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# Emergency Vehicle Guidance System

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**Abstract**

Every day, traffic conditions in both rural and urban areas are getting worse and worse. In such situations, if there is an emergency like a medical crisis, fire, road accident, or natural disaster, emergency vehicles need to move through heavy traffic. At these critical times, even a difference of a few milliseconds can mean the difference between life and death. To deal with this problem, we need to take effective steps and create a strong system that helps guide emergency vehicles to find the best path, even when traffic is getting worse.

**Keywords:** Smart Traffic Management; IoT Communication; MQTT Protocol; Real-Time Signal Control; Road Safety Enhancement.

**How to Cite This Article**

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## Introduction

In today's fast-growing urban areas, traffic jams have become a big problem for emergency services. Ambulances, firefighters, and police cars often get stuck at traffic lights, causing delays that can cost valuable time and even lead to loss of life. To solve this issue, the Emergency Vehicle Guidance System (EVGS) has been introduced. It is an IoT-based solution that combines GPS, microcontroller-controlled traffic signals, and wireless communication methods like GSM, Wi- Fi, and MQTT to give priority to emergency vehicles. The system uses GPS to track the location of emergency vehicles and sends this information to nearby traffic controllers. When an emergency vehicle is approaching an intersection, the system automatically switches the traffic light to green in that direction, allowing the vehicle to pass through more quickly. This innovative system improves the effectiveness of emergency responses and supports the development of Smart City infrastructure, aiming to connect intelligent traffic management with IoT technology.

## Literature Review

Several studies and projects have been suggested in the area of smart traffic management and helping emergency vehicles get priority: Smart Traffic Light System using IoT (2019) – This project suggested using IoT technology for traffic lights that change their timing based on how many cars are around, but it didn't include a special way for emergency vehicles to get through faster.

GPS and GSM-based Vehicle Tracking System (2020) – This project used GPS to track vehicles and sent their location information through GSM modules, which helped set up a system to know where emergency vehicles were. Intelligent Transportation Systems (ITS) (2021) – This suggested using communication between vehicles and road infrastructure (V2I) for better traffic control, but it needed expensive network setup.

Emergency Vehicle Priority System using RF Communication (2022) – This used short-range radio signals but had problems with how far it could reach and interference from other signals. IoT-enabled Emergency Vehicle System using MQTT Protocol (2023) – This focused on using the MQTT protocol for cloud communication, making data transfer quicker and easier to scale. Looking at these projects, it's clear that using GPS, IoT, and wireless communication methods can be a good and affordable way to create a dependable system for guiding emergency vehicles.

## Methodology

The system uses an ESP32 device placed in the emergency vehicle, which has a GPS module that sends the vehicle's location continuously through the internet using Wi-Fi or MQTT. At every traffic light, another ESP32 gets this location data and detects when an emergency vehicle is coming. Then, the system controls the traffic lights by turning on the green light for the emergency vehicle and stopping the lights in other directions. Once the vehicle has passed, the traffic lights go back to their usual schedule. This helps emergency vehicles move quickly and without delays through busy areas.

*Block diagram:*

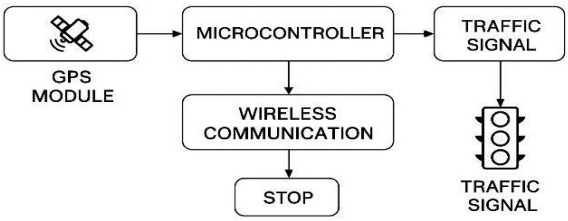


***Fig.1**. Block Diagram*

The block diagram of the Emergency Vehicle Guidance System (EVGS) shows how different components work together to provide priority to emergency vehicles at traffic signals. It mainly consists of a GPS module, a microcontroller (ESP32), wireless communication, and traffic signal units. The GPS module is installed in the emergency vehicle and continuously tracks its real-time location in terms of latitude and longitude. This location data is sent to the ESP32 microcontroller, which acts as the brain of the system. The microcontroller processes the received data and determines whether the vehicle is approaching a traffic intersection. Once the system detects that the emergency vehicle is near a signal, the ESP32 communicates with the traffic control unit using wireless technologies such as Wi-Fi, GSM, or MQTT protocol. Through this communication, the traffic signal is controlled automatically. The signal in the direction of the emergency vehicle is turned green, while signals in all other directions are turned red to stop other vehicles. This ensures that the emergency vehicle can pass through

the intersection without delay. After the emergency vehicle crosses the junction, the system resets the traffic signals back to their normal operation. The block diagram clearly represents the flow of data from the GPS module to the microcontroller and then to the traffic signal through wireless communication. Overall, it explains how the system enables real-time decision-making and efficient traffic management, helping to reduce delays and improve response time for emergency services.

*ESP32 Microcontroller:*

The ESP32 is the main brain of our project. It has Wi-Fi built right inside, so it can easily send and receive information over the internet without needing any extra part. Why We Use It: It handles the GPS location data, it sends signals to the traffic lights system, it connects to the network using Wi-Fi or MQTT. Important Features: Works with 3.3 volts, has two processors that can run up to 240 MHz, has built-in Wi-Fi and Bluetooth, has 34 pins for connecting other parts, Supports communication methods like Serial, I2C, and SPI.

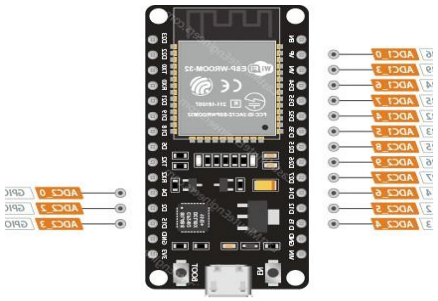

***Fig.1*** *Esp 32 Microcontroller*

*GPS Module (NEO- 6M / uBlox GPS):*

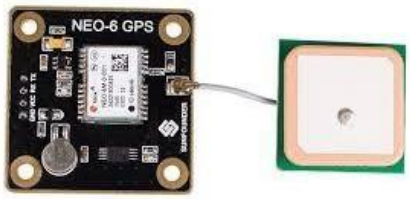


***Fig.2*** *Gps Module*

The GPS module gives the current position of the emergency vehicle. It keeps sending the location details like latitude and longitude to the ESP32 all the time.

Why We Use It: To know where the emergency vehicle is, to check if it is near a traffic signal. Features, Works with 3.3 volts to 5 volts, Accurate up to about 2.5 meters, communicates through UART using TX and RX pins, sends one data reading every second by default

*Relay Module:*


***Fig.3*** *Relay Module*

The relay acts like an electrical switch. It helps the ESP32 control the traffic lights without dealing with high voltage wires directly.

Why We Use It: ESP32 cannot work with high voltage, The relay makes the system safer and keeps parts separate.

Features: Needs 5 volts to operate, can handle up to 250 volts AC and 10 amps, It is an electromagnetic relay, It is electrically isolated (Optocoupler is suggested for safety).

**Results and discussions**

The Emergency Vehicle Guidance System was tested in traffic simulations using ESP32 controllers at intersections and GPS tracking on the emergency vehicle. The system correctly found the real-time location of the emergency vehicle and changed the traffic lights to green in its direction while turning red for all other lanes. During testing, the average time the emergency vehicle had to wait at intersections dropped a lot, making the response faster than usual traffic conditions. The system showed strong wireless communication, quick response times, and smoothly returned to normal traffic light settings after the vehicle passed.

*Signal Is Red*

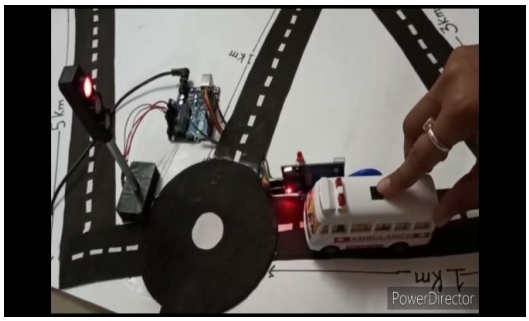


***Fig**. Result 1*

*Signal Turns Green When Ambulance Arrives*

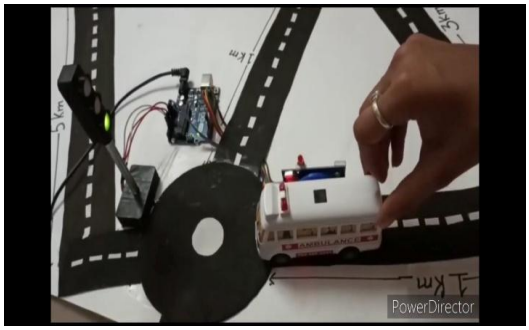


***Fig**. Result 2*

**Conclusions**

The proposed Emergency Vehicle Guidance System (EVGS) tackles a major problem in city traffic — slow emergency responses caused by heavy traffic. By using GPS tracking, Internet of Things (IoT) communication, and automatic traffic signal control, the system gives emergency vehicles priority in real time. This helps them reach their destination faster, which can save lives. This project sets the stage for creating smarter, more advanced traffic systems in cities that use automation, connected devices, and quick decision-making.

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