STM JOURNALS

International Journal of
Satellite Remote Sensing

Volume 1, Issue 2, 2023
July–December
DOI (Journal): 10.37591/IJSRS

https://journals.stmjournals.com/ijsrs

Research IJSRS

Density Based Traffic Control with Remote Override

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Abstract

With the burgeoning urbanization, the number of people residing in cities has been increasing since the last few decades. That implies an increase in the number of vehicles, which further leads to a calming traffic gridlock menace. Although the traditional traffic control signals are the ideal solution in this scenario, they have not proven effective due to poor time distribution. Typically, the time intervals allocated to each road are equal without considering the extent of vehicles on that road. Consequently, drivers are forced to wait a bit longer than needed. Therefore, our innovation is density-based traffic control. Thus, this system is developed to control the road traffic problems based on road density. This is accomplished by using IR sensors in order to find the density and utilizing this information, the signal timings are adjusted. Urbanization has been burgeoning these last few decades, and the number of people residing in cities has likewise expanded in tandem. More people imply more cars in which they can travel, which leads to traffic gridlock calming hazard. Traditional traffic control signals are the ideal solution in this scenario, but maintaining them has not proven effective because of time distribution. The time allocated to each of the road is traditionally allocated equally without analysing how many vehicles are on the broadcast. It forces drivers to stop more than necessary. Therefore, our innovation this time is density-based traffic control. Therefore, the system is developed to control the road traffic issues based on road density.

Keywords: Density-based-traffic, IR-sensors, RF-transmitter, receiver, emergency-vehicles

INTRODUCTION

Traffic Congestion and the Need for Traffic Control

Although transportation has always been an essential component of human civilization, the problem of traffic congestion did not emerge until the latter half of the 20th century. In the worst (and far more common) scenario, traffic congestion causes a reduction in the throughput of the available infrastructure, which in turn causes an acceleration of the congestion increase, which in turn causes greater degradation of the infrastructure, and so on.

Increased environmental pollution, longer delays, and decreased safety are the outcomes of traffic congestion. The European Commission's "White Paper—European Transport Policy for 2010" has the following noteworthy statement:

There is a significant chance that traffic will make Europe less economically competitive. According to the most recent research on the topic, the external costs of traffic congestion on the roads alone account for 0.5% of the GDP of the community.

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Received Date: April 15, 2024
Accepted Date: April 20, 2024
Published Date: April 30, 2024

Citation: Prakash Kumar Chaudhary, Ritik Sharma, Yuvraj Kumar Jha, S.D. Lokhande, S.S. Lokhande. Density Based Traffic Control with Remote Override. International Journal of Satellite Remote Sensing. 2023; 1(2): 22–27p.

Road congestion is expected to worsen dramatically by 2010 if nothing is done, according to traffic estimates for the next ten years [1].

Additionally, the expenditures associated with congestion will rise by 142% to 80 billion year, or roughly 1% of the Community GDP [2, 3].

New needs for innovation in the transportation sector have arisen as a result of traffic (i.e., a large number of interacting vehicles sharing a shared infrastructure) and traffic congestion (i.e., demand momentarily exceeding infrastructure capacity). The increasing importance of environmental concerns, the energy crisis of the 1970s, and the finite amount of physical and financial resources are some of the main reasons why a brute force approach—that is, constantly expanding the amount of transportation infrastructure that is available—cannot be the only solution to the ever-increasing transportation and mobility needs of contemporary societies. The effective, secure, and less polluting movement of people and products requires the best possible use of the infrastructure that is already in place through the appropriate implementation of a range of traffic management systems The speed at which communications and computing (telematics) have advanced has made this trend possible, but it is also clear that the effectiveness and applicability of the control approaches being used directly affect traffic control efficiency. An overview of advanced traffic control techniques is given in this study for three specific domains: route guidance and information systems, urban road networks, and highway networks [4, 6].

has taken center stage as a result of the sharp rise in both the quantity of cars and the demand for transportation across almost all modalities. When too many cars try to use a shared transportation system that isn't built to capacity, traffic congestion results. In the optimal scenario, when the infrastructure capacity (also known as "the server") is being completely utilized, traffic congestion causes queueing phenomenon (and related delays) [5].

The Control Loop

Traffic congestion presents a severe issue to urban cities, worsened by the rapidly increasing number of vehicles and insufficient infrastructure growth. Furthermore, it is not merely a minor annoyance for drivers, but a severe impediment to overcome to function effectively. Indeed, in particular cases, such as when it is necessary to quickly and effectively reach a hospital or obtain assistance in an emergency, the timely arrival of an automobile can be a question of life and death. The manual controls of traffic flow, which was initially done by police officers, remained an optimal option until the city became so big that such an approach became extremely ineffective [7]. The Control Loop is shown in Figure 1.

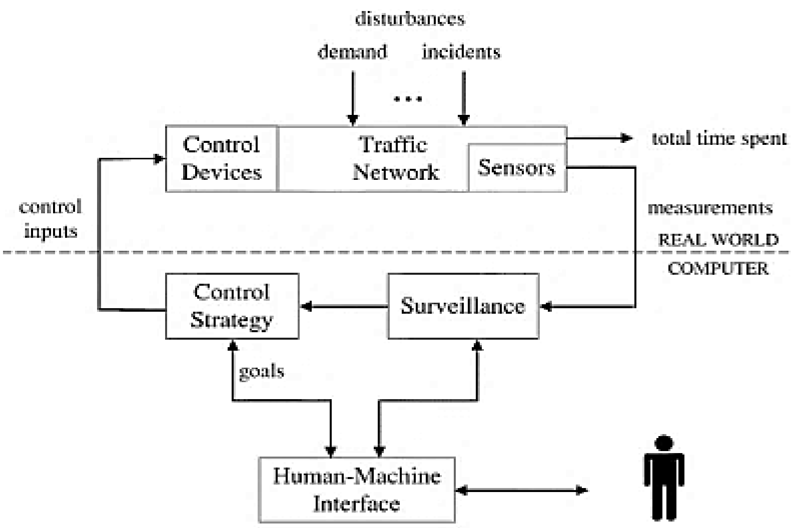

Figure 1. The control loop.

The conventional traffic light system was developed as a result of such necessity. Nevertheless, regardless of their status, they are still insufficient for managing the flow of traffic through the city. One of the specific sites can receive more cars, while others may stay nearly clear. Therefore, the current project aims to address the outlined concern.

The system can monitor the traffic density at different places, allowing it to change the traffic light cycle to minimize time wasted in traffic and properly manage the traffic. Moreover, the project would have signal overrides through RF communication Ang20. In case of an emergency such as an ambulance or fire brigade being stuck in traffic, the control system can override the standard signal to allow the priority vehicles to pass for some time before it resets and the usual cycle resumes. This will allow the emergency vehicles to move without much delay, saving time and potentially some lives [8–10].

Overall, this project seeks to implement a comprehensive solution to alleviate traffic congestion and improve emergency response times in urban areas, enhancing overall safety and efficiency on the roads.

OVERVIEW

Each lane has three zones for IR sensors: low, medium, and high, as shown in Figure 2 below. As a vehicle passes in between the zone created by IR transmitter and receiver, the sensors are triggered, which feed the signal to the junction controller. The system contains thousands of signal timings, and as vehicles congest in one of the lanes, the signal timings are immediately modified to avoid any hang of vehicles that leads to unnecessary delays. The traffic junction modes are three as described:

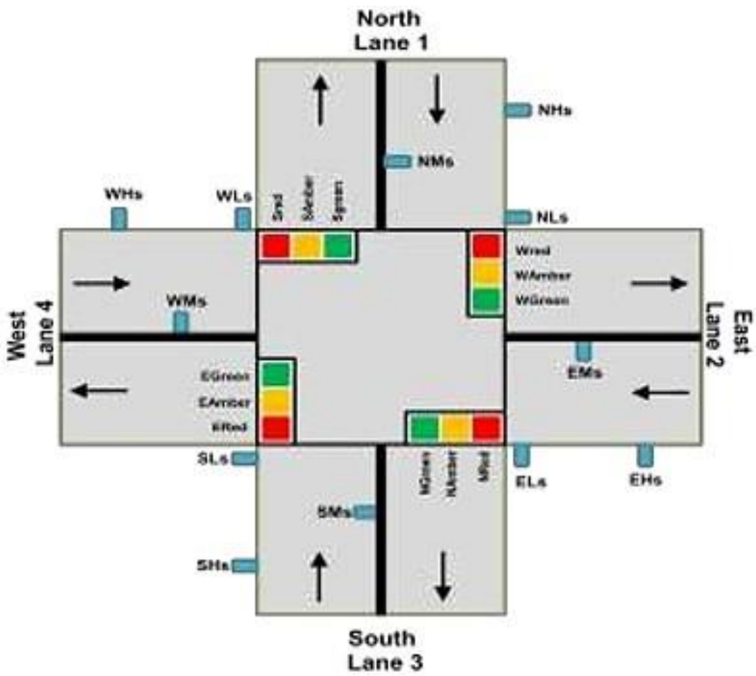

Figure 2. Represent-of-signal-junction.

- *Normal mode:* As the term implies, in this mode, the traffic signal lights change based on a normal fixed period, acting like the conventional traffic signals. It is used when the vehicle density in all lanes are almost the same at the junction.
- *Density mode:* Density mode operates the traffic signals depending on the actual vehicle density at the junction. It is used when the vehicle density at the junction, for instance, is entirely different between two lanes.
- *Override mode:* It allows the emergency vehicles the priority passage by skipping the normal traffic signal sequence. They take out the vehicles immediately, which play essential roles.

METHODOLOGY

Using IR sensors interfaced with Arduino Mega board, we measure traffic density. In each crossroad, three IR sensors are installed to sense low, medium, and high traffic density. If low sensor triggered, green signal is given to that lane, else skipped if medium or high alone. When all are triggered, a maximum time interval of the green signal is given. If low, normal, and high occurred, it is allocated for 10, 15, and 20 seconds, respectively. Arduino Nano, a GPS module called SKG13BL, and an RF transmitter are used in emergency vehicles. In the receiver side, a GPS receiver is connected with Mega. This receiver is used to receiving GPS coordinates and which is connected to the Arduino Mega.

The emergency mode takes precedence over the normal traffic signal sequence. As a result, emergency mode gives green light to the approaching lane for 25 seconds. The order of priority, in this case, is North, East, South, and West. The ambulances get prioritized as they get into the lane depending on the activation of the RF communication. System initialization includes the power supply, traffic lights, IR sensors, and RF communication. If an emergency occurs, the emergency mode program is loaded, but if there is no urgency, normal operation or density mode based on traffic load is loaded. The system continues the process of looping until the reset button gets pressed.Block Diagram of Proposed system is shown in Figure 3.

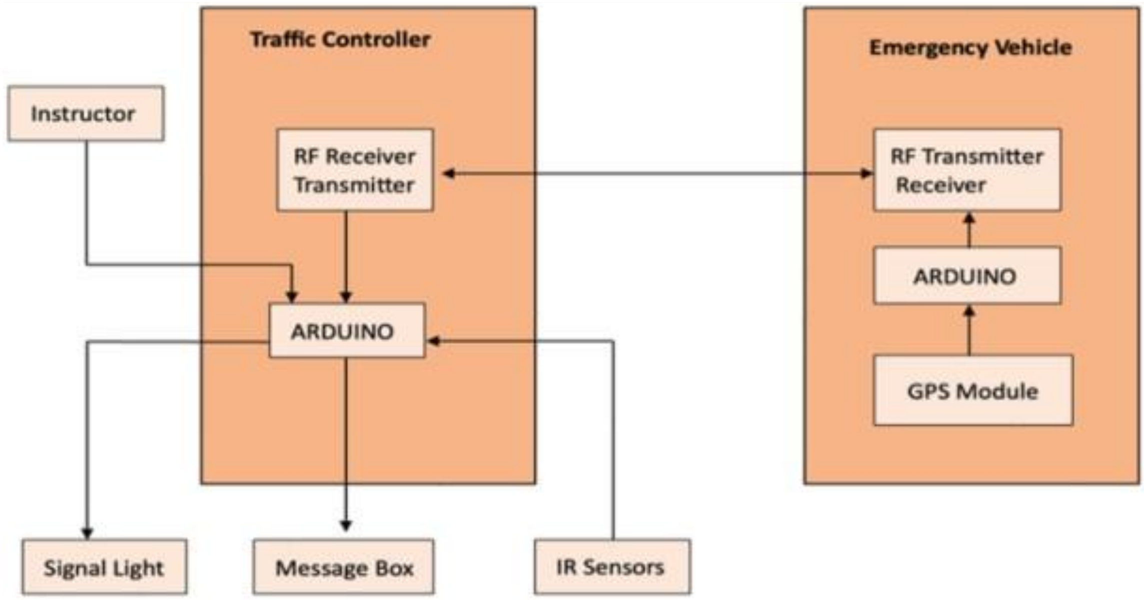

Figure 3. Block-diagram.

LITERATURE REVIEW

Various works associated with chosen study has been investigated and their work is also shown in Table 1.

Table 1. Studies investigated and reviewed.

Title	Author	Publication Year	Methodology
"Density-Based Remote Override Traffic Control System"	Varshney et al. [2]	2022	The methodology involves implementing a density-based traffic control system using IR sensors and microcontroller technology, with emergency override capabilities, to optimize signal timings and alleviate traffic congestion.
"Smart Vehicle Tracking System using	Tummanapally, Shraddha Shree and Sunkari, Saideep [11]	2021	The methodology involves integrating Arduino UNO with GPS and GSM

GPS and GSM Technologies"			modules to develop a vehicle tracking system capable of real-time location monitoring and SMS communication.
"A Brief Review on Internet of Things (IoT)"	Gannavaram V, T. K., Kandhikonda, U. M., Bejgam, R., Keshipeddi, S. B., & Sunkari [12]	2021	The methodology involves conducting a comprehensive literature review to gather information on the evolution, technology intervention, applications, advantages, and disadvantages of IoT, supplemented by qualitative analysis for synthesis and coherence.

CONCLUSION

The emergency vehicle's GPS module becomes powered up to more accurately determine the position of the vehicle. This process is called trilateration, based on which the GPS calculates an object's position by measuring its distance to three known points. In this case, the known points are the satellites revolving around the earth. While the emergency vehicle moves, the GPS keeps rectifying its position to provide fresh latitude and longitude coordinates. The new coordinates are compared to the previous coordinates to identify the direction of the vehicle's movement. This comparison is what gives you the movement direction. If, for example, then that would mean that the vehicle is moving from the position corresponding to the South-West orientation to the one corresponding to the North-East orientation. As already noted, the same approach can be used to deduce other forms of orientation from different possible combinations of positive and negative values. Once again, this information is crucial for the traffic system to be able to adjust to the priority lanes as needed, allowing the emergency vehicle to swiftly pass through the junction with the minimal delay. If the system knows in which direction the emergency vehicle is likely to come from, then it can pre-adjust the timers, meaning that no extra delay is likely to occur, making the response significantly faster.

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