A Project Report On

SMART AMBULANCE TRAFFIC CONTROL SYSTEM USING BLUETOOTH

Real Time Research Project submitted in partial fulfillment of the requirements for the award of the degree of

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IN
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(2023-2027)
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HYDERABAD

2024-25

CERTIFICATE

This is to certify that it is a bonafide record of Real Time Research Project work entitled

"SMART AMBULANCE USING BLUETOOTH" done by **"B.MAHESH CHANDRA REDDY (23241A12D7), R.SHASHEEL(232421A12J1), P.RAJESH(23241A12H8)" of B.Tech in the Department of Information of Technology, Gokaraju Rangaraju Institute of Engineering and Technology during the period 2023-2027 in the partial fulfillment of the requirements for the award**

of degree of **BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY** from GRIET,
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DECLARATION

This is to certify that the mini-project entitled "**SMART AMBULANCE TRAFFIC CONTROL SYSTEM USING BLUETOOTH"** is a bonafide work done by us in partial fulfillment of the requirements for the award of the degree **BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY** from Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad.

We also declare that this project is a result of our own effort and has not been copied or imitated from any source. Citations from any websites, books and paper publications are mentioned in the Bibliography.

This work was not submitted earlier at any other University or Institute for the award of any degree.

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ABSTRACT

Traffic congestion in urban areas often causes significant delays for emergency vehicles, leading to critical situations for patients in need of urgent medical care. This project presents a Smart Ambulance Traffic Control System using Bluetooth to provide ambulances with priority passage at traffic signals. The system consists of HC-05 Bluetooth modules installed in ambulances and Bluetooth receivers at traffic junctions. When an ambulance approaches a signal, the receiver detects its presence and transmits data to a microcontroller (Arduino), which automatically switches the traffic light to green in the ambulance's direction while turning others red, ensuring a clear path.To enhance monitoring and control, a web-based dashboard displays real-time traffic updates and ambulance detections. The system eliminates manual intervention, reducing response times and improving emergency medical services (EMS) efficiency. Unlike traditional GPS-based systems, Bluetooth provides a cost-effective, low-power alternative that is easy to implement in existing infrastructure. The proposed system can be integrated into smart cities to improve overall traffic management and save lives by enabling ambulances to reach hospitals faster.

Keywords: Smart Traffic Control, Ambulance Priority System, Bluetooth HC-05, Emergency Vehicle Detection, Automated Traffic Signals.

1. INTRODUCTION

2.1 1.1 Urban Traffic and Emergency Response Issues

Modern cities are grappling with ever-increasing vehicle density, leading to congested roads and frequent traffic bottlenecks. Among the most critically affected during such scenarios are emergency services, particularly ambulances. In a race against time, ambulances often find themselves delayed at intersections due to unresponsive traffic lights and uncooperative drivers, jeopardizing the lives of patients in urgent need of medical attention.
Despite advancements in healthcare and emergency response systems, road traffic management still lacks efficient mechanisms to prioritize emergency vehicles. While traffic police occasionally intervene manually, such practices are inefficient and unreliable in larger metropolitan areas.

2.2 The Need for Intelligent Traffic Systems

In the age of smart cities, there is a growing emphasis on integrating technology with public infrastructure. Intelligent Traffic Systems (ITS) aim to use sensors, wireless communication, and automation to control traffic efficiently. A critical area where ITS can be life-saving is in facilitating faster movement of emergency vehicles.
However, fully automated traffic control systems based on AI, GPS, and camera-based technologies can be expensive and complicated to implement citywide. Hence, a more affordable and practical solution is required, especially in developing countries where resources and infrastructure may be limited.

2.3 Present Technique

Manual and Traditional Traffic Control

Currently, emergency vehicles like ambulances rely on:

- **Manual signaling by traffic police** to stop other vehicles.
- **Siren-based alerts**, expecting drivers to yield.
- **Fixed traffic signal timers** with no dynamic control.

These approaches are largely inefficient due to:

- Human delay in reacting to emergencies.
- Lack of awareness or discipline among regular drivers.
- No integration between emergency vehicles and traffic systems.

Drawbacks of the Current System

- **Delays at intersections** cause critical loss of time.
- **Lack of automation** makes it prone to errors.
- **Unreliable cooperation** from public drivers.
- **No real-time control** over traffic lights based on emergency priorities.

2.4 Working Mechanism

Normal Mode

- Traffic lights operate in a predefined cycle:
    - Green for 30 seconds in one direction
    - Yellow for 5 seconds
    - Red for other directions
- The cycle repeats continuously unless interrupted.

Emergency Mode (Ambulance Detected)

- Bluetooth module scans for predefined ambulance IDs.
- If matched, the Arduino is triggered.
- All directions are set to Red, except the ambulance's path, which turns Green.
- After the ambulance passes, the system reverts to normal cycle.

2.5 Objective of the Project

The main objectives of this project are:

- To **design a cost-effective traffic control system** prioritizing ambulances.
- To use **Bluetooth communication** for detecting approaching emergency vehicles.
- To ensure **automatic switching of traffic lights** without human intervention.
- To build a **prototype** that simulates real-life junction behavior with emergency override.
- To **reduce ambulance delay times** at traffic junctions, improving emergency response.

2.6 Advantages

Life-Saving Efficiency
Minimizes response time by giving ambulances priority at intersections.
Affordable Implementation
Cost-effective compared to camera or GPS-based systems.
Automation
Removes dependency on manual signaling or driver awareness.
Low Maintenance
Utilizes simple hardware, reducing the cost and complexity of maintenance.

2.7 Limitations

- **Short Detection Range** (Bluetooth range limited to ~10 meters).
- **Dependency on Bluetooth Device**: If the device is off or not functioning, the system won't work.
- **No Central Control**: Currently designed for single-junction automation only.

2.8 Scope of the Project

The scope includes:

- Developing a prototype for a **Bluetooth-based ambulance detection system**.
- Creating an **automated traffic control logic** using Arduino.
- Testing for **range, accuracy, and response time** of detection.
- Providing a base system that can be scaled up for **real-time urban deployment**.

In the future, the project can be expanded to:

- Handle **multiple intersections**.
- Incorporate **mobile app-based monitoring**.
- Provide **data analytics** to traffic management authorities.

2.9 Conclusion

The Smart Ambulance Traffic Control System using Bluetooth offers a practical solution to a critical urban challenge—delays in emergency response due to traffic congestion. By detecting ambulances using simple Bluetooth technology and automatically managing traffic signals, the system ensures that emergency vehicles can pass through intersections without delay.

The project demonstrates how low-cost embedded systems can be integrated into public infrastructure to improve service delivery. While the prototype focuses on a single junction, it opens the door for further expansion using IoT, GPS, and real-time data management. This innovative solution paves the way for smarter, safer, and more responsive cities.

2.10 Proposed Technique

This project proposes a smart traffic control system that gives **priority to ambulances using Bluetooth technology**. The key idea is to:

- Equip ambulances with a **Bluetooth transmitter**.
- Place a **Bluetooth receiver (HC-05)** at traffic junctions.
- When the ambulance is within range, the receiver detects its presence and sends a signal to a **microcontroller (Arduino)** to override the traffic light cycle.
- The traffic signal turns **green** in the ambulance's direction and **red** in others.

2. SYSTEM REQUIREMENTS

2.1 Hardware Requirements

- Processor – i5 and above (64-bit OS).
- Memory – 8GB RAM (Higher specs are recommended for high performance)
- Input devices – Keyboard, Mouse

2.2 Software Requirements

- NodeJS
- ReactJS
- VS Code / WebStorm
- MongoDB / Firebase (if backend is connected)
- Git for version control

3. LITERATURE SURVEY

Traffic congestion is a common issue in urban areas, significantly affecting the movement of emergency vehicles. According to a study by the **World Health Organization (2019)**, delays in ambulance response times contribute to increased mortality rates during critical medical emergencies. Traditional traffic lights do not account for emergency vehicles, which leads to unnecessary stoppages and slower transit.

Several research efforts have utilized **camera-based image processing** and **infrared sensors** to detect ambulances. For instance, a system developed by **Baskar et al. (2016)** used siren sound and image detection for recognizing ambulances and triggering green signals. However, these systems are often costly and require heavy computation and real-time image processing, making them unsuitable for budget-constrained implementations.

Bluetooth has emerged as a lightweight alternative in smart systems. **Singh and Sharma (2017)** demonstrated the use of **Bluetooth Low Energy (BLE)** modules for short-range vehicle detection and communication in smart parking systems. The **HC-05 Bluetooth module**, used in the present project, offers an efficient and affordable solution for device-to-device communication within 10 meters. Although its range is limited, it serves well in point-to-point systems like traffic intersections.

Gaps in Existing Systems

From the reviewed literature, it is evident that:

- High-end solutions like AI and GPS are expensive and require infrastructure.
- Manual systems are inefficient and delay ambulance response times.
- RFID and camera-based systems lack flexibility or are complex to deploy.
- There is a lack of simple, low-cost, and reliable emergency vehicle prioritization systems for developing regions.

The proposed **Bluetooth-based ambulance traffic control system** offers a simple, economical, and practical solution by:

- Using easily available modules like Arduino and HC-05.
- Providing automated signal control without central infrastructure.
- Requiring no complex processing or expensive hardware.
- Serving as a scalable model for developing smart intersections.

This project addresses the limitations of traditional systems by focusing on cost-effectiveness, ease of deployment, and automation, thus making it ideal for small-scale cities or as a prototype for larger smart city initiatives.

4. TECHNOLOGY

The **Smart Ambulance** platform is built using a modern and modular technology stack that balances performance, security, and ease of development. The system is designed to serve the needs of both end users and administrators, offering a clean interface for motorcycle rentals while maintaining backend control through a robust web framework. This section outlines the major technologies used across the application's architecture, categorized into backend development, frontend development, database management, and additional libraries/tools.

4.1 Backend Technologies

Python 3.8+

Python is a high-level programming language known for its simplicity and wide library support. It enables rapid development and is particularly effective for handling web server logic, database interactions, and form processing. Its syntax and community support make it ideal for full-stack development.

Flask Framework

Flask is a Python-based micro web framework used as the backbone of the backend. It offers flexibility and is well-suited for small to mid-sized applications. Flask handles HTTP requests, routes URLs, manages user sessions, and renders templates using Jinja2. Its minimalistic nature allows for faster deployment and easier integration of extensions.

4.2 Frontend Technologies

HTML5

Hypertext Markup Language (HTML) is used to create the structural layout of the web pages. It defines the headings, forms, buttons, and containers used across the user interface.

CSS3

Cascading Style Sheets (CSS) are used to style the pages built with HTML. CSS ensures that the user interface is responsive, visually consistent, and compatible across various screen sizes and devices.

JavaScript (ES6+)

JavaScript is used for enhancing user interaction. It adds dynamic behaviors to the website, such as form validation, alerts, toggles, and client-side rendering enhancements.

4.3 Database Management

SQLite 3

RIDEWAVE-R uses SQLite, a serverless, file-based relational database engine. It stores motorcycle listings, user credentials, booking data, and admin information. SQLite is chosen for its simplicity, low overhead, and ease of integration with Flask.

SQLAlchemy ORM

SQLAlchemy is a Python ORM (Object Relational Mapper) used to connect the Flask app to the SQLite database. It allows developers to interact with the database using Python classes instead of raw SQL, improving readability and maintainability.

4.4 Backend Technologies

Flask (Python)

A lightweight web framework used for building web applications and REST APIs

Django(Python)

A high-level Python framework that encourages rapid development and clean, pragmatic design.

Werkzeug

Used for password hashing and securing sensitive data in user profiles. It is a security-focused WSGI utility library that integrates well with Flask.

Git & GitHub

Version control is implemented using Git, with all source code managed in a GitHub repository. This allows for code tracking, backup, and team collaboration.

4.5 Browser Compatibility

The application is tested on modern browsers such as **Google Chrome**, **Mozilla Firefox**, and **Microsoft Edge**, ensuring consistent behavior and layout across different environments.

5. IMPLEMENTATION

Sample Data set for the Problem Statement:

- **AMBULANCE DETECTION CODE**

```
/* Ambulance Detection Badge */
.ambulance-badge {
    transition: all 0.5s ease;
}

.ambulance-badge.detected {
    background-color: var(--bs-danger) !important;
    animation: pulse 1.5s infinite;
}

@keyframes pulse {
    0% {
        transform: scale(1);
    }
    50% {
        transform: scale(1.1);
    }
    100% {
        transform: scale(1);
    }
}
```

- **SYSTEM STATUS AND CONTROLS**

```
<!-- System Status & Controls -->
<div class="row mb-4">
    <div class="col-lg-4 col-md-6 mb-4">
        <div class="dashboard-box">
            <h4 class="mb-3">Traffic Light Status</h4>
            <div class="traffic-light mb-3">
                <div class="light red"></div>
                <div class="light yellow"></div>
                <div class="light green"></div>
            </div>
            <div class="text-center">
                <h5>Current State: <span id="traffic-state" class="badge bg-danger">RED</span></h5>
                <p class="text-muted">Last updated: <span id="last-updated">--:--:--</span></p>
            </div>
        </div>
    </div>

    <div class="col-lg-4 col-md-6 mb-4">
        <div class="dashboard-box">
            <h4 class="mb-3">Ambulance Detection</h4>
            <div class="text-center mb-4">
                <span id="ambulance-status" class="ambulance-badge badge bg-secondary p-3 fs-5 mb-3">NONE</span>
                <p id="ambulance-status-text">No ambulance currently detected</p>
            </div>
            <div class="d-grid gap-2">
                <button id="detect-ambulance" class="btn btn-danger">
                    <i class="fas fa-ambulance me-2"></i> Simulate Ambulance Detection
                </button>
                <button id="clear-ambulance" class="btn btn-secondary">
                    <i class="fas fa-times me-2"></i> Clear Ambulance
                </button>
            </div>
        </div>
    </div>
```

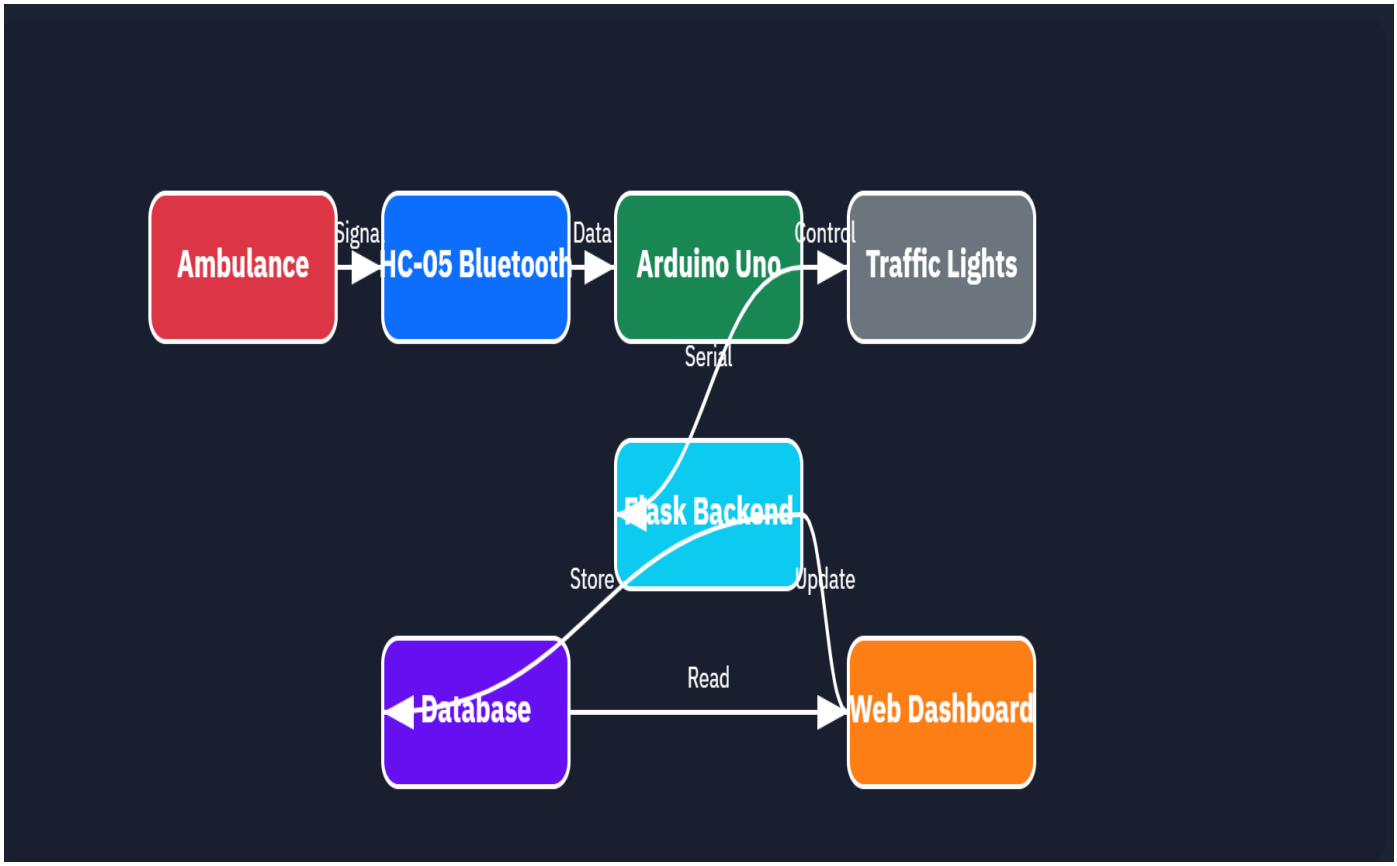
- **DASHBOARD JS**

```javascript
// ----- DASHBOARD JS -----
// Sample data for standalone HTML (replace with actual data source in real implementation)
const sampleTrafficEvents = [];
const sampleAmbulanceDetections = [];
let currentTrafficState = "red";
let ambulanceDetected = false;
let systemMode = "normal";

// Initialize sample data
function initializeSampleData() {
    // Clear existing data
    sampleTrafficEvents.length = 0;
    sampleAmbulanceDetections.length = 0;

    // Add past traffic events (last 24 hours)
    const now = new Date();
    const states = ["red", "yellow", "green"];

    for (let i = 0; i < 48; i++) {  // 24 hours with approx 30min intervals
        const eventTime = new Date(now.getTime() - (24 * 60 * 60 * 1000) + (30 * 60 * 1000 * i));
        const state = states[i % 3];
        sampleTrafficEvents.push({
            state: state,
            timestamp: eventTime.toISOString()
        });
    }
```

Model Construction

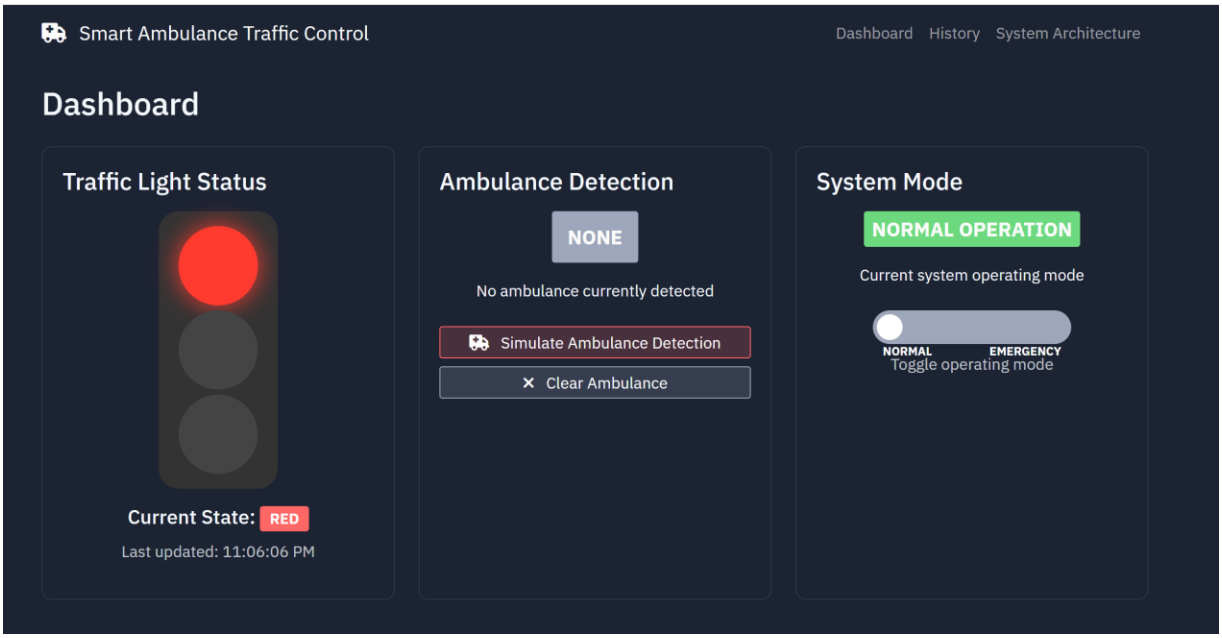
```javascript
function simulateTrafficCycle() {
    // Only cycle if in normal mode
    if (systemMode === "normal") {
        // Cycle through states: red -> green -> yellow -> red
        if (currentTrafficState === "red") {
            currentTrafficState = "green";
        } else if (currentTrafficState === "green") {
            currentTrafficState = "yellow";
        } else if (currentTrafficState === "yellow") {
            currentTrafficState = "red";
        }

        // Add to traffic events
        const now = new Date();
        sampleTrafficEvents.push({
            state: currentTrafficState,
            timestamp: now.toISOString()
        });

        console.log(`Traffic light changed to ${currentTrafficState}`);
    } else {
        console.log("Traffic cycle not changed - system in ambulance priority mode");
    }
}
```

ARCHITECTURE:

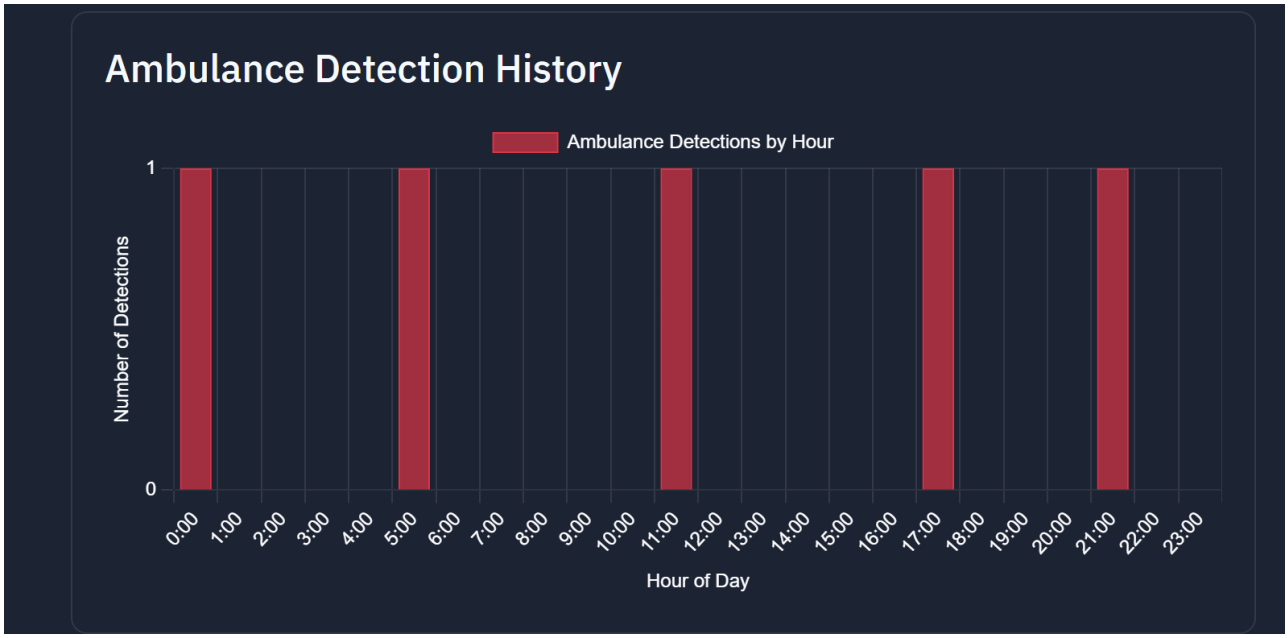


8. RESULTS

DASHBOARD:

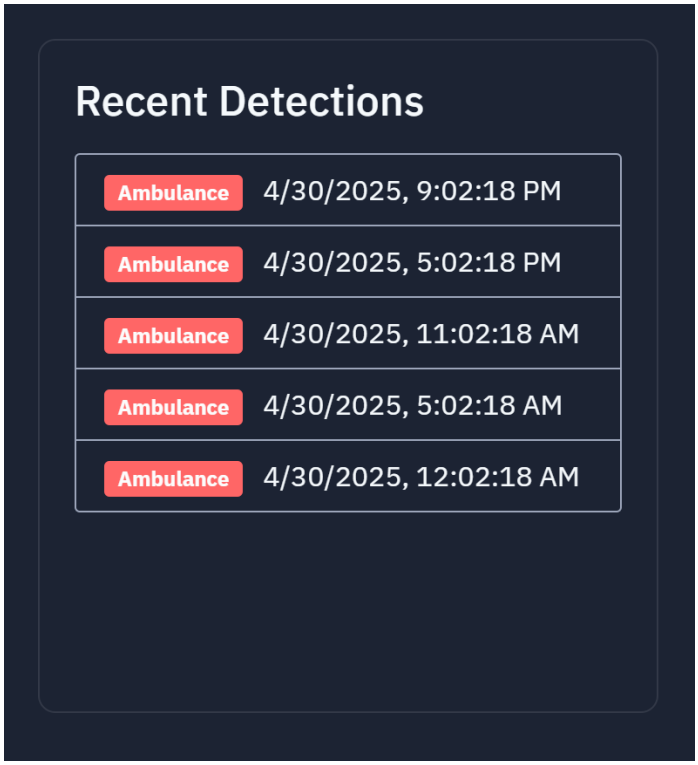


DETECTION HISTORY:



TRAFFIC LIGHT HISTORY:

RECENT DETECTIONS:



7. CONCLUSION

The increasing traffic congestion in urban areas poses a significant challenge for emergency services, especially ambulances, which require rapid and uninterrupted movement to save lives. This project, ***Smart Ambulance Traffic Control Using Bluetooth***, addresses this critical issue by proposing an intelligent and cost-effective solution that integrates basic electronics and communication systems to prioritize ambulance movement at traffic intersections.

The system utilizes an HC-05 Bluetooth module connected to an Arduino microcontroller installed in the ambulance. When the ambulance approaches a traffic signal, the module communicates wirelessly with a corresponding receiver installed at the traffic control unit. Once authenticated, the system overrides the normal traffic light cycle, turning the signal green in the ambulance's direction and red for the other lanes.

After the ambulance passes, the system automatically resumes normal traffic operation. The proposed model significantly reduces human intervention and delays, enhancing response times during medical emergencies. Moreover, it uses readily available, low-cost components like Arduino UNO, HC-05, LEDs, and basic sensors, making it suitable for real-world deployment, especially in developing regions with limited budgets.

This smart system not only improves emergency response efficiency but also lays the foundation for integrating more advanced technologies like GPS, GSM, and IoT in the future. By automating traffic light control in the presence of ambulances, the project ensures safer, quicker, and more reliable emergency transportation. Thus, it contributes to saving lives and improving overall urban traffic management through an efficient, scalable, and digital solution.

8. FUTURE ENHANCEMENTS

GPS and GSM Integration

The system can be enhanced by integrating GPS and GSM modules to track ambulance locations in real time and send location data to the central traffic control system for automatic signal control without relying on Bluetooth range.

IoT-Based Control System

With IoT integration, traffic lights across a city could be centrally managed using cloud-based systems. Ambulances can be detected and prioritized even before they reach intersections. 2. Mobile Application Development

Application for Real-Time Control

A application can be developed for ambulance drivers or control centers to manually or automatically communicate with traffic signals, improving flexibility and monitoring**.**

Battery Backup System

To ensure uninterrupted operation during power outages, a UPS or solar power system can be installed to power the traffic control system.

Integration with City-Wide Smart Traffic Systems

The system can be scaled to work with smart traffic management platforms used in smart cities, enabling better coordination with public transport and traffic police.

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