BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 304 (Project Report)

Digital Electronics Laboratory

Final Project Report

Section: A1 Group: 08

Smart 4-Way Traffic System

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Signature of Instructor: ______________________________

Academic Honesty Statement:

IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. Type the student ID and name, and put your signature. *You will not receive credit for this project experiment unless this statement is signed in the presence of your lab instructor.*

"In signing this statement, We hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), and cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, We will each receive a score of ZERO for this project and be subject to failure of this course."

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1 Abstract

Efficiently managing traffic at four-way intersections in metropolitan areas has become a significant challenge. By effectively controlling these intersections, we can reduce wasted time, increase employee productivity, and save valuable time. Our project's goal is to create a hybrid traffic management system for four-way intersections using 74 series Integrated Circuits (ICs). We will enhance this system with three distinct features: intelligent congestion management, handling ambulance and VIP movement, and implementing an automatic pedestrian crossing. Our implementation includes both automatic and manual control options to assist traffic police in managing congested city intersections. The system automatically regulates traffic on the most congested road, while ambulance and VIP crossings are managed manually by traffic officers. The pedestrian crossing is automated and synchronized with the other two features.

2 Introduction

In large cities, traffic management has frequently been neglected as a problem. Cities that are crowded and overpopulated have trouble controlling the crossings. Despite having traffic signals, the majority of the crossings are rarely used. Different roadways have unpredictable variations in congestion, necessitating manual intervention. The crossing is under the jurisdiction of traffic police, who allow more time in busy lanes and less time in other lanes. If an automatic system is in place, this management will be lot simpler and more dependable. Our concept offers a prototype of an autonomous four-way traffic control system in this situation.

Our projects employ automatic jam management by giving green signal more time in congested roads. A road with more vehicles is considered more congested. If roads with ambulance or VIPs are detected, the signal automatically remains on in the road until police intervenes and restarts the automatic process. Traffic police detects the priority vehicles (a separate lane must be present for emergency vehicle crossing) and by a switch holds the road with a proprietary vehicle at green light as long as the vehicle has crossed. Automatic pedestrian crossing system is employed with only red and green light reducing the manual workload of traffic police. There is also an option available at the hand of traffic police to hold a road at green signal as long as he want (same logic as emergency crossing). The full prototype is constructed by 74 series ICs.

3 Design

3.1 Problem Formulation

Our problem has a basic fundamental block which is we have to implement a working cycle among the 4 traffic lights where there are total 4x3=12 lights in total. We first implemented a timer/clock which will provide us a sequence of time. Then we must pass the clock to a decade counter which will circulate through our traffic lights.

Then comes our second part of the problem which is implementing logic through another decade counter to control each lights to be manipulated in our designed way which we will see through implementation.

3.1.1 Identification of Scope

First of all, we have to solve the issue of timer. So, we chose to build timer using 555 timer. We had to calculate circuital element values such that timer has a quite good timing cycle to operate. Secondly, we needed a decade counter to observe the timing count properly. For that we chose 4017IC decade counter which is widely used for this purpose.

Inside circuit logics had to be developed manually. Other than that we thought of another 4017IC which will help us to manipulate fundamentally generated cycle which will run traffic lights. We needed a lot logical circuits like AND,OR,NOT to implement our logic.

3.1.2 Literature Review

Introduction

Traffic congestion in metropolitan areas continues to be a pressing issue, leading to increased travel times, reduced productivity, and environmental concerns. Traditional traffic signal systems, with fixed timing, struggle to adapt to dynamic traffic conditions. The emergence of smart traffic control systems offers a promising solution to these challenges. Moreover, the efficient management of emergency vehicle movement is critical for timely responses during crises. This literature review explores the current state of research and development in the field of smart traffic control systems and their integration with emergency vehicle prioritization.

Traffic Signal Control Systems

Traditional traffic signal systems, employing fixed timing sequences, have long been the backbone of traffic management in urban areas. However, these systems often result in inefficiencies during peak hours and fail to respond to sudden changes in traffic patterns. Research in adaptive traffic signal control systems has gained momentum. These systems utilize real-time traffic data obtained from sensors and cameras to dynamically adjust signal timing. Adaptive systems have shown promise in reducing congestion and improving traffic flow [1].

Smart Traffic Management Systems

The advent of smart traffic management systems represents a significant leap in traffic control technology. These systems leverage advanced technologies such as the Internet of Things (IoT) and artificial intelligence (AI) algorithms to optimize traffic flow. Studies have demonstrated that smart traffic management systems, when integrated with real-time data analytics, can reduce traffic congestion by efficiently rerouting vehicles and adjusting traffic signals based on current conditions [2]. Cities like Singapore and Barcelona have successfully implemented such systems, yielding substantial benefits.

Emergency Vehicle Management

The efficient movement of emergency vehicles, such as ambulances and fire trucks, is crucial in emergency response situations. Traditional traffic systems can lead to delays that are life-threatening. Emergency vehicle prioritization systems, which grant emergency vehicles the right of way and adjust traffic signals in their favor, have emerged as a solution. Research has shown that these systems significantly reduce response times during emergencies, saving lives and property [3].

Integration of Smart Traffic Control with Emergency Vehicle Prioritization

Efforts to integrate smart traffic control with emergency vehicle prioritization are ongoing. Research has explored the development of systems that allow emergency vehicles to communicate with traffic management systems to gain priority and navigate traffic seamlessly [4]. These integrated systems promise to revolutionize emergency response by ensuring timely arrivals at critical scenes.

Automatic Pedestrian Crossings

Enhancing pedestrian safety and convenience is an integral part of traffic management. Automatic pedestrian crossing systems, which use sensors to detect pedestrian presence and adjust traffic signals accordingly, have gained attention. These systems enhance safety at intersections, reducing accidents and improving the overall flow of traffic [5].

Case Studies and Real-World Implementations

Several cities worldwide have embraced smart traffic control systems and emergency vehicle prioritization strategies. For example, Los Angeles has implemented an integrated system that has shown significant reductions in emergency response times [6]. Similarly, cities like Stockholm have deployed adaptive traffic management systems, resulting in noticeable reductions in traffic congestion [7].

Challenges and Future Directions

While these systems hold great promise, challenges persist. Infrastructure upgrades and public acceptance are significant hurdles in implementing smart traffic control systems and integrating emergency vehicle prioritization. Future research should focus on developing AI-based systems capable of handling complex traffic scenarios and addressing issues related to cybersecurity and data privacy.

Conclusion

In conclusion, the integration of smart traffic control systems with emergency vehicle prioritization represents a significant advancement in urban traffic management. Research and real-world implementations have demonstrated the potential to reduce congestion, improve emergency response times, and enhance pedestrian safety. As urban areas continue to grow, the development and implementation of such systems will play a vital role in addressing the challenges of traffic management and emergency response.

3.1.3 Formulation of Problem

We initially attempt to build a timer using 555 timer. Then connect the clock to a 4017 decade counter IC which will give us a basic rotating 4-way traffic lighting. Then we move onto 2nd 4017 IC which will help us implement congestion based traffic controlling where traffic lighting time will be manipulated according to amount of congestion.

We are also implementing emergency system where upon pressing the emergency button we will see halting of 4-ways to make passage for the emergency vehicles.

3.1.4 Analysis

Timer Clock: We will work with 555 timer in astable multivibrator mode. We will get approximately 6 unit time each cycle. Green will be on for 4 unit time and yellow for 2 unit time.

First 4017 IC Decade Counter: 4017 IC has 10 outputs as a decade counter. So it's cycle can at most reach 10 clock cycle from the timer. We used this whole time frame for out each cycle of traffic light.

Second 4017 IC Decade Counter: This IC helps us to control the traffic lights once light at a time. This IC's clock pulse comes from 1st 4017 IC through various logics so that we can manipulate switching time of the traffic lights.

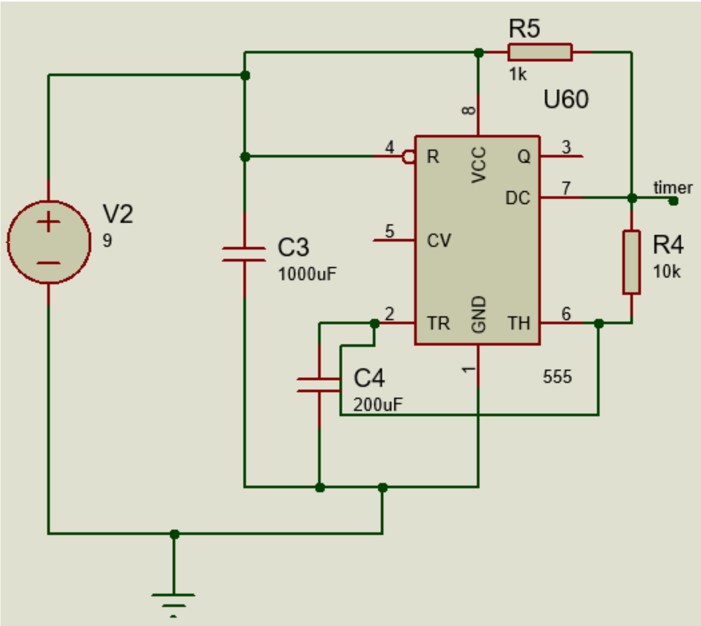
Traffic Lights: This is one of the important block where we get to see our logical output. One triplet of lights of traffic works in a simple logic that if one is on, others can't be on simultaneously.

Congestion: We wanted to take congestion through sensing. So we chose to get IR signal sensors which will provide us with signal that traffic is heavy. We used one sensor at each lane for the sake of simplicity.

Emergency: These are manually pushed buttons as for now. It gives us convenience to work with. We will get these signals manually from the traffic box and process with proper logic to halt all the lights.

3.2 Design Method

Timer Clock:

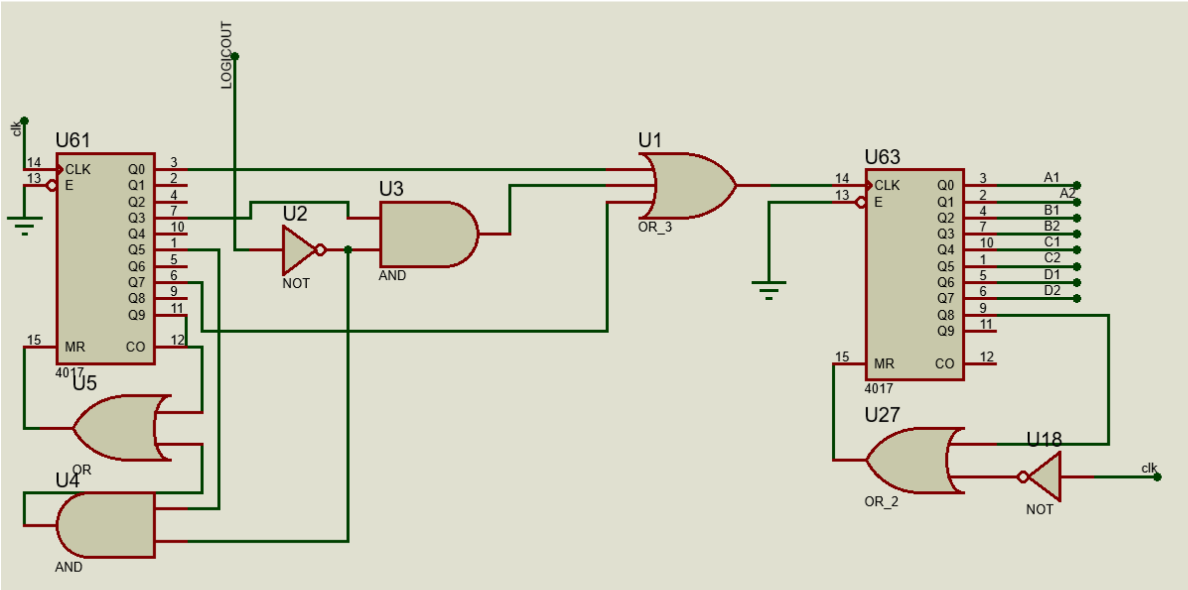


We implemented this circuit where we will get around 0.6 seconds of each cycle. Which will eventually add up to 6 cycle for 10 bit decade counter.

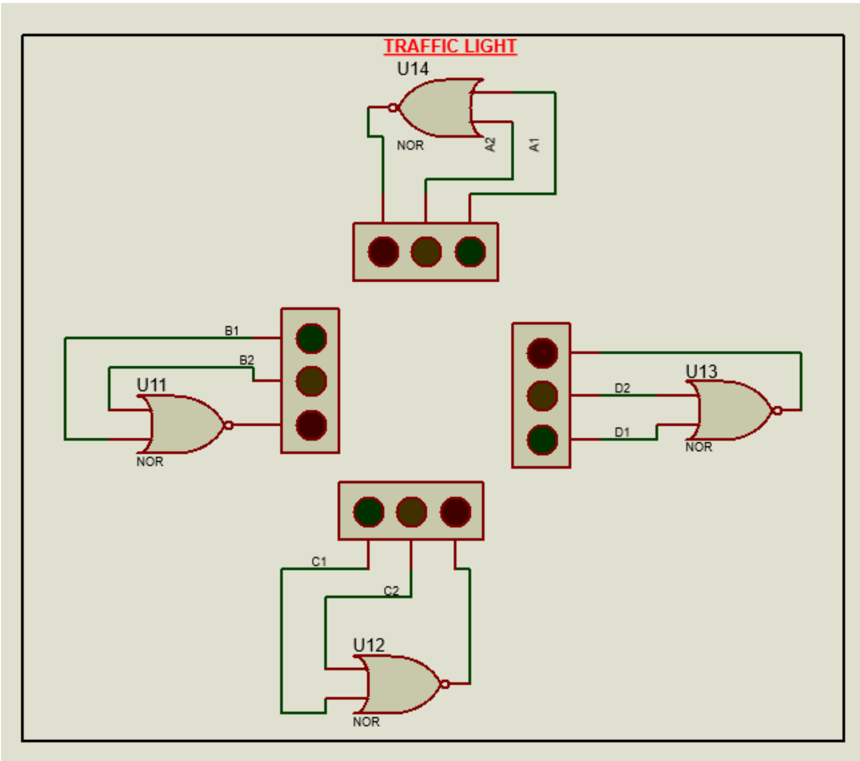
First 4017 IC Decade Counter: As the clock from the 555 timer will give around pulses after every 0.6 second, it will take 6 seconds to complete a series of traffic lights of one way. So we connected the 4th output Q3 to the next logic to switch to yellow after green. Then after 2 seconds we need to switch to red so that so we connected the Q5 in that logic. So we complete our cycle given that no abnormality.

But when our emergency logic or Congestion logic kicks in we need to reevaluate our choices. In case of congestion delay shifting from green to yellow by 2 count and shift yellow by count of 2. But in case of emergency the logic box is completely shut down by

Second 4017 IC Decade Counter: It mainly controls the lights of traffic that is output of the previous logics.

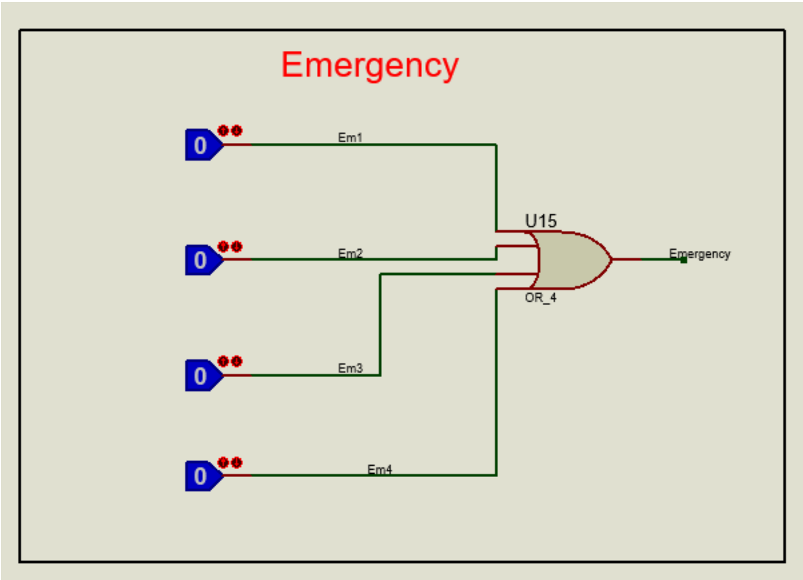


Traffic Lights: It works in a simple way that green and yellow signal are generated by ICs but red works inverted as whenever green and yellow are logic low red will logic high(ON).

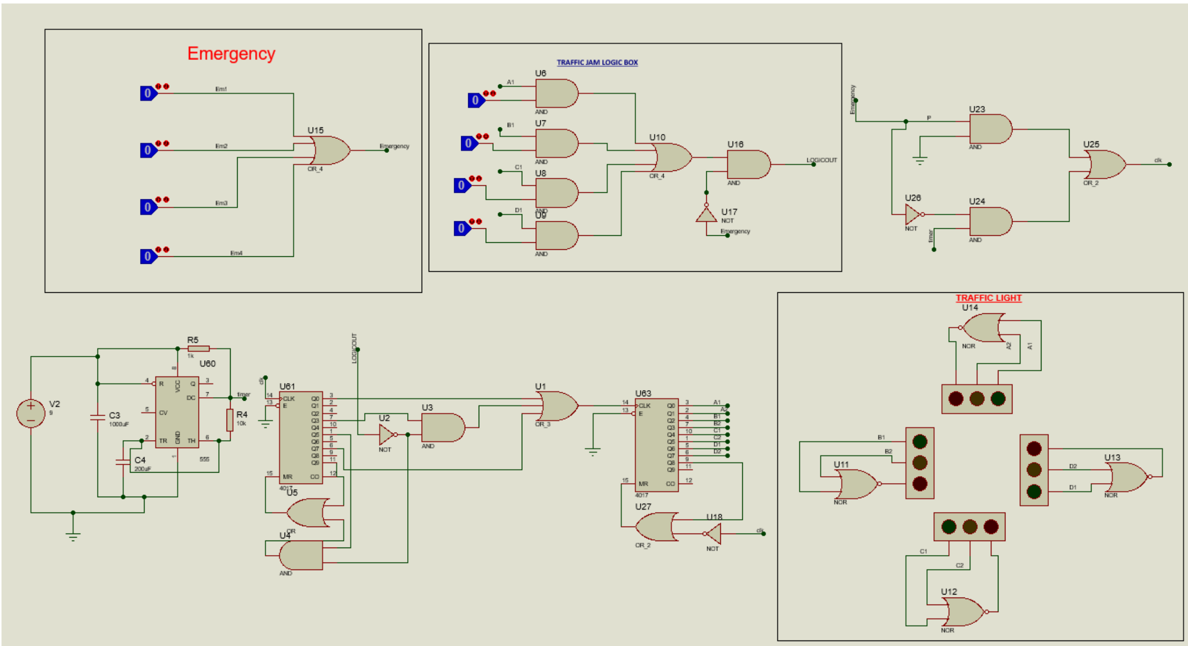


Congestion: Congestion is sensed by an IR sensor. This signal is processed in a way that it can make time delay for switching of a lane's green traffic light to yellow traffic light.

Emergency:. These are manually pressed button which are set in a way to stop the clock that is running the circuit and also reset all the traffic light to red light to make emergency passage in every lane.

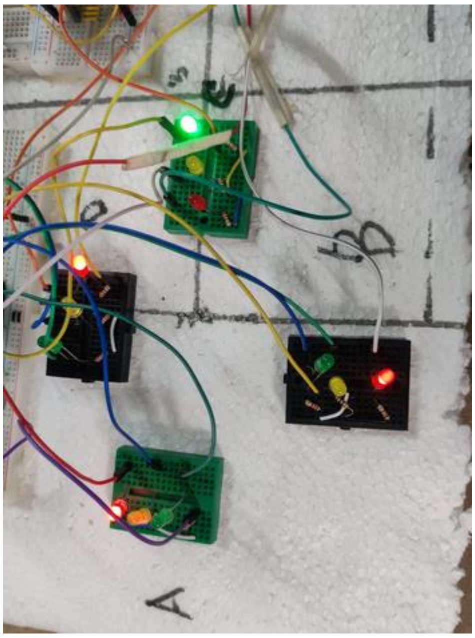


3.3 Simulation Model

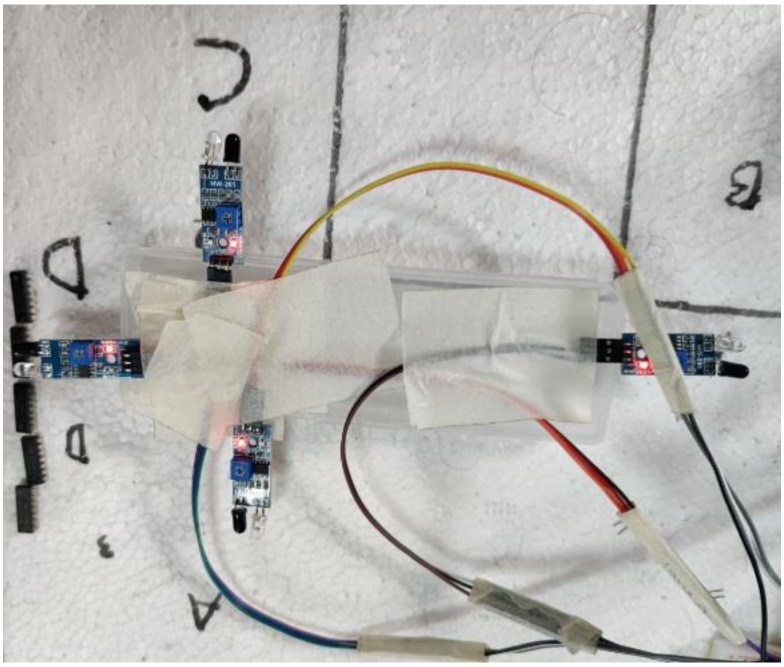


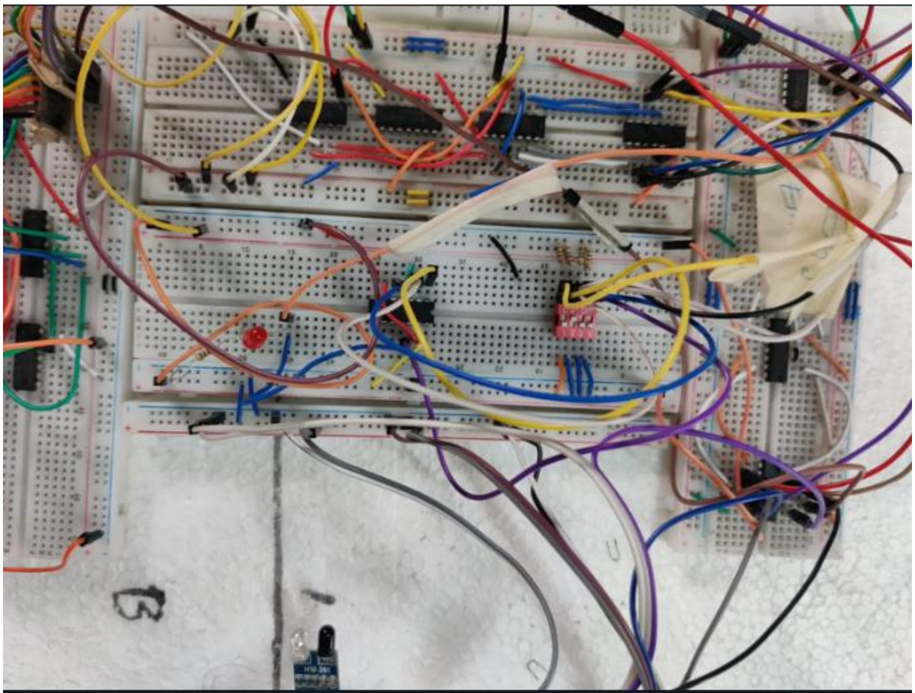
3.4 Hardware Design

Traffic Lights

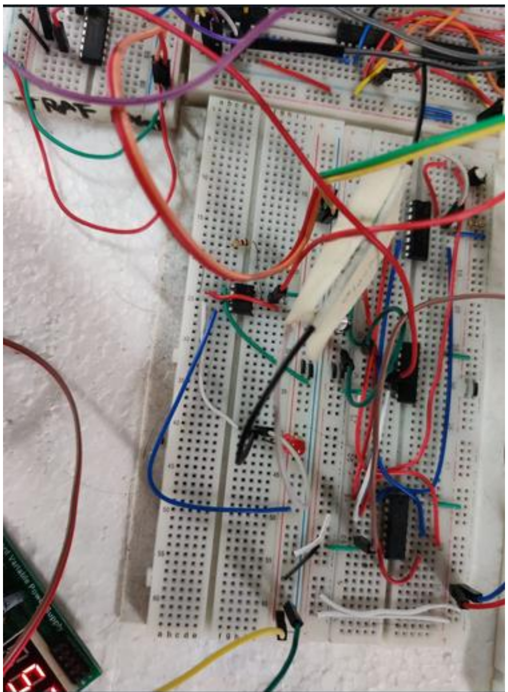


IR sensors

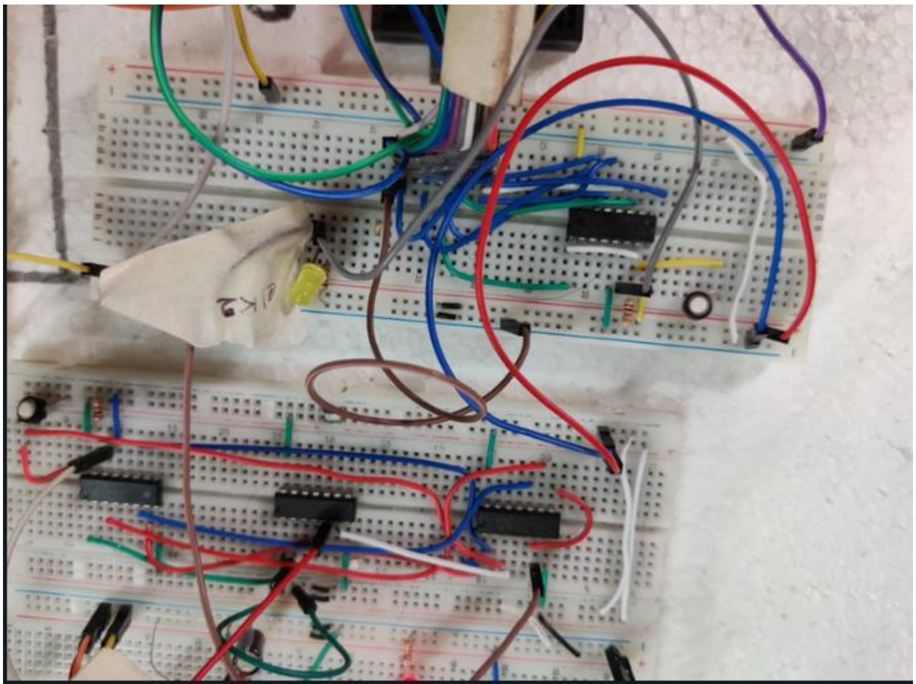




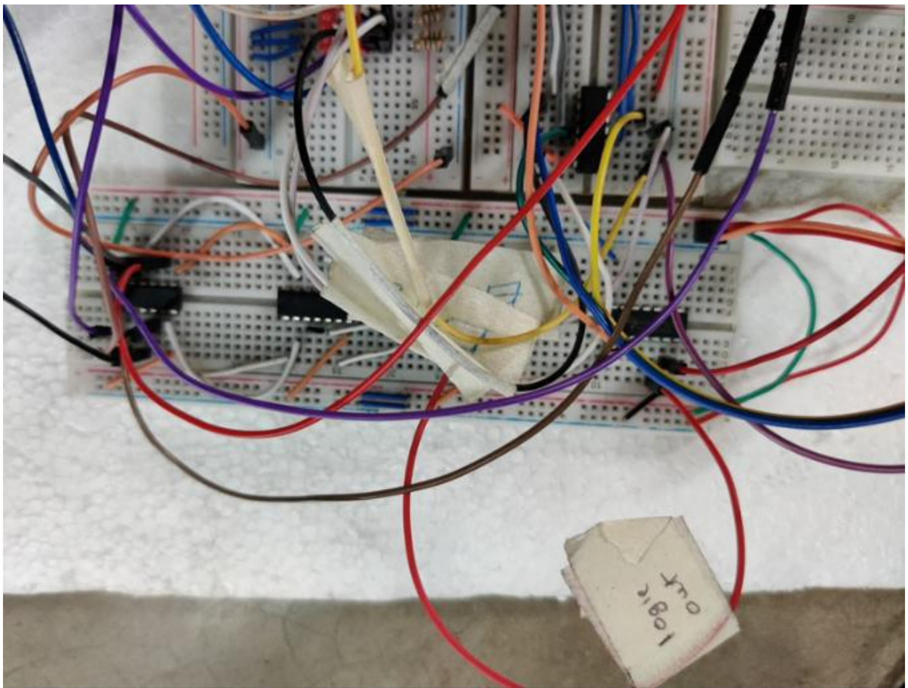
Emergency Block



555 timer block



Decade Counter



Automatic Logic block

4 Implementation

4.1 Description

We needed in total 8 breadboards. We implemented full project according to our proteus simulation blocks.

We kept the breadboards as clean as possible so that we can maintain inter-connections between circuits as clean as possible.

4.2 Experiment and Data Collection

We tested each circuits individually. Timer circuits gave on a average 1.2 seconds per pulse. We then tested decade counters individually which gives accurately 10 cycles that 12 seconds until it resets. Other than that we also tested LEDs, traffic logics, IR sensors working, emergency push buttons etc.

4.3 Data Analysis

Upon testing all the necessary data we concluded we could put up all the blocks together to get the projects up and running.

4.4 Results

We have checked our circuit properly. The basic traffic lights switching circuit is working properly. The congestion based circuit is also working properly. We find almost same timing for each green and yellow lights for each case. Unfortunately our emergency circuit didn’t work properly although we are sure enough that our logic is perfectly fine.

5 Design Analysis and Evaluation

5.1 Novelty

In different cities, a lot of traffic police must be appointed to control the traffic at intersections. But using our system the whole traffic system can be automated. With the IR sensor and emergency signal, we can smartly control the traffic in congestion in case of heavy traffic in one lane or ambulance emergency.

5.2 Design Considerations

5.2.1 Considerations to public health and safety

Emergency Vehicle Priority: The system should be equipped to detect and prioritize emergency vehicles, allowing them to navigate intersections quickly and safely.

Priority lane: If a lane gets congested, then that lane is kept open for a larger period of time. Thus, traffic in this lane can be eased.

5.2.2 Considerations to environment:

In manual mode of traffic control, drivers who face traffic jams tend to honk their horns, contributing to sound pollution. If we implement the smart traffic control system, they will know that the system is automated, with no benefit in honking horns. Thus, it will contribute in the environmental sector.

5.2.3 Considerations to cultural and societal needs:

Public awareness can increase the effectiveness of this new automated transport system. A traffic management system should be designed with cultural and societal needs in mind, considering the unique needs of the community it serves and striving to promote equity, accessibility, and safety for all.

5.3 Investigations

5.3.1 Literature Review

The concept of automated traffic management has evolved over the years. Traditional traffic control relied on static traffic lights and manual adjustments. Recent advancements in sensor technology, data analytics, and connectivity have enabled the development of more intelligent and responsive systems.

5.3.2 Experiment Design:

5.3.3 Data Analysis and Interpretation:

Each lane is given nine clock pulse, each pulse depending on the value of the capacitor used in the circuit. Seven clock pulses show the green light and two are used for transitioning from green to red. In this stage, yellow light is shown.

Limitations of Tools

IR Sensor:

Limited Range: IR sensors typically have a limited range compared to some other distance measurement technologies like ultrasonic sensors or LIDAR. The effective range depends on the sensor's design and the characteristics of the IR light used.

Angle Sensitivity: IR sensors can be sensitive to the angle at which they receive IR signals. Deviating from the sensor's specified angle of detection may result in reduced accuracy.

555 Timer:

555 timer has a limited frequency to operate. It can’t give exact timing at higher frequency. Besides, it has limited functionality. It can’t work properly in a complex traffic system.

Impact Assessment

Assessment of Societal and Cultural Issues:

Traffic Efficiency and Quality of Life: The implementation of an intelligent traffic control system can significantly improve traffic flow, reducing congestion and commute times. This can positively impact the quality of life for residents by reducing stress and environmental pollution.

Public Perception: It is essential to gauge public perception and acceptance of the new system. Conducting surveys and public meetings to gather feedback can help address concerns and ensure community support.

Urban Planning and Aesthetics: The placement and design of traffic lights and sensors must consider the cultural and aesthetic aspects of the area. The project should aim to blend seamlessly with the urban landscape to preserve cultural identity.

Assessment of Health and Safety Issues:

This system will make the traffic system more coordinated and smoother, which will prevent accidents. Besides, there is no health and safety issue in this project.

Assessment of Legal Issues:

Traffic Regulations: The system must adhere to local and national traffic regulations and standards. Compliance with signal timing, color codes, and pedestrian rights-of-way is critical.

Privacy Regulations: If the system collects and stores data, it should comply with privacy laws regarding data protection and user consent.

Accident Liability: In case of accidents or malfunctions, the allocation of liability between the system, vehicle operators, and other parties should be well-defined.

Sustainability and Environmental Impact Evaluation

The project aligns with sustainability goals by minimizing resource consumption, improving air quality, and reducing noise pollution, contributing to a more sustainable and environmentally friendly urban environment.

5.4Ethical Issues

Our project does not harm any cultural or ethical religious value.

6 Reflection on Individual and Team work

6.1 Individual Contribution of Each Member

1906016 - Hardware Assembly, Algorithm Development, Cost Analysis, Report

1906024- Hardware Assembly, Algorithm Development, Report

1906027- Presentation, Component Collection, Hardware Implementation

1906028-Hardware Implementation, Problem Analysis, Simulation

6.2 Mode of Teamwork:

1. **Normal traffic light operating circuit consisting of 555 timer and decade counter:** This portion of work is designed and simulated by all of our group members (1906016,1906024,1906027,1906028).

2. **Designing logic circuit of congestion management and emergency crossing:** The designing of different logic and synchronizing it with the rest of the circuit was done by all of our group members (1906016,1906024,1906027,1906028)

3. **Final implementation, debugging and extra features:** Final implementation, circuit debugging and testing and adding automated mode was done by all of us.

6.3 Diversity Statement of Team

We divided the work into each team member, and everyone has a designated duty. Each member encouraged others and helped when faced with problems.

6.4 Log Book of Project Implementation

Date	Milestone achieved	Individual Role	Team Role	Comments
Week 5	Bought Components	1906024,1906028		
Week 7	Implemented the timer circuit	1906016,1906024,1906027,1906028		

Week 9	Implemented the other parts	1906016,1906024,1906027,1906028		The circuit didn’t work
Week 12	Debugging	1906016, 1906024,1906028,1906027		Emergency didn’t work

7 Communication

Executive Summary:

Bid farewell to urban traffic woes! We're thrilled to present the Smart 4-Way Traffic Control System, a groundbreaking solution for urban mobility. This innovation harnesses advanced technology to ensure the seamless flow of traffic, all while prioritizing environmental concerns by reducing pollution and noise. Additionally, it places a strong emphasis on pedestrian safety and maintains fairness by granting each lane its turn. Concerned about data privacy? No need to worry; our stringent data protection measures have got you covered. Thanks to collaborative efforts from local communities and experts, this system not only delivers efficiency but also upholds community values. Embrace a hassle-free, safer, and cleaner commute as we work together to shape a more promising urban future!

User Manual:

Our project is super easy to run. Here are the steps-

1. Give the power supply!

2. Reset the pin

3. Give an obstacle to see the impact of a busy lane.

8 Project Management and Cost Analysis

8.1 Bill of Materials

Product	Quantity	Unit price	Total price
CD4017 Johnson Counter	4	BDT 22	BDT 88
7432 OR Gate	6	BDT 25	BDT 150
7402 NOR Gate	4	BDT 25	BDT 100
On / Off Switch	10	BDT 6	BDT 60
Male to Female Jumper Wires 40 Pin 30cm	1	BDT 140	BDT 140
Male to Male Jumper Wires 40 Pin 30cm	1	BDT 140	BDT 140
Resistor		BDT 5	BDT 50
100uf/50v Capacitor	4	BDT 5	BDT 20
Breadboard	7	BDT 159	BDT 1,113
NE555 Timer	3	BDT 9	BDT 27
7408 AND Gate	10	BDT 32	BDT 320
4072 OR Gate	6	BDT 29	BDT 174
4075 OR Gate	2	BDT 39	BDT 76
7404 Gate	3	BDT 27	BDT 81
Capacitor	3	BDT 16	BDT 48
Total			BDT 2320

9 Future Work

Machine Learning Integration: Implement machine learning algorithms to enable the system to learn and adapt to changing traffic patterns dynamically.

Traffic Data Analytics: Utilize collected traffic data for in-depth analysis to further optimize traffic control strategies and identify trends for urban planning.

Pedestrian Pass: We can add pedestrian pass in it.

10 References

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