Traffic Density Management using Movable Divider and RFID

Gangadhar Immadi[1], Amina Anwar Puthiyaveettil[2], Ramakanth A[3], Samya Mannuru[4] Thakur Surya Kumari[5]

[1]Sr. Assistant Professor, Department of Information Science, New Horizon College of Engineering, Bangalore, Karnataka, India

[2,3,4,5] Student, Department of Information Science, New Horizon College of Engineering, Bangalore, Karnataka, India

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Abstract - *In majority of the cities, with the ongoing population increase, we see that there are cities with dense traffic flowing mainly in one direction be it in the morning or in the evening. During peak hours, usually one of the roads is scarcely used, thus leading to heavy traffic congestion on one side of the lane. A movable divider i.e. an automated road divider which moves or adjusts the lanes can redirect the rush and ease the congestion. It adds one more lane on either side depending on the traffic in that particular direction. This also helps the emergency vehicles navigate easier through the traffic. Our proposed system is implemented using an embedded technology to avoid such traffic congestion by monitoring, controlling and operating a dynamic system to ease the congestion.*

Key Words: *Automated Road Divider, Traffic Congestion, Internet of Things (IoT), Radio Frequency Identification (RFID).*

1. INTRODUCTION

In the recent years, with the constant increasing rate of population, development and industrialization in cities around the world, simultaneously a rapid increase in the number of automobiles can also be seen on the roads. Despite the increase in the number of vehicles on the road, the infrastructure remains static and this in turn makes it difficult to handle situations like road accidents, emergency vehicles, and unanticipated delays that can seriously impact the traffic flow and enable traffic violations. The congestion in traffic paves an adverse effect on the flow of traffic which also leads to chaotic circumstances, sound pollution, air pollution and consumption of excess fuel. Thus it is vital to analyses the intensity of the traffic congestion in order to determine an optimal solution and find appropriate measures to tackle it.

Traffic signals play a crucial role in traffic management. The traffic light signals are the devices responsible for controlling the flow of traffic but generally, the traffic signals are programmed for a certain time period.

This holds an unfair advantage across the different lanes having different densities of traffic and does so without prioritizing any emergency vehicles.

Ergo, the implementation of a movable divider to favor the lanes with a higher flow of traffic is fitting and an RFID system can grant the emergency vehicles the right of way.

2. RELATED WORKS

Here [1], the issue of road traffic is being discussed and its adverse effects on ambulances.

The traffic becomes an inconvenience and even a life threatening issue for ambulances carrying emergency patients. Ambulances not only get stuck in traffic but also have to wait for the vehicles surrounding it to pave a way for it to pass. Thus, the ambulance arrives at the hospital with much delay which then sometimes puts the patient in a critical situation.In this paper, embedded technologies are used to combat this issue by controlling the traffic signal automatically. Whenever an ambulance approaches, the red signal automatically turns green. The ambulances are recognized by utilizing RFID technology. Alongside maintaining priority for ambulances during traffic, this project also focuses on monitoring the patients' health while in the ambulance and providing a two-way communication with the doctor in the hospital. As he ambulance reaches the hospital, it is once again recognized and the hospital gates are automatically opened.

In [2], the fundamental point of the author is the diminishing of traffic blockage in our everyday life. Here the author points out the disadvantage in having a static divider as the quantity of paths on either side of the street is fixed. Here an optimal solution is proposed where better usage of existing assets like number of paths accessible can be implemented. Instead of utilizing one divider and moving it mechanically, the author utilizes two dividers; typical and expanded dividers. In this paper we place the ultrasonic sensor to the other side of the street to identify whether there is a congestion, in the event that there is a block, at that point the expanded divider raises up and typical divider is set to ground level, else the typical divider is raised up and expanded divider is set to ground level. Furthermore, on the off chance that there is a block, a message is sent to the close by traffic control police expressing that traffic blockage has occurred. So, this simple method eliminates the need for heavy machines as well as controls traffic.

The [3] paper has briefly explained how road dividers are under-utilized and how this affects the various timings in urban cities. To avoid manual motion, they used the concept of IOT to check the smoothness of the traffic on both the lanes and hence the divider is moved a certain distance towards the smoother lane so as to reduce the traffic on the busy lane. This project based on IOT helps save fuel as well as time which are beneficial. So this smart traffic control is implemented.

The paper [4] tells about the traffic problems that can be avoided in highly dense areas like shopping malls or industrial areas and also during peak hours like the morning or the evening. This can be rectified using IOT to deploy the movable road divider. The issues such as traffic congestion and jams can be rectified using an automated mobile street divider instead of protocols like manual traffic coordinator or manual mediation.

3. PROPOSED SYSTEM

This project is employed to eliminate traffic congestion and chaos in the traffic system as well as paves way for emergency vehicles with a dynamic technique. From recent surveys and social analytics, it is known the most compromised is that of the Indian traffic system. Our proposed project targets to revise this issue. The focal point of this project is introducing and implementing a dynamic divider. By estimating the intensity of the traffic congestion, the divider moves to extend the lane on the side with the denser traffic.

The movable divider is a key module of this project. In urban cities, the traffic density is majorly on one side of the road during the day and the opposite side of the road in the evening due to the timings of companies. The instructions received from the Arduino Uno microcontroller impacts the movement of the movable divider. The ratio of the two lanes is determined by the Arduino Uno microcontroller and the divider is activated to move.

Let us take an example here where during the day 75 vehicles move on one lane (Lane A) and 25 vehicles are moving on the opposite lane (Lane B).
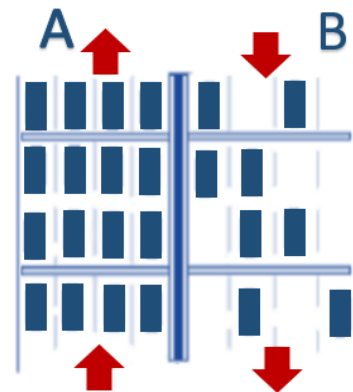

Fig -1: High traffic density in one direction.

This creates traffic congestion and delay. This traffic density, calculated by the IR sensors and the Arduino Uno microcontroller determines the movement of the movable traffic divider. The ratio of Lane A and Lane B is 3:1. Hence the divider needs to move 25% towards Lane B. This reduces the traffic congestion in Lane A. After the movement of the movable divider, Lane A occupies 75% of the entire stretch (lane size expanded) and Lane B occupies 25% of the road (lane size reduced).
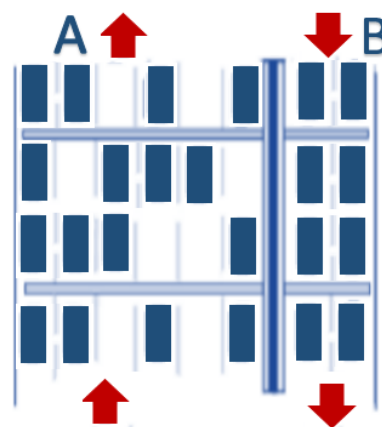

Fig -2: Adjusted lanes to balance traffic density on both directions

The proposed methodologies are implemented in this project around the data that is received from the sensors fitted alongside of the road, then the data is gathered regarding the standing of every vehicle by utilizing the IR transceivers and conveys this to microcontroller. This data is then computed to determine the density of the traffic at that given time. When the density reaches beyond the pre-set threshold, the microcontrollers perform the forward and reverse movements of the actuators using an H bridge, this operates the divider.

In addition to this, an RFID reader will also be equipped at a reasonable distance which can read the RFID tag of the emergency vehicle prior to its arrival at the traffic signal. This allows time for the divider to move and create a lane for the ambulance. The RFID reader also forwards input to the microcontroller in order to operate the divider.

4. MATERIALS

4.1 IR Sensor

The significant part of this project is to determine the density of the traffic on each side of the lane. We make use of IR Sensors for the same. Infrared Technology inscribes a wide range of wireless applications. The main areas are detection/sensing and remote controls. The basic functionality of an Infrared sensor is the emission and/or detection of infrared radiation to sense its surrounding objects. The infrared signal bounces from the surface of an object and the signal is received at the infrared receiver. The operating of any Infrared detector is ruled by 3 laws: Planck's Radiation law, Stephen - Ludwig Boltzmann law and Wien's Displacement law.

Infrared sensors can be active or passive. We make use of active infrared sensors which consist of two elements: IR source and IR detector. The energy effused by the infrared source is reflected by an object back to the infrared detector.

In our project, the IR sensor emits its energy and the energy is reflected back by the vehicle in front of it. The IR sensors are placed on the pavements on either side of the lanes. We place multiple IR sensors in the entire stretch of the road to calculate the density of the traffic in its lane. Starting from the first IR sensor placed, we check all the IR sensors that are active. This gives us the density of the traffic on the road. The IR sensors send information back if a vehicle is obstructing them, thus increasing the traffic density. The number of IR sensors activated by the stable traffic result in the increase of the traffic density. Similarly, the density is calculated on both the lanes and this information is sent to the Arduino Uno microcontroller. The numbers of IR sensors also determine the accuracy of the traffic on the respective lane.
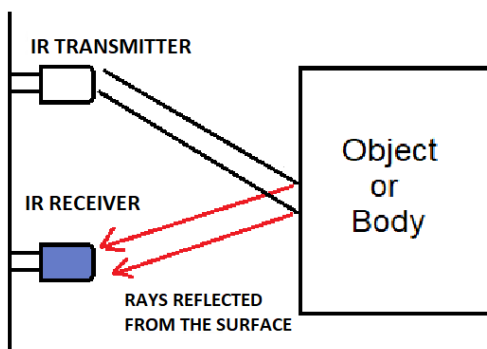

Fig -3: Working of an IR sensor

4.2 RFID Reader and Tag

RFID or "Radio Frequency Identification" is a technology that works by reading digital data that is encoded in RFID tags through a reader via radio waves. RFID serves a purpose that is similar to that of a bar code where data from a label or tag is captured by the device and then is stored in the database. RFID is classed as a group of technology that is referred to as Automatic Identification and Data Capture (AIDC).

An RFID tag contains an integrated circuit as well as an antenna. The integrated circuit is responsible storage and processing of data whiles the antenna responsible for the transmission and receiving of signals. RFID tags also contain a non-volatile memory storage which usually includes a programmable or fixed logic for transmission and to sensor the data. The types of tags are: passive, active and battery-assistive passive.

The tag emits radio waves which is detected by the receiver and is then converted to a more usable form of data. This data collected from the tag is then transferred via a communications interface into a host computer system where the data can be stored and then analyzed later.

As our project also prioritizes and facilitates a way for emergency vehicles, it is important to detect an incoming emergency vehicle ahead of time. We will equip the emergency vehicles with and RFID tag. An RFID reader present at a significant distance will detect any incoming emergency vehicle ahead of time; this allows time for the divider to pave a lane for the vehicle in the case of high traffic density.

The RFID reader picks up the signal of any RFID tag approaching and transfers this data to the Arduino Uno microcontroller. Subsequently, this data is analyzed and if it recognized as data of an emergency vehicle then the data collected from the IR sensors are also analyzed. In the case that the density is above the threshold, then a signal is sent from the microcontroller to perform the necessary operation. Then a row of LEDs present along the pavement emits a red light to alert the traffic to stay towards the pavement and away from the divider so that an emergency vehicle approaching can pass through and/or the divider is moved to create a lane for the emergency vehicle.

4.3 Arduino Uno

Arduino Uno is a microcontroller that is open-sourced that is based on Microchip ATmega328P microcontroller chipset developed by Arduino. The board is supplied with sets of digital and analogue input/output (I/O) pins which will be interfaced to numerous enlargement boards (shields) and different circuits. The board has fourteen (14) digital I/O pins, six (6) analogue I/O pins, and is programmable with the Arduino IDE, via a type - B USB cable or a type – A USB

cable or an external 9-volt battery (regular voltage acceptance - voltages between 7 and 20 volts).

The Uno board is that the initial during a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, that have currently evolved to newer releases. The ATmega328 comes pre-programmed with a bootloader that makes uploading new code onto it easy without making use of an external hardware program.

The Arduino Uno includes a variety of facilities for human activity with a laptop, another Arduino Uno board, or different microcontrollers. The 16U2 computer code uses the quality USB COM drivers, and no external driver is required.

The IR sensors and the RFID sensors send the information regarding the traffic density and the emergency vehicles approaching respectively. The Arduino Uno microcontroller analyses the information and sends the necessary movement ratio to the actuator arm (motor) and the divider moves depending on the code written in the Chipset.

4.4 Actuator

As the key aim of our project is to induce a physical moving divider, the focus is on the movement of this divider. The collected data can be used as a trigger to operate the actuator mechanism. This is a scenario where the data is the activator of a given data pattern to produce an event. Actuators transform electrical signals into a corresponding physical action such as a movement or force. An actuator can also be categorized as a transducer since it changes one type of physical quantity into another type of quantity and is mostly activated or commanded by a low voltage signal. Actuators can be categorized as either a binary or continuous device which is based on the number of stable states their output possess as well as based on energy sources.

As our project deals with a movable divider, we only need to operate it in a linear motion that is forward and reverse. The actuator most apt and fits within these criteria is the linear actuator arm. A linear actuator is one that produces motions in a straight line as opposed to the usual circular motions of the traditional electric motors. The trigger data is fed into the controller via the IR sensors and in the case that this data exceeds the threshold, the Arduino Uno microcontroller then proceeds to send a signal to the actuators. Then accordingly, the actuators begin to move forward or reverse in order to extend or retract a lane as per the traffic density. Thus, the actuator plays a vital role is controlling the physical aspect of the project.

5. RESULTS AND DISCUSSION

Upon integration of all the modules, the resulted structure works towards reducing the chances of traffic jams and provides clearance of road vehicles. We have designed and developed a demonstration and working of our project. But as this is only a prototype, there is space for improvement when it is implemented as a product type.

Advantages:

- Roads and lanes are utilized efficiently and the traffic congestions are eliminated.
- Lane discipline is maintained.
- Time taken for commute is optimized and waiting time is reduced.
- Priority is given to emergency vehicles.

The proposed system also has limitations which need to be considered. As the model for production starts development, additional features can be implanted as well. An LCD display alerts the traffic can be fixed at traffic signals. It can also double as a timer to efficiently a lot time for the present vehicles to align them in preparation for an emergency vehicle to pass.

The system can be connected to a cloud as well as satellites; this can estimate the traffic beforehand by collecting data from other junctions and roads. Thus, actions can be taken fully automatically.

6. CONCLUSION

In conclusion, the urban areas with highly dense population create a lot of traffic on the roads which result in congestion and traffic jams. This can be avoided with this project – "Traffic Density Management using Movable Divider and RFID". In this project, we have successfully developed and designed this new dynamic system that overtakes the existing static road divider system that is inefficient in urban cities. We make use of multiple IoT concepts and modules such as Arduino Uno microcontroller to program the code by taking input from the input module via the IR sensors, which measure the traffic density on both the lanes and return the data; and the RFID sensors, which sense any accessible RFID tags and returns the information. The chipset receives this data, processes it and hence commands the LED lights to light up if an emergency vehicle is approaching or if the divider is about to move. The motor driver moves the divider by the instructions received from the Arduino Uno microcontroller whether it is to reduce traffic congestion or to give way to the emergency vehicles.

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