposed approach contributes to the development of smart city infrastructure by leveraging Internet of Things (IoT) technologies for efficient and life-saving transportation management.

agement.

Key Words- IoT, Smart Traffic Control, Ambulance Prioritization, ESP32, GPS Tracking, LoRa Communication, Dijkstra Algorithm, Green Corridor.

I. INTRODUCTION

Traffic congestion in urban and metropolitan areas has become one of the most critical challenges affecting emergency medical services worldwide. Ambulances carrying critically ill patients frequently encounter severe delays caused by heavy traffic volumes, fixed signal timings, and the complete absence of emergency vehicle prioritization mechanisms at intersections. In time-sensitive medical emergencies such as cardiac arrests, strokes, and trauma cases, even a delay of a few minutes can drastically reduce patient survival rates and negatively impact treatment outcomes.

Conventional traffic signal systems operate on predetermined fixed time intervals and are designed solely to regulate general traffic flow. These systems lack the intelligence to detect an approaching emergency vehicle and dynamically adjust signal timings in response. Consequently, ambulances are often compelled to halt at busy junctions or rely entirely on audible sirens and manual intervention to clear the road. In densely congested urban environments, this approach proves highly inefficient and unreliable, resulting in prolonged emergency response times.

To overcome these limitations, this paper proposes a Smart Emergency Corridor Creation Using IoT-Based Traffic Control System that enables real-time ambulance tracking and automated traffic signal management. The system integrates GPS technology for continuous location tracking of the ambulance, LoRa wireless communication modules for low-power long-range data transmission, and ESP32 microcontrollers embedded within traffic junction controllers. As the ambulance approaches a junction, its location data is transmitted to the respective signal controller, which automatically switches the signal to green while halting cross traffic. This process is coordinated across multiple consecutive junctions to establish a seamless and uninterrupted green corridor for the ambulance.

Furthermore, the system incorporates Dijkstra's shortest path algorithm to determine the most efficient route from the ambulance's current location to the destination hospital, considering real-time traffic density and junction distances. A dedicated mobile application provides role-based access to the ambulance driver, traffic administrator, and hospital personnel, enabling real-time monitoring, route guidance, and patient arrival alerts. This integrated approach positions the proposed

system as a reliable and intelligent solution for emergency transportation management within smart city infrastructure.

II. LITERATURE SURVEY

Traffic signal management systems have evolved significantly from traditional fixed-time mechanisms to advanced intelligent and IoT-based systems. Early traffic control systems operated on predetermined fixed time intervals, which are inefficient in dynamic urban traffic conditions and completely incapable of detecting or prioritizing approaching emergency vehicles. These systems caused significant delays for ambulances at intersections, directly impacting emergency response times and patient survival rates.

GPS-based ambulance tracking systems introduced location-aware emergency vehicle detection, enabling traffic controllers to receive real-time positional data of approaching ambulances. However, these systems lacked reliable wireless communication infrastructure for transmitting data between the ambulance and junction controllers in real time [1]. IoT-based smart ambulance systems addressed this limitation by integrating sensors and wireless modules to establish communication between emergency vehicles and traffic signal units, improving response coordination [2].

Software-defined networking integrated with IoT has further advanced emergency vehicle prioritization in smart cities by enabling centralized, real-time traffic decision-making across multiple junctions simultaneously [3]. Similarly, intelligence-based IoT traffic control systems demonstrated the effectiveness of automated signal switching upon ambulance detection, reducing manual dependency at intersections [4].

Survey studies on emergency vehicle route optimization have highlighted the critical need for multi-junction coordination and shortest path computation to minimize ambulance travel time across urban road networks [5]. Recent GPS-enabled intelligent signal management systems have demonstrated improved emergency response efficiency in smart city environments by dynamically adjusting signals based on vehicle proximity [6].

Despite these advancements, most existing systems address only single-junction prioritization and lack integrated route optimization, multi-junction green corridor creation, and role-based monitoring. The proposed Smart Emergency Corridor Creation Using IoT-Based Traffic Control System addresses this gap by combining GPS tracking, LoRa communication, ESP32-based signal control, Dijkstra's shortest path algorithm, and a role-based mobile application into a unified intelligent emergency traffic management framework.

III. PROPOSED SYSTEM

The proposed Smart Emergency Corridor Creation Using IoT-Based Traffic Control System is designed to provide an intelligent and automated mechanism for emergency vehicle prioritization by integrating real-time GPS tracking, LoRa-based wireless communication, ESP32-based traffic signal control, and Dijkstra's shortest path algorithm. The system ensures uninterrupted movement of ambulances through urban intersections by dynamically creating a green corridor while maintaining centralized monitoring through a role-based mobile application.

0.1 System Architecture

The system consists of the following major components:

- GPS Module (NEO-6M)
- ESP32 Microcontroller
- LoRa Communication Module (SX1278)
- Traffic Light Module
- Dijkstra's Route Optimization Algorithm
- Role-Based Mobile Application

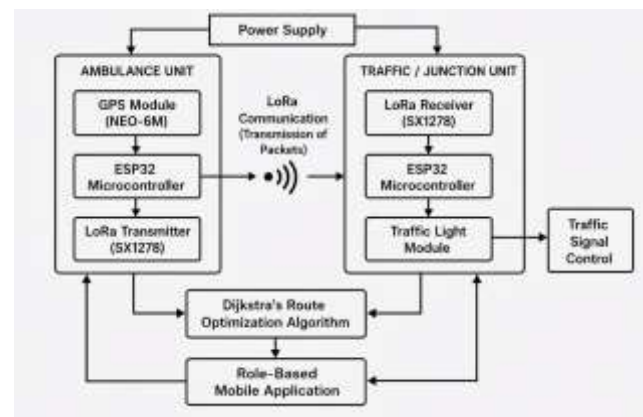


Fig. 1. System Architecture

The GPS module continuously captures the ambulance's real-time location, which is processed by the ESP32 microcontroller on the ambulance unit. The location and emergency status data are transmitted wirelessly to junction controllers via LoRa modules. Each junction controller receives this data and automatically adjusts the traffic signal to green for the ambulance's approach direction while halting cross traffic. The mobile application provides real-time visibility to the driver, traffic administrator, and hospital personnel.

0.2 Working Principle

The system operates in two main phases: Route Computation Phase and Green Corridor Activation Phase.

Route Computation Phase: - The ambulance GPS module captures the current location upon emergency activation - The ESP32 processes the location data and initiates route computation - Dijkstra's shortest path algorithm evaluates all possible routes based on real-time traffic density and junction distances - The optimal route is computed and transmitted to the mobile application and junction controllers along the path

Green Corridor Activation Phase: - The ambulance continuously transmits its GPS coordinates via LoRa communication - Junction controllers along the computed route receive the approaching ambulance's location - When the ambulance reaches a predefined proximity threshold, the junction controller switches the signal to green for the ambulance's direction - Cross traffic signals are simultaneously switched to red - As the ambulance clears each junction, the signal reverts to normal operation - This process is coordinated across all consecutive junctions to maintain a continuous green corridor

0.3 Control Logic

The system follows a multi-stage decision-making process to ensure seamless corridor creation:

- GPS location data is continuously captured and transmitted by the ambulance ESP32 unit - LoRa modules ensure low-power, long-range communication between the ambulance and junction controllers - Each junction controller independently evaluates proximity and activates signal switching - Dijkstra's algorithm dynamically recomputes the optimal route if traffic conditions change - The mobile application reflects real-time signal status and ETA updates across all three user roles

0.4 Key Features

- Real-time GPS-based ambulance location tracking - LoRa-based long-range, low-power wireless communication - Automated multi-junction green corridor creation - Dijkstra's algorithm for dynamic shortest path route optimization - Role-based mobile application for driver, administrator, and hospital personnel - Centralized traffic monitoring and manual override capability

0.5 System Advantages

The proposed system offers several advantages over conventional emergency traffic management mechanisms:

- Eliminates manual intervention and siren-based road clearing - Enables automated and coordinated multi-junction signal control - Reduces ambulance travel time and intersection waiting delays - Provides real-time route guidance and hospital arrival alerts - Scalable architecture suitable for smart city infrastructure deployment - Low-cost implementation using ESP32 and LoRa modules

0.6 Novelty of the Proposed System

Unlike conventional traffic signal systems that operate on fixed time intervals and lack emergency vehicle detection capability, the proposed system integrates real-time GPS tracking, LoRa wireless communication, and ESP32-based intelligent signal control within a unified IoT framework. The system not only detects an approaching ambulance but also proactively computes the optimal route using Dijkstra's shortest path algorithm and coordinates signal switching across multiple junctions simultaneously to create a continuous green corridor.

The integration of a role-based mobile application introduces a multi-stakeholder monitoring layer that provides real-time route guidance to the ambulance driver, centralized junction control to the traffic administrator, and live ETA alerts to hospital personnel. Furthermore, the manual override capability available to the traffic administrator ensures operational flexibility in unforeseen traffic scenarios.

The combination of route optimization, automated multi-junction coordination, real-time communication, and role-based monitoring within a single IoT-based framework represents the primary innovation of the proposed system, positioning it as a reliable and intelligent solution for emergency transportation management in smart city environments.

IV. HARDWARE IMPLEMENTATION

TABLE I
HARDWARE SPECIFICATIONS

Component	Specification
ESP32 Microcontroller	Dual-Core MCU with Wi-Fi and Bluetooth
GPS Module (Neo-6M)	UART GPS Receiver, 9600 Baud
LoRa Module (SX1278)	433 MHz Long-Range Transceiver
Traffic Signal LED Array	Red, Yellow, Green LEDs
Manual Override Switch	Digital Admin Control Input
Power Supply (Ambulance)	12V Battery Supply
Power Supply (Junction)	5V Regulated Adapter

A. ESP32 Microcontroller

The ESP32 serves as the central processing unit in both the ambulance unit and each traffic junction controller. In the ambulance unit, it collects GPS data, executes Dijkstra's algorithm, and drives the LoRa transmitter to broadcast real-time location and emergency status. In the junction unit, it receives LoRa packets, evaluates ambulance proximity, and controls the traffic signal LED array. The built-in Wi-Fi enables communication with the mobile application and cloud monitoring platform on both units.

B. GPS Module (Neo-6M) — Ambulance Unit The Neo-6M GPS module is mounted exclusively on the ambulance unit. It communicates with the ESP32 via UART at 9600 baud, continuously transmitting NMEA sentences containing latitude, longitude, speed, and timestamp data. This location data is processed by the ambulance ESP32 to determine the current position and compute the optimal route to the destination hospital using Dijkstra's algorithm.

C. LoRa Communication Module (SX1278) — Both Units The SX1278 LoRa module operates at 433 MHz and is used in both units serving different roles. In the ambulance unit, the LoRa module operates as a transmitter, continuously broadcasting the ambulance's GPS coordinates and emergency status to all junction controllers along the computed route. In each traffic junction unit, the LoRa module operates as a receiver, continuously listening for incoming ambulance location packets. LoRa's spread spectrum modulation ensures reliable data transmission exceeding 1 km in urban environments, making it well-suited for multi-junction coordination.

D. Traffic Signal LED Array - Traffic Junction Unit The traffic signal LED array is installed exclusively at each traffic junction unit. It comprises red, yellow, and green LEDs for each approach direction at the junction, controlled directly by the junction ESP32. When the ambulance approaches within the predefined proximity threshold, the junction ESP32 activates the green LED for the ambulance's direction and simultaneously switches all cross-traffic directions to red, establishing the green corridor. Once the ambulance clears the junction, normal timed signal operation is restored.

E. Power Supply Units — Both Units The ambulance unit is powered by a 12V battery-based regulated supply ensuring uninterrupted operation during vehicle movement. Each traffic

junction unit is powered by a 5V mains-regulated adapter providing stable voltage to the ESP32, LoRa receiver, and LED signal array. Proper voltage regulation across both units prevents fluctuations that could affect wireless communication reliability and signal switching accuracy.

F. System Integration All hardware components are distributed across two types of nodes — the ambulance unit and multiple traffic junction units — each centered around an ESP32 microcontroller. The ambulance unit integrates the GPS module, emergency button, and LoRa transmitter to form the mobile tracking and broadcasting node. Each junction unit integrates the LoRa receiver, ESP32 controller, signal LED array, and manual override switch to form the stationary signal control node. Together, these distributed units communicate wirelessly through LoRa to achieve real-time multi-junction green corridor creation for emergency vehicle prioritization in urban traffic environments.

V. SOFTWARE IMPLEMENTATION

0.7 Libraries Used

- TinyGPS++ library for GPS data processing
- LoRa library for wireless communication
- SPI library for LoRa module interface
- WiFi library for future IoT dashboard integration
- Arduino core libraries for GPIO control

The software implementation of the Smart Emergency Corridor Creation System is designed to integrate real-time GPS tracking, LoRa-based wireless communication, Dijkstra's route optimization, automated signal control, and role-based mobile application monitoring into a unified embedded and application framework. The embedded firmware is developed using Arduino IDE with embedded C/C++ for the ESP32 microcontrollers on both the ambulance unit and traffic junction units.

A. Embedded Firmware

Two separate firmware modules are developed and deployed on the two types of ESP32 nodes in the system.

Ambulance Unit Firmware: - Continuous acquisition of GPS NMEA data from the Neo-6M module via UART - Parsing of latitude, longitude, speed, and timestamp from GPS sentences - Execution of Dijkstra's shortest path algorithm to compute the optimal route to the destination hospital - Packaging of GPS coordinates and emergency status into LoRa data packets - Continuous transmission of data packets via the SX1278 LoRa transmitter upon emergency activation - Real-time route and signal status updates to the mobile application via Wi-Fi

Traffic Junction Unit Firmware: - Continuous listening for incoming LoRa data packets from the ambulance unit - Parsing of received GPS coordinates and emergency status - Computation of distance between the ambulance's current location and the junction coordinates - Comparison of computed distance against a predefined proximity threshold - Automated switching of traffic signal LEDs to green for the ambulance approach direction and red for all cross-traffic directions upon

threshold breach - Restoration of normal timed signal operation after ambulance clearance - Transmission of junction status data to the cloud monitoring platform via Wi-Fi

The firmware ensures efficient real-time coordination between GPS tracking, wireless communication, route optimization, and signal control processes across all distributed nodes.

B. Libraries And Tools

The implementation utilizes various Arduino and ESP32 libraries to enable efficient communication, computation, and control.

- **TinyGPS++ Library (TinyGPS++.h):** Used for parsing NMEA sentences from the Neo-6M GPS module, enabling extraction of latitude, longitude, speed, altitude, and timestamp data in real time. - **LoRa Library (LoRa.h):** Used for interfacing with the SX1278 LoRa module on both the ambulance transmitter and junction receiver units, enabling packet-based long-range wireless communication. - **WiFi Library (WiFi.h):** Enables wireless communication between the ESP32 nodes and the mobile application backend and cloud monitoring platform. - **Arduino Core Libraries:** Used for serial communication, GPIO operations, UART interfacing with the GPS module, and digital output control for traffic signal LEDs. - **Dijkstra's Algorithm (Custom Implementation):** ** A custom C++ implementation of Dijkstra's shortest path algorithm is embedded within the ambulance unit firmware, evaluating junction nodes weighted by real-time traffic density and distance to compute the optimal emergency route.

These libraries simplify development, improve system efficiency, and ensure seamless integration of hardware and software components across both unit types.

C. Route Optimization — Dijkstra's Algorithm

The ambulance unit firmware incorporates a custom implementation of Dijkstra's shortest path algorithm to determine the most efficient route from the ambulance's current GPS location to the destination hospital.

- The road network is modeled as a weighted graph where each junction is a node and each road segment is a weighted edge - Edge weights are assigned based on junction distance and real-time traffic density values - Upon emergency activation, the algorithm initializes from the ambulance's current GPS coordinates as the source node - The algorithm iteratively evaluates neighboring junction nodes, selecting the minimum-cost path at each step - The computed optimal route is stored as an ordered list of junction nodes and transmitted to the mobile application and all junction controllers along the path - The algorithm recomputes the route dynamically if traffic conditions change during transit

This ensures that the ambulance always follows the fastest and least congested path to the destination hospital.

D. Signal Control Logic

Each junction ESP32 implements an independent proximity-based signal control logic that operates in real time upon receiving ambulance location data.

- Received GPS coordinates of the ambulance are compared against the stored coordinates of the junction - Haversine formula is used to compute the real-time distance between the ambulance and the junction - When the computed distance falls below the predefined proximity threshold, the signal switching sequence is triggered - Green signal is activated for the ambulance's approach direction while all cross-

traffic directions are simultaneously switched to red - A minimum green hold time is enforced to ensure the ambulance fully clears the junction before signal reversion - Upon clearance, the junction reverts to its standard fixed-time signal cycle - Manual override input from the traffic administrator is continuously monitored and takes precedence over automated switching when activated

This logic ensures safe, coordinated, and reliable green corridor creation across all junctions along the ambulance's route.

E. Cloud Monitoring Platform

A centralized cloud monitoring platform is integrated with the system to support real-time tracking, event logging, and traffic analysis across all junction nodes.

- Receives real-time junction status updates and ambulance location data from ESP32 nodes via HTTP - Maintains a time-stamped log of all emergency activations, signal switching events, and route computations - Provides a web-based dashboard for system-wide traffic monitoring and historical data analysis - Enables remote supervision of junction status and ambulance movement for traffic management authorities

F. Real-Time Communication Framework

The proposed system employs a dual-layer communication framework combining LoRa wireless communication for ambulance-to-junction data transmission and Wi-Fi-based HTTP communication for junction-to-cloud and application data synchronization. Real-time coordination is achieved through event-driven firmware logic on each ESP32 node, enabling instantaneous signal switching upon ambulance proximity detection. The combination of low-power long-range LoRa communication and high-speed Wi-Fi connectivity ensures reliable and responsive operation of the entire system across both the field hardware layer and the application monitoring layer.

VI. SYSTEM IMPLEMENTATION

The Smart Emergency Corridor Creation System is implemented as an integrated distributed IoT solution that combines real-time GPS tracking, LoRa-based wireless communication, Dijkstra's route optimization, automated traffic signal control, and role-based mobile application monitoring. The system is designed to operate reliably in real-time urban traffic conditions while ensuring uninterrupted emergency vehicle movement through coordinated multi-junction green corridor creation.

A. System Overview

The implementation integrates hardware components including the Neo-6M GPS module, SX1278 LoRa transceivers, ESP32 microcontrollers, and traffic signal LED arrays with software modules responsible for location tracking, route computation, proximity detection, and signal switching. Communication between the ambulance unit and junction units is coordinated wirelessly through LoRa, while Wi-Fi connectivity enables synchronization with the mobile application and cloud monitoring platform.

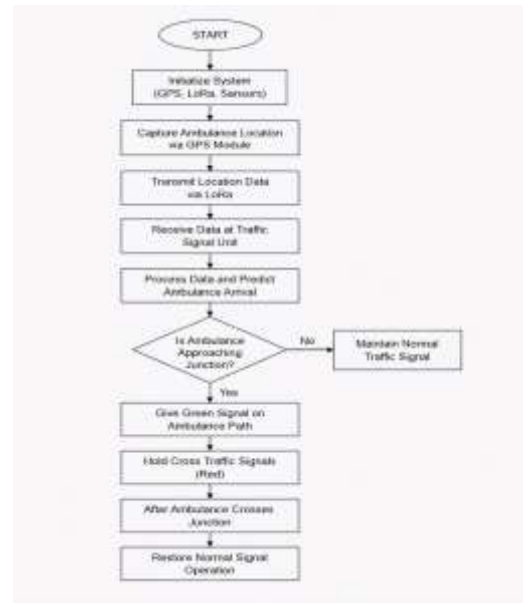


Fig. 2. System Flow Diagram

B. Emergency Activation Phase Implementation

During the emergency activation phase, the ambulance unit is initialized and begins broadcasting its location upon emergency button press. This phase is critical as it establishes the optimal route and initiates communication with all relevant junction controllers.

- The ambulance driver presses the emergency activation button mounted in the vehicle - The ESP32 on the ambulance unit powers up the Neo-6M GPS module and begins acquiring location data - The GPS module transmits NMEA sentences to the ESP32 via UART, providing real-time latitude and longitude coordinates - The ESP32 parses the GPS data and validates the fix quality before proceeding - Dijkstra's shortest path algorithm is executed using the current GPS coordinates as the source node and the destination hospital as the target node - The road network graph, pre-loaded with junction coordinates and weighted edge distances, is evaluated to determine the optimal route - The computed route is stored as an ordered list of junction nodes and transmitted to the mobile application via Wi-Fi - The ambulance ESP32 begins continuous LoRa packet transmission, broadcasting real-time GPS coordinates and emergency status at regular intervals

To ensure reliable communication, multiple LoRa transmission attempts are made per interval, and GPS data is validated for fix quality before each broadcast. The activation process is initiated only upon genuine emergency button press, preventing unnecessary disruption to normal traffic flow.

C. Green Corridor Execution Phase Implementation

The green corridor execution phase performs real-time proximity detection and automated signal switching at each junction along the computed route.

- Each junction ESP32 continuously listens for incoming LoRa packets from the ambulance unit - Upon receiving a valid packet, the junction ESP32 parses the ambulance's GPS coordinates - The Haversine formula is applied to compute the real-time distance between the ambulance and the junction - The computed distance is compared against a predefined proximity threshold - When the ambulance enters the threshold range, the junction ESP32 triggers the signal switching sequence - The green LED is activated for the ambulance's

approach direction while all cross-traffic direction LEDs are simultaneously switched to red - A minimum green hold timer is enforced to ensure the ambulance fully clears the junction before signal reversion - Upon ambulance clearance, the junction reverts to its standard fixed-time signal cycle - Junction status updates are transmitted to the cloud monitoring platform and mobile application in real time

This phase ensures that only the relevant junction activates the green corridor at the appropriate moment, preventing premature or delayed signal switching across the route.

D. Route Optimization Implementation

After successful GPS fix and emergency activation, the ambulance ESP32 executes the route optimization process to determine the most efficient path to the destination hospital.

- The road network is represented as a weighted graph where junction nodes are connected by edges weighted by distance and real-time traffic density - Dijkstra's algorithm initializes from the ambulance's current GPS location as the source node - The algorithm iteratively selects the minimum-cost unvisited node and updates neighboring node costs - The optimal route is finalized as an ordered sequence of junction nodes from source to destination - If traffic conditions change during transit, the algorithm dynamically recomputes the route using updated weights - The recomputed route is immediately transmitted to the mobile application and relevant junction controllers

This ensures that the ambulance always follows the fastest and least congested path regardless of changing urban traffic conditions.

E. Mobile Application Implementation

The mobile application provides real-time role-based monitoring and interaction with the system across three user interfaces.

- The ambulance driver interface displays the live GPS location of the ambulance on a map, the computed optimal route with turn-by-turn junction guidance, and the real-time signal status of each upcoming junction along the route - The traffic administrator interface provides a centralized dashboard showing live status of all monitored junctions, real-time ambulance location tracking, manual override controls for individual junctions, and a time-stamped event log of all signal switching activations - The hospital personnel interface displays the live estimated time of arrival of the approaching ambulance, the patient's emergency status transmitted from the ambulance unit, and incoming patient alert notifications to enable advance medical preparation

All three interfaces receive real-time data updates from the ESP32 nodes and cloud platform via HTTP API calls, ensuring synchronized visibility across all stakeholders throughout the emergency response operation.

F. Monitoring and Safety Mechanisms

The system incorporates continuous monitoring mechanisms at both the hardware and application levels to enhance reliability and operational safety.

- Each junction ESP32 continuously monitors the LoRa channel for incoming ambulance packets, ensuring no proximity event is missed - The cloud monitoring platform maintains a live status dashboard of all junction nodes, detecting communication failures or unresponsive units - The traffic administrator retains manual override capability at any junction, al-

lowing immediate intervention in the event of system anomalies or unforeseen traffic scenarios - The mobile application displays real-time signal status for each junction along the route, alerting the administrator to any discrepancy between expected and actual signal states - If the ambulance GPS fix is lost during transit, the system maintains the last known trajectory and continues corridor activation based on predicted position until the fix is restored

These mechanisms ensure that the system not only automates emergency signal control but also maintains continuous situational awareness for all stakeholders throughout the emergency response operation.

VII. MOBILE APPLICATION AND DASHBOARD

The proposed system includes a mobile application with role-based access for three users: Ambulance Driver, Traffic Administrator, and Hospital Personnel.

0.8 Ambulance Driver Interface

The driver dashboard displays live ambulance tracking, assigned accident location, destination hospital, route information, distance, ETA, speed, and green corridor status. It also provides a start trip option and signal activation log.

0.9 Traffic Administrator Interface

The admin dashboard provides city-wide monitoring of active ambulances, active corridors, hospitals, and traffic signals. It also supports manual override alerts and centralized traffic junction monitoring.

0.10 Hospital Interface

The hospital dashboard displays incoming ambulances, active emergencies, accident location, ambulance route, and emergency alerts. This helps hospital personnel prepare for incoming patients in advance.

VIII. RESULTS AND DISCUSSION

The Smart Emergency Corridor Creation System was evaluated through practical testing of GPS tracking, LoRa communication, Dijkstra-based route optimization, automated signal switching, and mobile application functionality. The system demonstrated reliable performance under simulated urban traffic conditions across multiple junction test scenarios.

A. GPS Tracking and Route Computation Performance

The Neo-6M GPS module successfully acquired real-time location data and transmitted coordinates to the ambulance ESP32 through UART communication. The GPS readings remained stable and accurate during testing. Dijkstra's shortest path algorithm correctly computed the optimal route from the ambulance location to the destination hospital by evaluating junction distances and traffic density weights. Route computation was completed within a short processing time, demonstrating the feasibility of executing the algorithm on the ESP32 platform.

B. LoRa Communication Performance

The SX1278 LoRa modules established reliable wireless communication between the ambulance and junction units.

GPS coordinates and emergency status packets were successfully transmitted and received with minimal delay. The communication remained stable throughout the testing process, confirming the suitability of LoRa technology for real-time ambulance-to-junction communication in urban traffic environments.

C. Signal Control and Green Corridor Creation

The proximity-based signal switching mechanism operated successfully at all junctions. When the ambulance entered the predefined threshold distance, the corresponding traffic signal switched to green while cross-traffic signals turned red. After the ambulance cleared the junction, normal signal operation was restored. Multi-junction testing demonstrated continuous green corridor creation through coordinated signal activation, ensuring uninterrupted ambulance movement across multiple intersections.

D. Mobile Application Functional Testing

The mobile application was tested across all three user interfaces: Ambulance Driver, Traffic Administrator, and Hospital Personnel. The driver interface displayed real-time ambulance location, route information, and signal status. The administrator interface provided junction monitoring and manual override functionality, while the hospital interface displayed ambulance ETA and emergency notifications. Real-time synchronization was successfully maintained across all user roles.

E. System Reliability

The complete system workflow, including GPS acquisition, route computation, LoRa communication, signal control, and mobile application updates, functioned reliably during testing. Multiple trial runs confirmed consistent green corridor generation and successful restoration of normal traffic operation after ambulance passage. The centralized monitoring platform accurately tracked system status throughout the testing period.

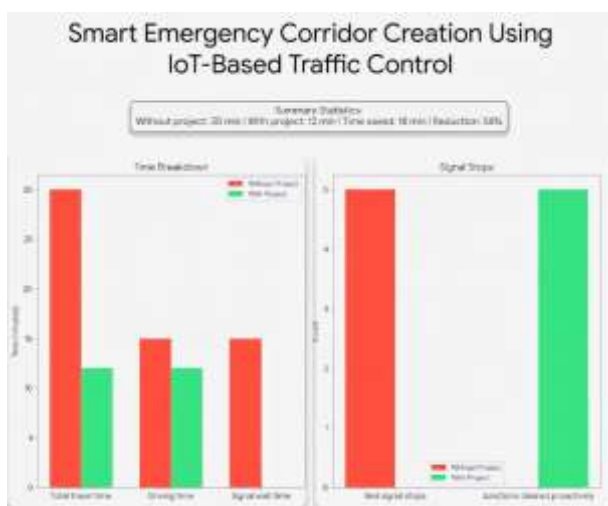


Fig. 3. Performance Analysis of Smart Emergency Corridor System

F. Discussion

The results demonstrate the effectiveness of integrating GPS tracking, LoRa communication, Dijkstra's route optimization, and ESP32-based traffic control into a unified emergency corridor framework. The distributed architecture reduced dependency on centralized control while maintaining reliable performance. The mobile application enhanced oper-

ational awareness for drivers, administrators, and hospital personnel, improving overall emergency response coordination.

G. Limitations

The current implementation was evaluated in a simulated environment using predefined road networks and junction coordinates. GPS accuracy may be affected in dense urban areas, and LoRa performance under heavy interference requires further validation. Future work will focus on integrating real-time traffic data, expanding road network coverage, and conducting large-scale field testing for smart city deployment.

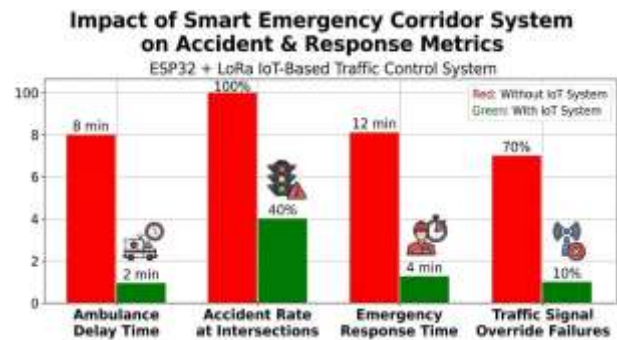


Fig. 4. Performance Evaluation of Smart Emergency Corridor Creation Using IoT-Based Traffic Control System

IX. FUTURE SCOPE

Future enhancements will focus on strengthening system intelligence, communication reliability, scalability, and integration with broader smart city infrastructure. Secure communication protocols can be incorporated to protect GPS location data and emergency status packets transmitted between the ambulance unit and junction controllers over LoRa wireless links, preventing unauthorized signal injection or jamming attacks on the corridor creation process.

Multi-junction scalability can be improved by expanding the pre-loaded road network graph to cover larger urban areas, with real-time traffic density data feeds dynamically integrated into Dijkstra's route optimization algorithm to improve path accuracy under varying congestion conditions. Machine learning techniques can be incorporated to predict ambulance travel time and junction waiting delays based on historical traffic patterns, enabling proactive signal pre-switching before the ambulance reaches the proximity threshold.

Integration with existing centralized traffic management systems and smart city control centers can enable coordinated green corridor creation across entire city networks. Vehicle-to-infrastructure communication protocols such as DSRC or C-V2X can replace LoRa modules in future versions to achieve higher data rates and lower latency in dense urban deployments. GPS positioning accuracy in urban canyon environments can be improved by fusing Neo-6M data with inertial measurement units or integrating assisted GPS for reliable location tracking under satellite obstruction conditions.

Cloud deployment can enhance scalability and support centralized multi-city junction monitoring, historical emergency response analysis, and remote firmware updates across all junction controller nodes. Future versions may also integrate with government emergency dispatch systems and hospital management platforms to enable fully automated end-to-end emergency response coordination from dispatch through

patient handover. These enhancements will enable the proposed system to evolve into a comprehensive intelligent emergency transportation management platform within smart city infrastructure.

X. CONCLUSION

This paper presented a Smart Emergency Corridor Creation System that integrates GPS-based ambulance tracking, LoRa wireless communication, and automated traffic signal control to reduce emergency vehicle delays at urban intersections. The system utilizes a Neo-6M GPS module, SX1278 LoRa transceivers, and ESP32 microcontrollers to track ambulance location in real time and coordinate signal switching across multiple traffic junctions simultaneously.

The implementation demonstrated reliable GPS acquisition and LoRa-based communication between the ambulance unit and junction controllers, with consistent proximity detection and accurate automated signal switching upon ambulance approach. The integration of Dijkstra's shortest path algorithm enabled optimal route computation directly on the embedded ESP32 platform, while the role-based mobile application provided real-time visibility to the ambulance driver, traffic administrator, and hospital personnel throughout the emergency response operation.

The proposed system successfully created a continuous multi-junction green corridor for the ambulance, eliminating the need for manual intervention or siren-based road clearing in test scenarios. The distributed IoT architecture, combining low-power LoRa communication with ESP32-based signal control, demonstrated feasibility for real-world deployment within smart city infrastructure. The results confirm that the proposed approach contributes meaningfully to improving emergency response efficiency, reducing ambulance travel time, and enhancing urban traffic management.

XI. ACKNOWLEDGEMENT

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