

Smart Traffic Light System

Semester Group Project

Bachelor of Technology – Electronics and Communication Engineering

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Team Member: Geetanjali Saini

Introduction

Rapid urbanization has led to a significant increase in vehicular traffic, making traffic congestion a major challenge in modern cities. Conventional traffic signal systems operate on fixed-time intervals and do not adapt to real-time traffic conditions, resulting in inefficient signal usage and increased waiting time.

This semester group project focuses on the design and implementation of a **Smart Traffic Light System** that dynamically adjusts traffic signal timing based on vehicle detection at an intersection.

Problem Statement

Traditional traffic light systems suffer from the following limitations:

- Fixed signal timing irrespective of traffic density
- No real-time traffic awareness
- Increased congestion and idle green signal time

These limitations motivate the need for an adaptive traffic control system that responds to real-time traffic conditions.

Objectives

The main objectives of this project are:

- To detect the presence of vehicles at an intersection
- To dynamically adjust green signal duration based on vehicle detection
- To reduce unnecessary waiting time and improve traffic flow

System Description

The Smart Traffic Light System uses vehicle detection sensors placed on each road approaching an intersection. The sensor outputs are fed to a microcontroller, which processes the inputs and determines the appropriate signal timing.

When vehicles are detected on a particular road, the system allocates a longer green signal duration to that road. If no vehicles are detected, the green duration is reduced to avoid idle signal time.

Project Setup

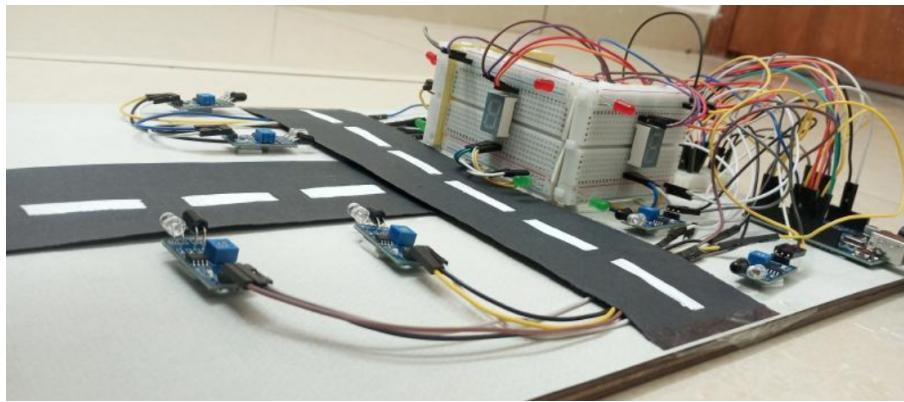


Figure 1: Smart Traffic Light System Prototype

Hardware and Software Used

Hardware Components:

- Microcontroller (Arduino / ESP32)
- IR or Ultrasonic Sensors for vehicle detection
- Traffic Signal LEDs (Red, Yellow, Green)
- Breadboard, resistors, and connecting wires

Software Tools:

- Arduino IDE
- Embedded C / C++ programming language

Working Methodology

The working of the system can be summarized as follows:

1. Sensors continuously monitor the presence of vehicles on each road.
2. Sensor data is sent to the microcontroller as digital input signals.
3. The microcontroller executes predefined logic to determine green signal duration.
4. Traffic lights are switched accordingly to manage traffic flow efficiently.

Control Logic

The control logic is based on vehicle presence detection:

- If vehicles are detected on a road, green signal duration is increased.
- If no vehicles are detected, the green signal duration is minimized.
- Signals operate sequentially to avoid conflicts at the intersection.

This logic ensures fair and efficient allocation of signal time.

Results and Observations

The implemented system was tested under different traffic conditions. The observations include:

- Reduced idle green signal time
- Improved traffic movement at the intersection
- Better response compared to fixed-time traffic signals

Applications

- Urban traffic intersections
- Smart city traffic management systems
- Traffic control in campuses and industrial areas

Limitations

- Vehicle count is based on detection, not exact density measurement
- Performance depends on sensor placement and accuracy

Future Scope

The project can be enhanced by:

- Camera-based vehicle counting using computer vision
- Emergency vehicle detection and priority handling
- IoT-based remote monitoring
- AI-based traffic prediction algorithms

Conclusion

This semester group project successfully demonstrates a Smart Traffic Light System that adapts traffic signal timings based on real-time vehicle detection. The system addresses the inefficiencies of conventional fixed-time traffic signals and provides a scalable solution for modern traffic management.