Traffic Density Controller

For the Evaluation of

CAT II Project Mode – IT 23331- Digital Logic and Computer Architecture

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Bonafide Certificate

This is to certify that the Mini project work titled "**Traffic density controller**" done by "Students Moniga K 231001117,Monesh M 231001116,Jayasurya J 231001072, is a record of bonafide work carried out by him/her under my supervision as a part of Mini project for the Course IT23331-Digital Logic and Computer Architecture , Department of Information Technology, REC.

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ABSTRACT

Urban traffic congestion is a growing concern in modern cities, leading to longer commute times, increased fuel consumption, and higher levels of air pollution. To address this challenge, efficient traffic management systems are essential. This project presents a Traffic Density Control System utilizing an Arduino Uno microcontroller in combination with Infrared (IR) sensors, designed to optimize traffic flow at intersections based on real-time vehicle density.The system works by strategically placing IR sensors on each lane of the intersection to detect the presence of vehicles. These sensors send data to the Arduino Uno, which continuously monitors traffic density in real-time. The microcontroller processes this data and adjusts the timing of the traffic lights accordingly. For example, if a particular lane is detected to have high traffic density, the system will extend the green light duration for that lane, allowing for smoother vehicle movement. Conversely, lanes with fewer vehicles will receive shorter green light durations, minimizing waiting times and reducing congestion. The proposed system is highly adaptable and can dynamically respond to fluctuating traffic conditions, ensuring that traffic flow is always optimized. It can also adjust for off-peak times when traffic is lighter, reducing unnecessary delays and enhancing road safety. The solution is low-cost, simple to implement, and can be scaled to accommodate a variety of intersection layouts. By combining hardware components such as IR sensors, traffic lights, and the Arduino Uno with efficient software algorithms, the Traffic Density Control System offers an innovative approach to modern traffic management. It promises to alleviate traffic congestion, reduce environmental impact, and improve overall transportation efficiency in urban settings.

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CHAPTER 1

1.Introduction:

A traffic density controller is a system designed to manage and regulate vehicle flow in hightraffic areas, reducing congestion and enhancing road safety. By monitoring traffic density through sensors and data analysis, it adjusts signals or routes in real-time to optimize the movement of vehicles. This technology not only minimizes delays but also improves fuel efficiency and reduces pollution by maintaining smoother traffic flow. Its implementation is essential in modern urban planning to address the growing demand on road infrastructure**.**

1.1 Problem Statement

Urban traffic congestion is a critical issue in modern cities. Traditional fixed-time traffic lights contribute to prolonged wait times, fuel wastage, and higher carbon emissions, as they cannot adjust based on real-time traffic conditions. These fixed systems often cause inefficiencies, especially during peak hours or in high-density areas, leading to delays for commuters and emergency vehicles. Thus, a responsive and adaptive traffic control solution is necessary to handle variable traffic patterns and reduce congestion.

1.2 Objective of the Project:

The main objective is to develop a real-time Traffic Density Controller (TDC) that dynamically adjusts traffic signal durations according to the density of vehicles on each lane. By using IR sensors for vehicle detection and Arduino microcontrollers for processing, the system aims to enhance traffic flow efficiency, reduce vehicle idle time, improve fuel economy, and reduce air pollution caused by excessive idling.

1.3 Organization of the Report :

This report is organized into the following sections:

Chapter 2: System Design, detailing architecture, UML modeling, and system specifications.
Chapter 3: Implementation, which includes input signal processing, code structure, output analysis.
Chapter 4: Conclusion, references**.**

CHAPTER 2

2. System Design:

2.1 System Architecture :

The Traffic Density Controller system consists of multiple components: IR sensors for vehicle detection, an Arduino microcontroller to process input, and LEDs to represent traffic lights. IR sensors are strategically placed on each lane of an intersection to detect the number of vehicles and send density data to the microcontroller. The microcontroller uses this data to calculate density and adjust the traffic light timings based on pre-set algorithms that prioritize high-density lanes.

circuit diagram:

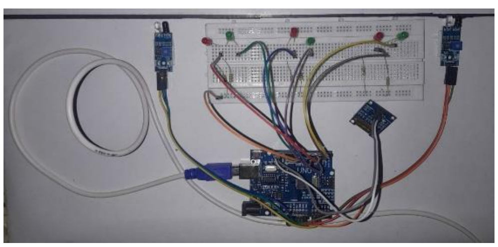

Fig:2.1

2.2 UML Modeling :

2.2.1 Use Case Diagram :

Fig:2.2

2.3 System Specification:

1. Vehicle Detection using IR Sensors:

The system employs Infrared (IR) sensors to detect the presence and movement of vehicles in real-time on each lane of the intersection. These sensors are strategically placed above or along the road to accurately measure traffic density by sensing changes in infrared radiation as vehicles pass over them.

2. Arduino Uno Microcontroller:

The system is powered by an Arduino Uno microcontroller, which processes input from the sensors and controls the traffic lights accordingly. The Arduino board is responsible for managing the logic that adjusts the green, yellow, and red light timings based on the detected traffic density.

3. Dynamic Traffic Light Control:

The system dynamically adjusts the traffic light cycles in real-time based on the number of vehicles detected on each lane. Lanes with higher traffic density will receive extended green light durations to reduce congestion, while lanes with lower traffic volume will receive shorter green light cycles, ensuring efficient traffic flow.

2.4 Tools / Platforms:

2.4.1 Software Requirements:

- **Arduino IDE:** Used to write, compile, and upload code to the microcontroller.
- **IR Sensor Libraries**: Libraries for managing IR sensor input, signal processing, and timing.
- **Simulation Software**: Software such as Proteus for testing circuits and simulating sensor and signal behavior.

2.4.2 Hardware Requirements:

- **IR Sensors:** For vehicle detection; selected based on range and accuracy.

Fig:2.3

- **Arduino**: Processes real-time data from sensors and controls LED outputs.

Fig:2.4

- **LEDs**: Represent traffic signals; green, yellow, and red LEDs are used to simulate light changes on each lane.

Fig:2.5

- **Power Supply**: Provides adequate power to the sensors and microcontroller.

CHAPTER 3

3. Implementation:

3.1 Input image:

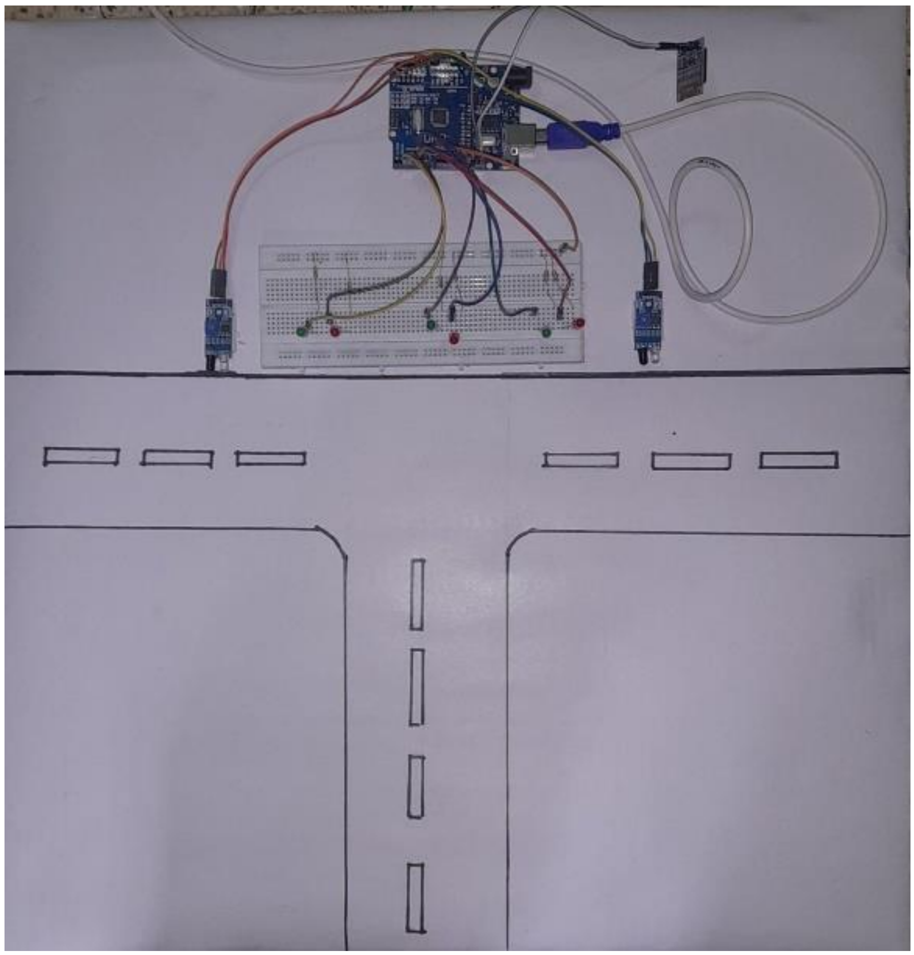

Fig:2.6

3.2 coding:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Initialize the LCD (I2C address is usually 0x27)
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Pin assignments for IR sensors
#define IR_SENSOR1 A0
#define IR_SENSOR2 A1

// Traffic light pins for Road 1
#define R1_RED 2
#define R1_GREEN 3

// Traffic light pins for Road 2
#define R2_RED 4
#define R2_GREEN 5
// Traffic light pins for Road 3
#define R3_RED 6
#define R3_GREEN 7
```

```
void setup() {
  // Initialize IR sensor pins
  pinMode(IR_SENSOR1, INPUT);
  pinMode(IR_SENSOR2, INPUT);
  // Initialize traffic light pins
  pinMode(R1_RED, OUTPUT);
  pinMode(R1_GREEN, OUTPUT);
  pinMode(R2_RED, OUTPUT);
  pinMode(R2_GREEN, OUTPUT);
  pinMode(R3_RED, OUTPUT);
  pinMode(R3_GREEN, OUTPUT);
  // Initialize LCD
  lcd.init();
  lcd.backlight();
  // Start with all RED lights
  digitalWrite(R1_RED, HIGH);
  digitalWrite(R2_RED, HIGH);
  digitalWrite(R3_RED, HIGH);
}
void loop() {
  // Road 1
```

```
int density1 = analogRead(IR_SENSOR1); // Read density for Road 1
  manageRoad("Road 1", R1_GREEN, R1_RED, density1, R2_RED, R3_RED);
  // Road 2
  int density2 = analogRead(IR_SENSOR2); // Read density for Road 2
  manageRoad("Road 2", R2_GREEN, R2_RED, density2, R1_RED, R3_RED);
  // Road 3 (fixed time since it has no sensor)
  manageRoad("Road 3", R3_GREEN, R3_RED, 0, R1_RED, R2_RED);
}
// Function to control traffic lights and LCD display
void manageRoad(const char* roadName, int greenPin, int redPin, int density, int otherRed1, int otherRed2) {
  int duration;
  if (density > 500) {
    duration = 10; // High density, green light for 10 seconds
  } else {
    duration = 5; // Low/no density, green light for 5 seconds
  }
  // Turn ON green light for the current road and red for others
  digitalWrite(greenPin, HIGH);
  digitalWrite(redPin, LOW);
  digitalWrite(otherRed1, HIGH);
  digitalWrite(otherRed2, HIGH);
```

```
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print(roadName);
 lcd.setCursor(0, 1);
 lcd.print("Time: ");
 lcd.print(duration);
 lcd.print(" sec");

 // Countdown timer on LCD
 for (int i = duration; i > 0; i--) {
  lcd.setCursor(10, 1);
  lcd.print(i); // Update remaining time
  delay(1000);  // Wait for 1 second
 }

 // Turn OFF green light for the current road
 digitalWrite(greenPin, LOW);
 digitalWrite(redPin, HIGH);
}
```

3.3 Output image :

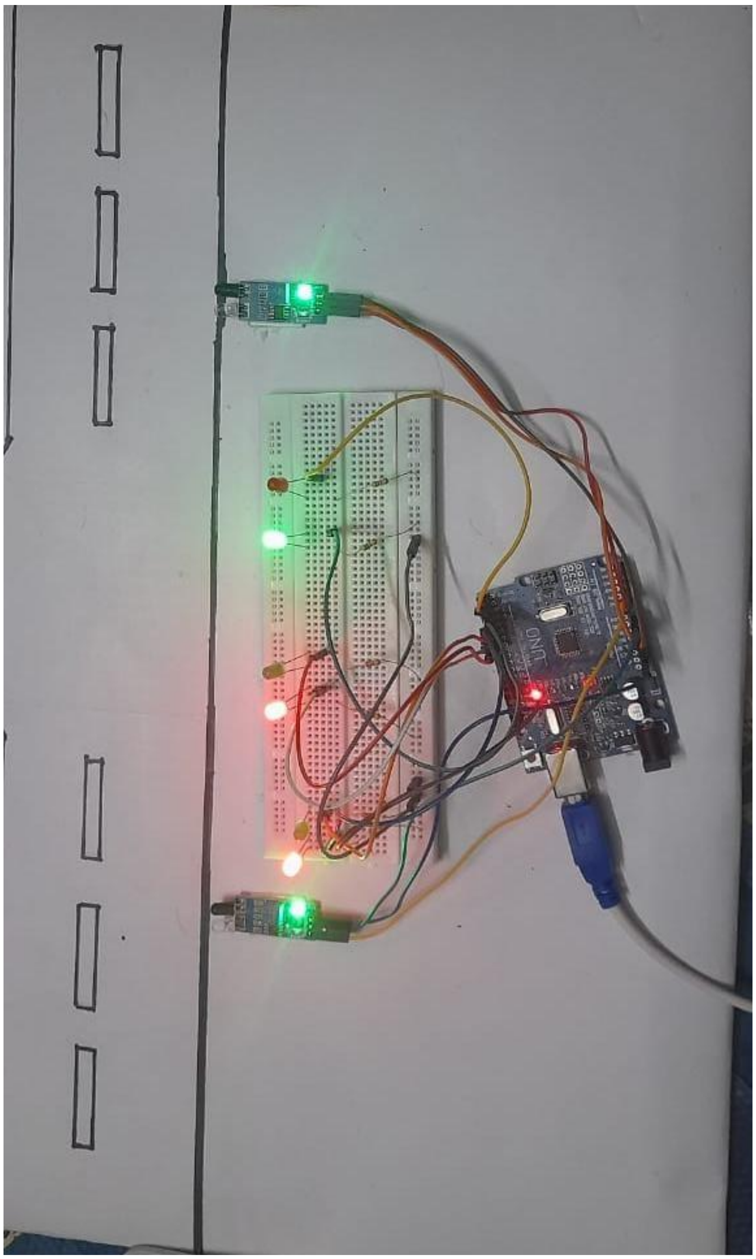

Fig:2.7

CHAPTER 4

4. Conclusion:

The Traffic Density Controller system presents an innovative and effective solution for managing traffic flow at urban intersections. By leveraging the capabilities of Arduino Uno microcontroller and Infrared (IR) sensors, the system offers dynamic, real-time adjustments to traffic light cycles based on actual vehicle density. This approach optimizes traffic flow, reduces congestion, minimizes fuel consumption, and lowers emissions by preventing unnecessary idling at traffic signals.

The system's adaptability, simplicity, and low-cost design make it a viable solution for various urban environments, from small intersections to more complex traffic networks. With the ability to fine-tune parameters such as light timing, it can accommodate changing traffic patterns throughout the day, improving both efficiency and road safety.

Ultimately, this traffic density control system enhances the overall management of urban traffic, offering a scalable and sustainable solution to one of the most pressing challenges of modern transportation. As cities continue to grow, systems like this will play a key role in improving transportation infrastructure, reducing environmental impacts, and ensuring smoother, more efficient traffic management.

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