AUTOGREEN
SMART AMBULANCE TRAFFIC CONTROL

➢ INTRODUCTION:

Traffic congestion is one of the most significant problems worldwide, leading to various issues. In this research paper, we focus on one major issue: the challenge faced by emergency vehicles stuck in traffic at red signals while transporting patients. AUTOGREEN is a smart traffic signal system that changes the traffic signal when an emergency vehicle approaches a traffic junction. The AUTOGREEN system utilizes the **RF method** (which does not rely on GPS or internet connectivity) to detect the approaching emergency vehicle and switch the traffic light from red to green, ensuring a clear path for the vehicle. By ensuring a clear and uninterrupted path, AUTOGREEN enhances the efficiency of emergency response and helps save lives.

➢ OBJECTIVES:

Minimized Delays: An emergency vehicle passes through several traffic signals to reach its destination (hospital) and loses a significant amount of time at each signal, which may lead to death or result in a more critical condition for the patient. AUTOGREEN focuses on reducing the significant amount of time taken by the emergency vehicle at each signal using the RF method, ensuring a faster and more efficient passage.

Faster Emergency Response: This project ensures a quicker response time immediately after detecting the emergency vehicle through the signal transmitted from the transmitter, which is sent by the driver of the emergency vehicle. This helps reduce the travel time of the emergency vehicle by ensuring it does not have to wait in traffic until the signal turns green.

Life-Saving Impact : This is one of the main objectives and the primary goal of this project: to reduce time delays and enable emergency vehicles to reach the hospital as quickly as possible, ultimately saving critical lives and decreasing the death count worldwide.

Cost-Effective Operation: The primary approach to solving this issue is to use GPS and internet connectivity. However, in this project, we have used the RF method to make it cost-effective while also ensuring that the system is more efficient than any

other method.

➢ INITIAL PLANNING:

PROTOTYPE CONSIDERATION: Initially, we decided to create a prototype using hardware components.

Challenges identified:

It increases the time required to complete the project due to the limited availability of components. Additionally, the complex circuit connections may take so much time to analyze, design, and complete the project successfully.

SIMULATION DECISION:

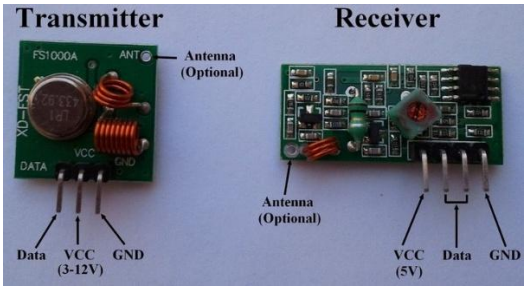
We decide to choose simulation over prototype for the the following reasons

1. Trial and Error: If any issue occurs, we can easily identify the faulty component or design method, making the process more efficient and cost-effective.
2. Easily establish connections without the need for any hardware components.
3. Reduces the prototype building time through simulation, allowing for efficient testing and development.

➢ COMPONENT SELECTION:

1. RF Transmitter and Receiver Modules:

Used for wireless communication between ambulances and traffic signals. Ensures signal transfer up to 100 meters without GPS or internet dependency. Enables wireless communication between the ambulance and traffic signal without GPS or internet.



2. ESP32:

Processes signals received from the RF module. Decides when to switch the traffic light based on the ambulance's approach. Processes RF signals and controls traffic

lights based on ambulance detection. It does Faster processing, low power consumption, and has potential for future IoT integration.

3. Traffic Light System (LEDs/Relays):

It changes light from red to green upon ambulance detection. It simulates accurate traffic signals; switches from red to green when an ambulance is detected. It is a cost-effective method to test and visualize the system's workings.

4. Power Supply:

It provides power to the ESP32 and RF modules. It provides the necessary voltage to ESP32 and RF modules for uninterrupted operation. It ensures stable and reliable power delivery to all components.

5. **Omni-Directional Antenna:**

It improves signal reception and determines the ambulance's direction by placing omni directional antennas on each junction. It ensures better signal reception and determines the ambulance's direction. It improves accuracy and ensures signals are received only from the intended direction.

➢ SYSTEM DESIGN & WORKING MECHANISM:

1. RF Transmitter Module (433MHz/315MHz):

On approaching the junction, it is installed in an ambulance to send an emergency signal to the traffic signal. An encoded "ambulance detection" broadcasts the signal to alert the traffic system. Works at long distances (100 meters or more) with low power consumption. Effective in tunnels, underpasses, or areas with weak GPS signals.

2. **RF Receiver Module (433MHz/315MHz):**

Function:

It is mounted on the traffic signal pole to detect signals from incoming ambulances. It receives the encoded RF message and passes it to the microcontroller (ESP32). It serves as a cost-effective substitute for GPS tracking. It provides instantaneous reception of ambulance signals without the use of cellular networks. It is very Efficient even under crowded urban settings where GPS tracking is non-functional.

3. ESP32 (Signal Processing Microcontroller & Traffic Light Control)

Function:

It works as the intelligence of the system by processing the RF signal from the ambulance.

It decodes the incoming signal and controls the traffic lights based on that.

If an ambulance is found, it changes the red color to green at the intersection.

It provides more speed in processing than Arduino. It supports WiFi and Bluetooth, making it easy to expand for future use in IoT-based intelligent traffic management.

uses low power, which makes it suitable for real-world deployments.

4. Traffic Light System (LEDs/Relays for Actual Traffic Lights)

It is the real traffic light system at the intersection.

It is in operation under regular conditions but goes green on ambulance detection. The relay-based system supports integration with actual traffic light infrastructure.

It gives a graphical representation of how the system works prior to deployment.

5. Antenna – RF Signal Strengthening

Function:

Mounted on the traffic signal pole and ambulance to enhance transmission and reception of RF signals. It boosts signal quality and eliminates spurious actuations

from neighboring vehicles. It affords consistent signal detection, even at heavy intersections with several automobiles.

➢ IMPLEMENTATION:

- **System Purpose:** Prioritizes ambulance movement at traffic signals to improve emergency response times.
- **Design Evolution:** Initially considered a computer vision-based approach using OpenCV.
- **Transitioned to an RF-based system** due to cost, efficiency, and reliability advantages.
- **Working Mechanism**

Ambulance transmits an RF signal upon approaching a red traffic light.

Multiple RF receivers determine the direction of the incoming signal.

The ESP32 processes this data and triggers the relay module to switch the traffic signal accordingly.

The system then resets to normal operation after the ambulance has passed.

➢ CHALLENGES AND SOLUTIONS:

RF signal interference:

Multiple RF signal may interact at the junction of roads and can disturb other ambulance detection.

Solution: will be using a omnidirectional antenna in which the antenna facing the ambulance receives the signal first and allows the ESP 32 to find its direction.

Frequency selection and Optimization:

Another problem that is faced by this model is the selection of optimal Operating frequency for minimal disturbance and reliable communication.

Solution: will be to select the 915 MHz frequency (ISM Band) for reduced interference, extended range, and regulatory compliance.

➢ NEXT STEPS: SIMULATION PHASE

Purpose: Validate the functionality of the Smart Ambulance Traffic Control System before real-world implementation. And to test the working, Proteas software is used, which is easier to use and debug simultaneously.

Simulation Approach: Used Arduino Uno in the simulation environment instead of ESP32 for easier testing and system behavior evaluation.

➢ FUTURE DEVELOPMENTS:

The model allows easy integration with other emergency vehicles like fire trucks and police vehicles, and can be incorporated by configuring their RF transmitters.

Potential Enhancements:

Multi-Vehicle Integration: Prioritizing multiple vehicles at the same time.

GPS and IoT Integration: Incorporate real time tracking for better monitoring, to detect ambulance earlier.

Adaptive Traffic Signal Control: Implement AI based algorithms for real-time traffic flow optimization.

➢ SIMULATION RESULTS:

1**. Transmitter Side**

A logic input is connected to the M145026 encoder.

The encoder processes the logic input (1 or 0) and sends the encoded signal to the RF Transmitter Module.

The RF Transmitter (U2) modulates the signal and transmits it wirelessly through its antenna.

2. Wireless Transmission

The signal transmitted wirelessly and is received by the RF Receiver (U1).

3. Receiver Side

The RF Receiver (U1) receives the transmitted signal and sends it to the M145027 decoder.

The decoder (M145027) converts the received signal back into logic data and send data to output pin

4. Switching Mechanism

A MOSFET is used for switching purposes.

The gate terminal of MOSFET is connected to the output of the receiver module.

Since the receiver module provides sufficient voltage, it turns the MOSFET ON or OFF.

5. Output Verification

To verify a LED is connected between the drain and source of the MOSFET with power supply

When the MOSFET is activated, the LED lights up, indicating a successful signal reception and switching operation.

Simulation components:

Transmitter side

Modulo Tx
M145026
Logic input
Battery

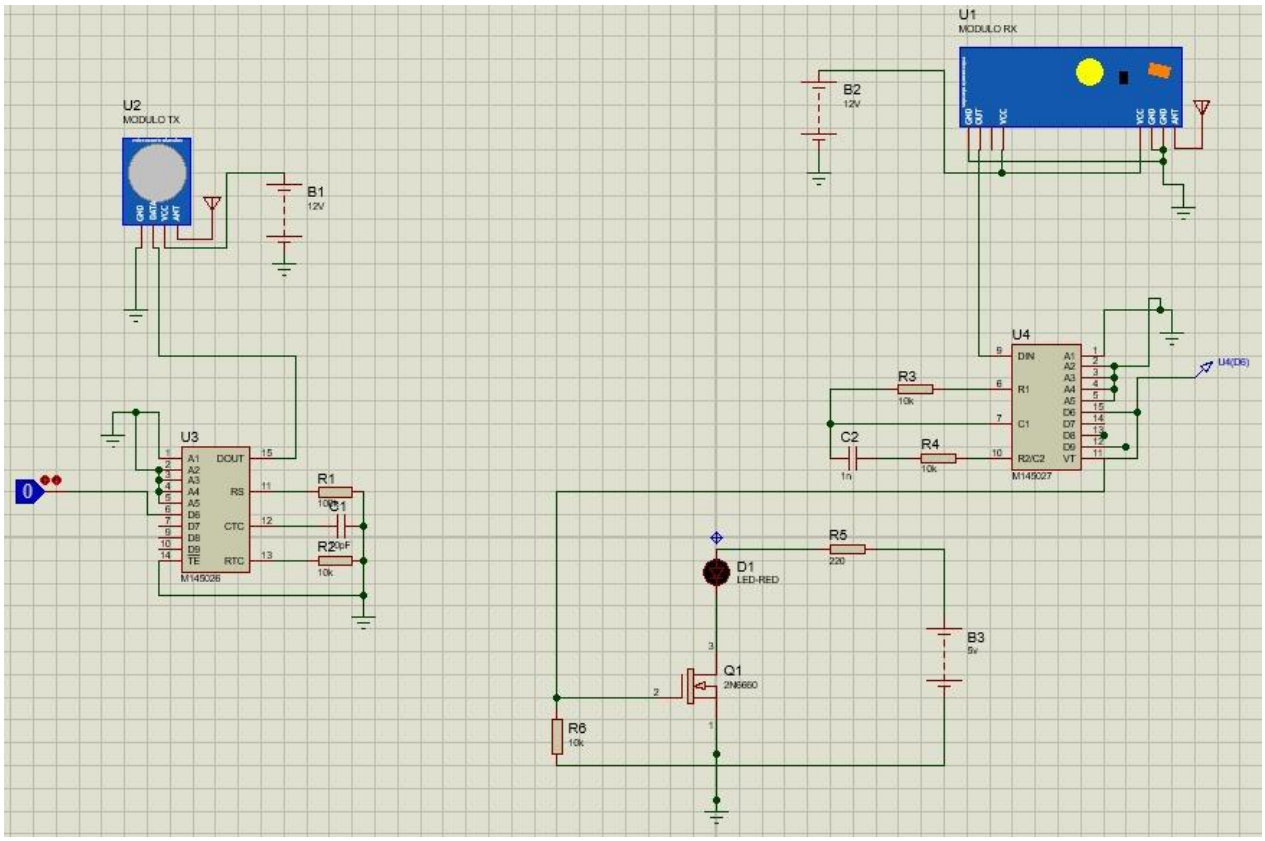
Receiver side

Modulo Rx
M145027
Battery

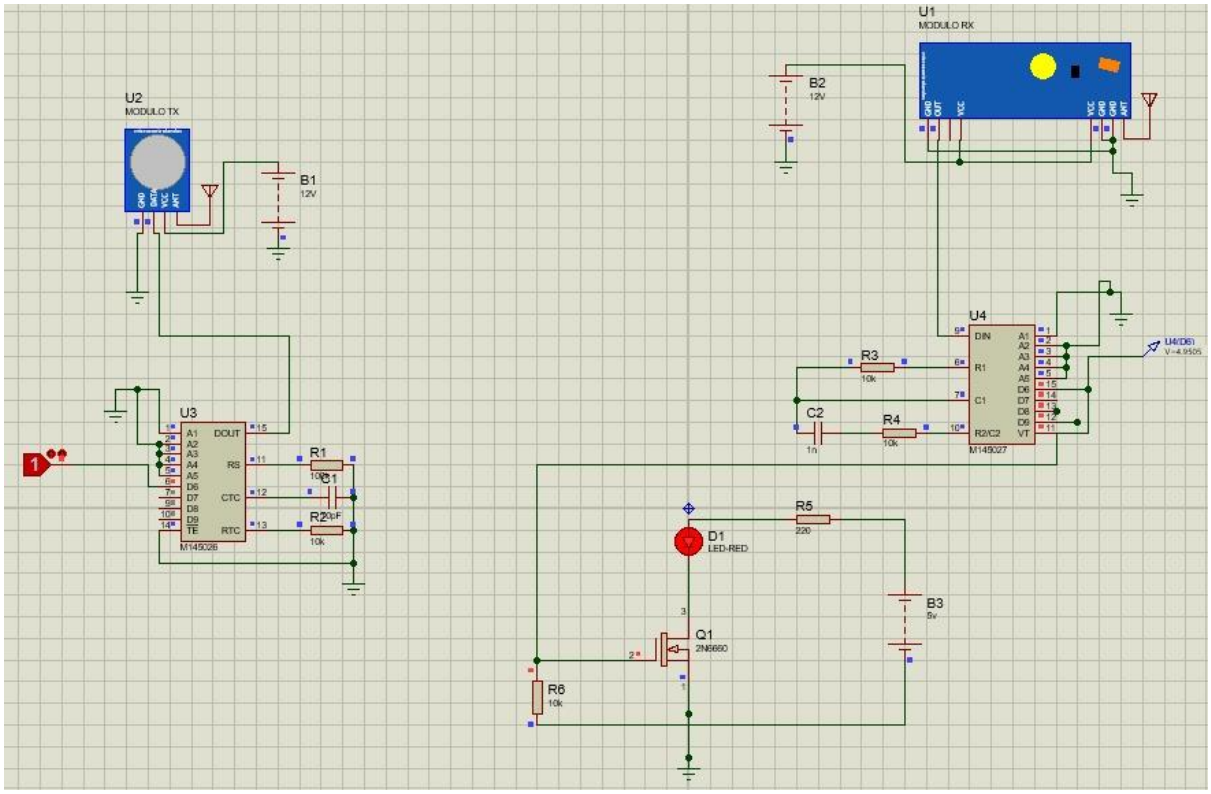
Switching side

MOSFET 2N6660
Led
Battery
Few resistor and capacitor(100k, 10k, 220),(10pF,1nF)

BEFORE SIMULATING:



AFTER SIMULATING:



➢ CONCLUSION:

The Smart Ambulance Traffic Control System enables ambulances to navigate traffic with minimal delays using cost-effective RF communication instead of GPS or AI-based solutions. It ensures reliable, weather-independent emergency vehicle prioritization. Future enhancements like IoT integration and adaptive traffic signal control will further improve efficiency and responsiveness in urban traffic management.