AN INNOVATIVE ROAD AND TRAFFIC SAFETY MANAGEMENT SYSTEM USING IoT

Dr. Dileep Reddy Bolla
Department of CSE
Nitte Meenakshi Institute of Technology,
Bengaluru, India
dileep.bolla@gmail.com

Aman Raj
Department of CSE
Nitte Meenakshi Institute of Technology,
Bengaluru, India
1nt20cs017.aman@nmit.ac.in

Harsh Suhane
Department of CSE
Nitte Meenakshi Institute of Technology
Bengaluru, India
1nt20cs071.harsh@nmit.ac.in

Mohit Ranjan
Department of CSE
Nitte Meenakshi Institute of Technology,
Bengaluru, India
1nt20cs105.mohit@nmit.ac.in

Samarth Chauhan
Department of CSE
Nitte Meenakshi Institute of Technology
Bengaluru, India
1nt20cs152.samarth@nmit.ac.in

Abstract- **With urbanization accelerating and traffic congestion intensifying, traditional traffic management approaches are strained to their limits. Embracing the transformative potential of Internet of Things (IoT) technology, this research delves into the design, implementation, and evaluation of IoT-based traffic control systems. Through meticulous data acquisition, real-time monitoring, and adaptive decision-making, these systems promise to revolutionize urban mobility. Key findings highlight remarkable enhancements in traffic efficiency, congestion reduction, and overall urban mobility. Innovations in predictive analytics and adaptive control mechanisms stand out, offering cities newfound capabilities in tackling congestion hotspots and optimizing traffic flow dynamically. The convergence of IoT and traffic control not only fosters safer, more sustainable urban environments but also sets the stage for smarter cities of the future.**

Keywords- Internet of Things (IoT), traffic control systems, urban mobility, congestion reduction, real-time monitoring, adaptive decision-making, predictive analytics, smart cities.

I. INTRODUCTION

In recent years, the surge in global urbanization has led to unprecedented challenges in managing road and traffic safety. With burgeoning populations, increasing vehicle numbers, and evolving urban landscapes, traditional methods of traffic management have become inadequate to ensure the safety and efficiency of transportation systems. In this context, the integration of Internet of Things (IoT) technology emerges as a promising solution to revolutionize road and traffic safety management.

A. *Real-time Monitoring and Decision-making:*

Our research will focus on developing algorithms and decision support systems capable of processing real-time data streams to detect anomalies, identify potential safety hazards, and dynamically adjust traffic signals or routing to prevent accidents and congestion.

B. *Integration with Smart Infrastructure:*

We will explore the integration of IoT technologies with existing infrastructure, such as smart traffic lights, road signs, and pedestrian crossings, to create a cohesive ecosystem that enhances safety and efficiency.

C. *Integration with Smart Infrastructure:*

We will explore the integration of IoT technologies with existing infrastructure, such as smart traffic lights, road signs, and pedestrian crossings, to create a cohesive ecosystem that enhances safety and efficiency.

II. LITERATURE SURVEY

This research proposed in [1] led to the proposal of a distinguish the presence and absence of vehicle in road images. Updated signal timing based on the density on the road. This system[2] controls the street lights by automatically switching them when there are vehicles around. Provides minimal power consumption. This system [3] controls the present system option introduces a street light monitor. Operate the entire system with mobile laptop. The research work proposed in [4] counts the number of vehicles on the road. Using these surveys, we conclude our objectives to enhance the traffic light for rescheduling algorithm. Another objective is to provide minimal power consumption using intensity of surrounding, and at last we upload all the data that comes from the sensors to the cloud for further enhancement of the project.

TABLE I. TABLE 1.1 STATEWIDE POLICE REPORTED CRASHES-DRIVER FATIGUE/ DROWSY OR FELL ASLEEP (FATAL/PERSONAL INJURY).

YEAR	DEATHS/INJURY
2018	2273
2019	2436
2020	2387
2021	2256
2022	2134
2023	2060

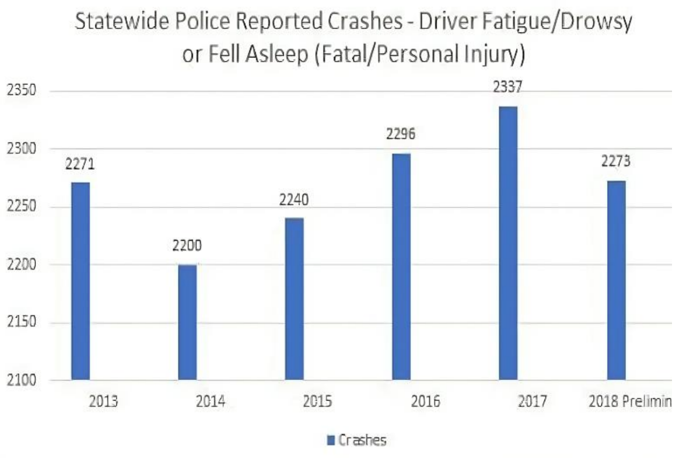

Figure 1: Figure shows the state wise crash report/ accident report.

III. SYSTEM DESIGN

This flowchart represents a basic outline of the rescheduling algorithm. It starts with collecting traffic data, followed by processing and analysing the data to evaluate current traffic conditions. Based on the evaluation, it checks if the traffic is congested. If not, it continues with the current timings. If yes, it triggers the rescheduling process to adjust the traffic light timings accordingly, followed by updating the timings and ending the process.

A. *Sensing:* The flowchart then moves to the sensing step, where the sensors (e.g., ultrasonic sensors) collect data about the environment.

B. *Data Processing:* The collected sensor data is processed using software algorithms (e.g., Rescheduling algorithm).

C. *Decision Making*: Based on the processed data, the Arduino makes decisions about its actions (e.g., to which lane it has to release the traffic).

D. *Communication:* The Arduino communicates with the system to send data, receive commands, and update its status.

E. *User Interaction*: Optionally, the flowchart may include steps for user interaction, such as providing status updates to users via a mobile app or receiving commands from users to control the robot remotely.

F. *Design Diagram Description*

The design diagram provides a comprehensive visualization of the architecture and functionality of the rescheduling algorithm of traffic light project using IoT. It outlines the integration of hardware and software components, communication interfaces, data processing algorithms, and user interaction mechanisms to create a functional and effective system. Arduino Mega: to store code and implement the output. Ultrasonic Sensor: to determine the density of the road. LED: for output signal. IR Sensor: for the detection of the vehicle.

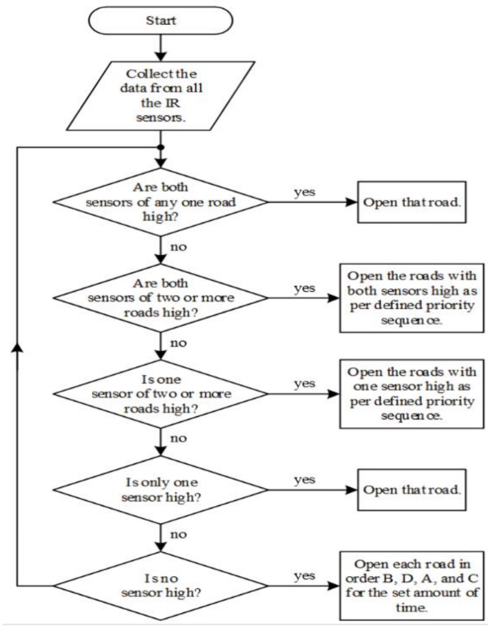

Figure 2: Proposed System Block Diagram

G. *METHODOLOGY/ALGORITHM*

The proposed methodology for creating a rescheduling algorithm for traffic lights follows a systematic approach to optimize traffic flow and alleviate congestion. Commencing with the collection and analysis of historical traffic data through sensors and cameras, the methodology aims to identify recurring patterns and congestion points. Clear definition of traffic objectives, considering local regulations and emergency vehicle prioritization, precedes the development of a simulation model to assess the existing traffic conditions. The algorithm design involves dynamic adjustments of traffic signal timings based on real-time data, with considerations for factors like traffic volume and pedestrian movements. Integration with Internet of Things (IoT) sensors ensures real-time information for the algorithm.

Algorithm1: Innovative road safety management system (ISMS)

Input **Q(t):** Total number of vehicles waiting at the traffic signal at J^{th} active lane in an I^{th} cycle;
Input **T:** Traffic cycle duration;
output Green light sequence.
Initialization Begin
1. First statement LOOP Process
/* the function of checking the presence of vehicles returns true if at minimum one vehicle is present and the priority is given to the kth lane*/

2 **If** (Vehicle Present is false)
Apply normal algorithm to the traffic light;
3. **Else** {
4. Calculate density for each lane.
5. **If** (density of any lane is more) Apply adaptive algorithm;
}
end if
6. **Assign** the next green light to the phase with maximum density;
7. **Return**

IV. RESULTS & ANALYSIS

The results and analysis of a rescheduling algorithm for traffic lights would typically involve assessing its effectiveness in improving traffic flow, reducing congestion, minimizing delays, and enhancing overall road safety.

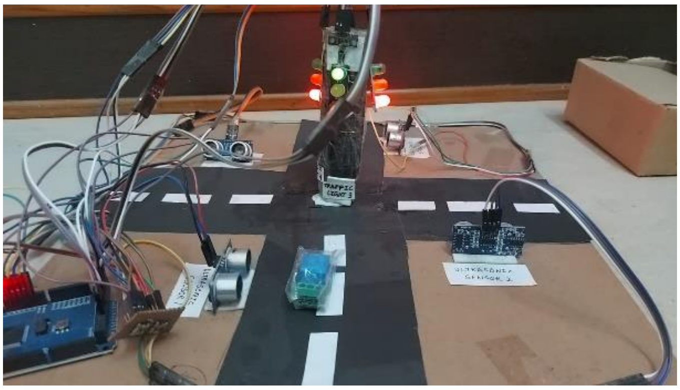

Figure 3: Representation of Actual Experiment – Sensor 1 turning Green.

```
S1: 36   S2: 2   S3: 71   S4: 17
S1: 36   S2: 2   S3: 72   S4: 17
S1: 36   S2: 2   S3: 71   S4: 17
S1: 36   S2: 2   S3: 71   S4: 17
S1: 36   S2: 2   S3: 71   S4: 17
S1: 36   S2: 2   S3: 71   S4: 17
S1: 36   S2: 2   S3: 72   S4: 17
S1: 37   S2: 2   S3: 71   S4: 17
S1: 38   S2: 2   S3: 71   S4: 17
2
S1: 38   S2: 2   S3: 71   S4: 17
S1: 38   S2: 2   S3: 71   S4: 17
S1: 37   S2: 2   S3: 72   S4: 17
S1: 37   S2: 2   S3: 71   S4: 17
S1: 36   S2: 2   S3: 72   S4: 17
```

Figure 4: Distance Recorded in Sensors – 2.

Where S1, S2, S3 and S4 are the data coming from the ultrasonic sensors.

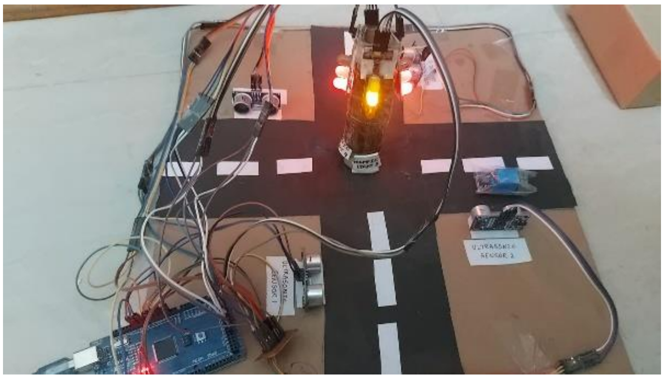

Figure 5: Representation of the Actual Experiment - Sensor 2 turning Yellow.

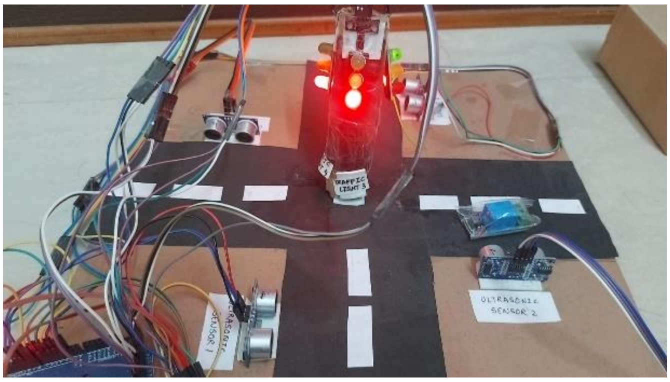

Figure 6: Representation of Actual Experiment – Sensor 2 turning Green.

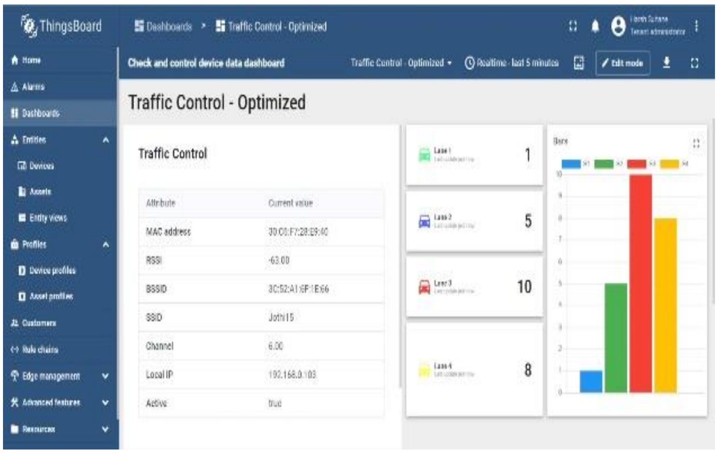

Figure 7: Cloud implementation result of the data coming from ultrasonic sensors.

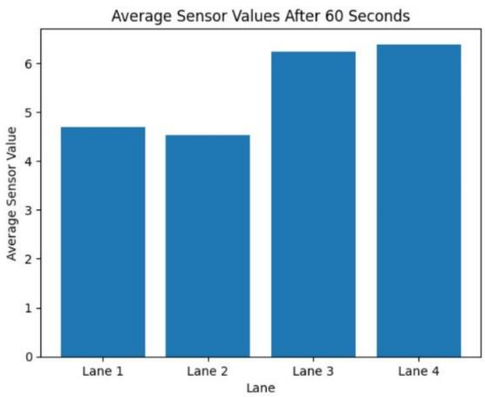

Figure 8: Average Sensor Value after 60 seconds.

```
Data sent successfully: {'S1': 2, 'S2': 10, 'S3': 7, 'S4': 10}
Data sent successfully: {'S1': 5, 'S2': 6, 'S3': 10, 'S4': 8}
Data sent successfully: {'S1': 8, 'S2': 5, 'S3': 6, 'S4': 6}
Data sent successfully: {'S1': 3, 'S2': 3, 'S3': 9, 'S4': 10}
Data sent successfully: {'S1': 3, 'S2': 6, 'S3': 5, 'S4': 2}
Data sent successfully: {'S1': 8, 'S2': 2, 'S3': 2, 'S4': 10}
Data sent successfully: {'S1': 5, 'S2': 7, 'S3': 3, 'S4': 4}
Data sent successfully: {'S1': 3, 'S2': 2, 'S3': 10, 'S4': 5}
Data sent successfully: {'S1': 3, 'S2': 2, 'S3': 6, 'S4': 5}
Data sent successfully: {'S1': 6, 'S2': 4, 'S3': 9, 'S4': 8}
Data sent successfully: {'S1': 2, 'S2': 2, 'S3': 9, 'S4': 2}
Data sent successfully: {'S1': 7, 'S2': 8, 'S3': 3, 'S4': 5}
Data sent successfully: {'S1': 6, 'S2': 2, 'S3': 2, 'S4': 8}
Average Sensor Values:
Lane 1: 4.6923076923076925
Lane 2: 4.538461538461538
Lane 3: 6.230769230769231
Lane 4: 6.384615384615385
```

Figure 9: Data sending to the cloud the lane having minimum sensor value will be given 1st priority in this case lane 2 will be give 1st priority.

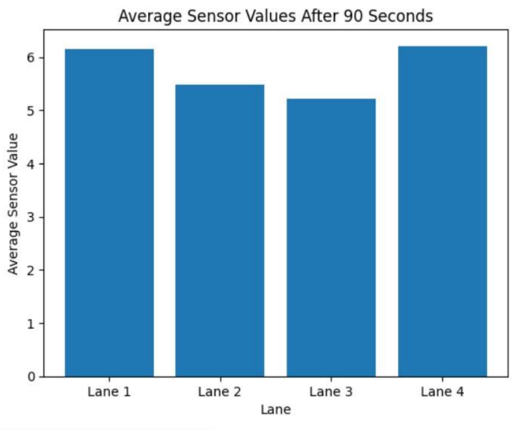

Figure 10: Average Sensor value after 90 seconds in this case lane 3 will be given 1st priority.

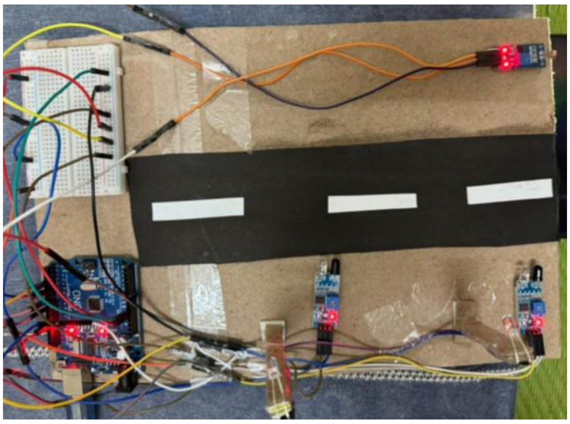

Figure 11: Intelligent Energy Efficient Street Light

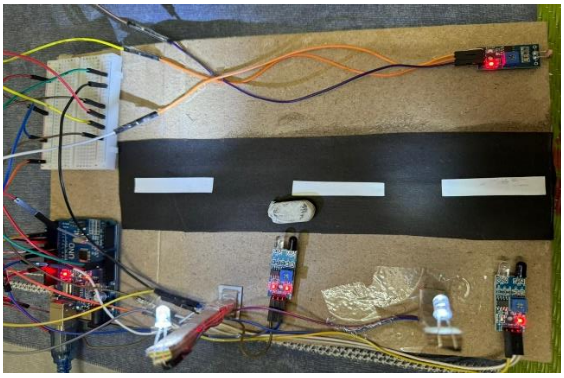

Figure 12: Intensity of light increases when vehicle come Infront of it.

V. CONCLUSION

In conclusion, the integration of a rescheduling algorithm for traffic lights using the Internet of Things (IoT) represents a significant stride towards revolutionizing urban traffic management. The proposed system, designed to dynamically adapt signal timings based on real-time data, demonstrates substantial potential for addressing the limitations of traditional static signal control systems. The utilization of IoT sensors strategically placed at intersections facilitates the continuous collection of data on traffic patterns, vehicle types, and environmental conditions. The sophisticated rescheduling algorithm, driven by advanced analytics and machine learning, enables the system to make informed decisions, optimizing traffic flow and reducing congestion.

VI. FUTURE SCOPE

The future trajectory of rescheduling algorithms for traffic lights, leveraging the Internet of Things (IoT), promises to be dynamic and transformative, driven by advancements, scalability, and integration with emerging technologies. Anticipated developments include a deeper infusion of advanced machine learning techniques into rescheduling algorithms, enabling predictive analytics and enhanced adaptability to evolving urban dynamics.

VII. REFERENCES

[1] S. Hossain and F. Shabnam, "A Comparative Study of IoT Based Smart Traffic Management System," 2021 IEEE International Women in Engineering (WIE) Conference on Electrical and Computer Engineering (WIECON-ECE), Dhaka, Bangladesh.

[2] O. Avatefipour and F. Sadry, "Traffic Management System Using IoT Technology - A Comparative Review," 2018 IEEE International Conference on Electro/Information Technology (EIT), Rochester.

[3] V. Bali, S. Mathur, V. Sharma and D. Gaur, "Smart Traffic Management System using IoT Enabled Technology," 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), Greater Noida, India.

[4] S, Shashank & P, Kiran & D, Nischay & M, Vinay & B R, Vatsala & Raj, (2021). IOT Based Traffic Management System. International Journal of Scientific Research in Computer Science, Engineering and Information Technology.

[5] S. Singh, B. Singh, Ramandeep, B. Singh and A. Das, "Automatic Vehicle Counting for IoT based Smart Traffic Management System for Indian urban Settings," 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU), Ghaziabad, India.

[6] A. Farahdel, S. S. Vedaei and K. Wahid, "An IoT Based Traffic Management System Using Drone and AI," 2022 14th International Conference on Computational Intelligence and Communication Networks (CICN), Al-Khobar, Saudi Arabia.

[7] M. K. M. Rabby, M. M. Islam and S. M. Imon, "A Review of IoT Application in a Smart Traffic Management System," 2019 5th International Conference on Advances in Electrical Engineering (ICAEE), Dhaka.

[8] M. Saifuzzaman, N. N. Moon and F. N. Nur, "IoT based street lighting and traffic management system," 2017 IEEE Region 10 Humanitarian Technology Conference (R10- HTC), Dhaka, Bangladesh.

[9] IoT based Traffic Light Control System, 2020 International Conference on Control, Power, Communication and Computing Technologies (ICCPCCT).

[10] Intelligent Energy Efficient Street Light Controlling System based on IoT for Smart City, 2022 International Conference on Smart Systems and Inventive Technology (ICSSIT).

[11] IOT based Smart Street Lighting System for Smart City, 2021 Chinese Automation Congress (CAC).

[12] [12] Md. Hasibul Islam; Khadija Yeasmin Fariya; Touhidul Islam Talukder; Azmi Aziz Khandoker, "IoT Based Smart Self Power Generating Street Light and Road Safety System Design". 2021 IEEE Region 10 Symposium (TENSYMP).

[13] J.V. Anchitaalagammai; S. Mohamed Alim; C. V. Amris Sarthy; SA Kirithic; A.Shiva Kumar, "IoT Based Automated Street Light Control with Fault Detection and Reporting System". 2023 5th International

Conference on Inventive Research in Computing Applications (ICIRCA).

[14] Shobana S; Shakunthala M; C. Vimala Josphine; M. Theodore Kingslin, “IoT based on Smart Traffic Lights and Streetlight System”, 2023 2nd International Conference on Edge Computing and Applications (ICECAA).

[15] S. Dhanasekaran; P. Gomathi; A. Renaldo Maximus; Thiyagarajan Krishnan; B. Kannan. “Smart City Street Light Control System using IoT BLYNK Platform”. 2022 International Conference on Automation, Computing and Renewable Systems (ICACRS)