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Smart City Traffic Management

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Abstract

In smart cities, traffic congestion is a significant challenge, leading to delays, hindrance to emergency vehicles, and localized pollution. Contributing factors include a surge in vehicles, inadequate infrastructure, system failures, and limited awareness of traffic signals. Diverse con- gestion identification techniques, such as image processing, laser tracking, and inductive loop systems, exist. However, this model centers on Infrared technology. It employs Infrared to gauge vehicle density, subsequently regulating traffic signals through ESP8266 NodeMCU, with data relayed to a central cloud system. The solution seamlessly integrates with existing models, offering rapid installation. Benefits encompass time savings for motorists, reduced traffic violations, and effective congestion management, furthering emergency vehicle access and abating environmental impact. Challenges involve precision in Infrared-based density assessment, scala- bility testing, sustained maintenance, and collaboration with pertinent authorities. Real-world data and user feedback offer prospects for algorithmic refinement, while historical traffic analysis informs urban planning. Exploring Internet of Things (IoT) integration enhances its potential in reshaping urban traffic control.

1 Introduction

In today's world, one of the biggest challenges we face is traffic congestion. This is due to the high number of vehicles on the roads, the absence of proper infrastructure, and so on. Urbanization and traffic congestion are two of the main reasons why intelligent and intelligent traffic management systems are designed to

save time. With the rapid increase in population, the number of vehicles, and the personal mobility of people all over the world, road infrastructure has become more complex and congested over the last few years. The extreme traffic congestion that has occurred during the peak hours of the day has highlighted the importance of a good traffic management system in preventing accidents, increasing emissions, and loss of time. There is an increase in the number of IoT devices. The Internet of Things (IoT) is a critical and rapidly advancing technology that has enabled efficient monitoring and traffic management through the cloud and a range of machine learning techniques. The reduction of road congestion relies on dependable and effective traffic management.

Currently, the signalized intersection approach lacks the necessary tools to improve traffic man- agement. Proponents of IoT suggested installing a system on the side of the road to collect data on traffic congestion. This data would then be managed by a PIC microcontroller located on a traffic signal that is relevant for emergency services such as ambulance services, allowing the services to be dispatched as required [2].The scientists used a hybrid model to figure out how to make traffic flow on roads smoother, and then created a system to manage different traffic conditions. They used a computer model to estimate how much traffic there would be using cameras and microphones, then changed the traffic signals. They then used an AI algorithm to predict how much traffic would be there when there was a line of cars. They also thought about what would happen if a fire broke out on the highway and used smoke detectors to detect it. They used a design that connected nearby help organizations to a server, as well as making traffic flow smoother, to prove how useful the traffic light control system was. They also found that around 85% of networks were disconnected, meaning they could not exchange data with each other or the cloud.

The term "Internet of things," on the other hand, refers to a system that facilitates connectivity as well as the process of connecting objects online for the purpose of collecting and analyzing the

data. IoT design attempts to make devices autonomous while also allowing them to connect to a web server for the data to be processed. The Internet of things (IoT) which has penetrated every country on earth is primarily a form of active participation. Although most of the junction forecasting models in use today are focused on main roads and city traffic control, extraordinarily little research has been done on concentration roads or confined campuses. For this scenario, the researchers proposed a real-time traffic data collection, processing, and transmission system using the Internet of Things (IoT). The main goal of the system was to make transportation more efficient by spreading traffic info about traffic jams and other unusual traffic events through roadside sending messaging devices. People could get early warnings, which could save them a lot of time, especially during rush hours. The device collects traffic info from the state government.

A huge traffic control system using the IoT, and predictive modeling is also

being proposed. The controller uses infrared sensors to keep an eye on how many cars are on the road and use flow algorithms to keep traffic signals running on time. It also sends the data to the remote network interface through a Wi-Fi subsystem. The idea is that if they find an emergency activity, the system will give drivers priority or a longer signal to cross the road. For example, if a car skips a red light, the technology could detect it and fine them, which they can pay for through a mobile app called the traffic wallet. This system is cheap, easy to set up, and easy to maintain. Traffic lights have been around since 1912 as a signaling tool to control traffic movements at road junctions, crossroads, railway tracks, and other locations. There are three widely accepted colors used in traffic lights: Green, Yellow, and Red. The green light allows traffic to proceed forward in the indicated direction while the yellow light warns drivers to come to a short halt [9]. Due to the lack of adequate infrastructure with sufficient resources to cope with the increasing number of vehicles and road users, partial solutions have been found by building more highways, flyovers, bypass roads, construction of rings, and road rehabilitation. Nowadays, many countries are facing serious traffic congestion problems that affect the city's transportation infrastructure. Optimizing massive traffic jams is still a major challenge, especially with a few junction nodes, after the replacement of traffic officers or signalers by automated traffic systems.

A city can be thought of as a complicated system with many independent subsystems. Traffic is one of the main subsystems. Studies have shown that traffic plays a crucial role in the global economy. It can also be considered as a major dimension of the city. Rapid growth in the world population has resulted in a vast number of vehicles on the roads. This leads to traffic congestion. Not only is traffic congestion a waste of time, but it also leads to crimes like mobile snatching. Long-term traffic jams also lead to air pollution. This has a negative impact on the environment and reduces the efficiency of industries.

There are several traffic management models. One of them is to send a message to the driver about the traffic information and allow him to choose the best way. There are also models for calculating the vehicle density using image processing. However, some project works are focused on RFID tags that read data from the vehicle and maintain the traffic data. Area Traffic Control System (ATCS) is a computer system that keeps track of traffic in a specific area. This system is dynamic and reacts to traffic variations. The implemented system provides the appropriate design and statistics to manage traffic in junctions, crossroads, and narrow lanes in many smart areas. The implemented system helps to avoid traffic congestion on busy roads and eliminates the traffic at traffic lights.

Fig. 1 shows the traffic management block diagram that uses area traffic control system (ATCS) under the name 'Keep going Hong Kong' with the aim of developing intelligent transport system, which can be detected through area traffic control system [12]. Fig.2 shows the flow chart for the signal control operation for the proposed systems. The system minimizes the delay time according

to the arrival time of the vehicles.

2 PROBLEMS AND OBJECTIVES

2.1 Problems

Below is a list of issues that are found in traffic management:

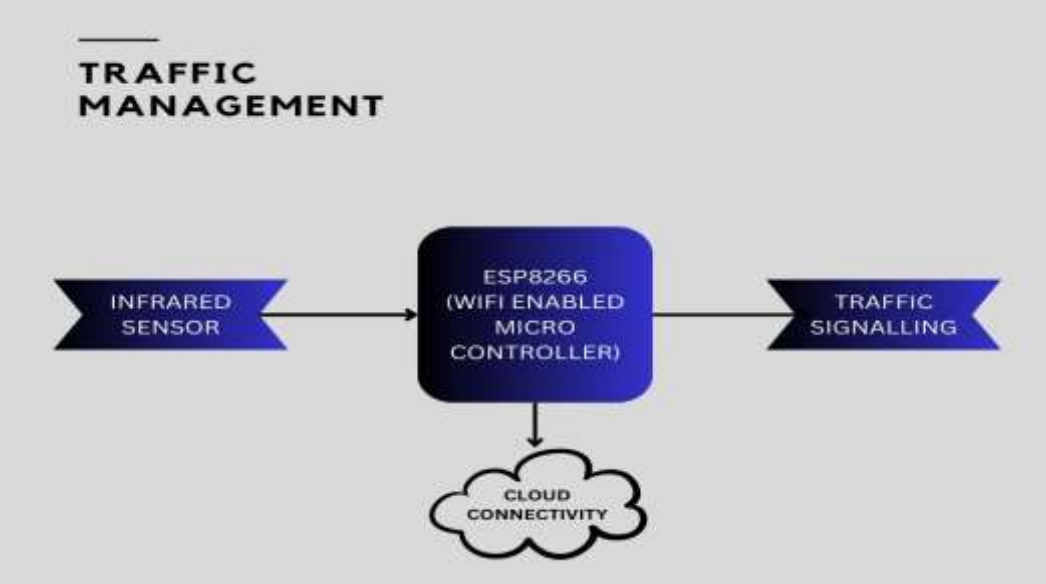

Figure 1: Traffic management block diagram

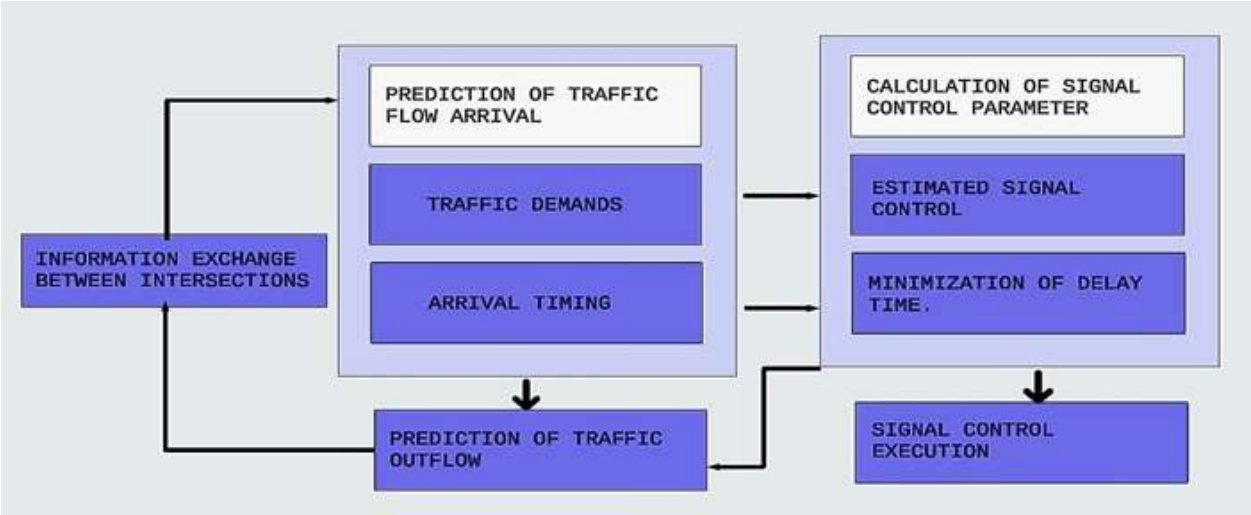

Figure 2: signal controlling flow chart

1. Lack of utilization of the public transport system due to lack of awareness of the bus timings
2. Traffic jams on crossroads and on busy streets during certain festivals and busy hours cause longwaiting times.
3. Giving a long green light on one side of a junction is problematic.

4. Manual control of traffic signals by traffic police is one of the problems.
5. There is no proper traffic management model that can be relied on for a traffic management model.
6. Vehicle parking is an issue.
7. Emergency vehicles such as Ambulances are stuck in traffic jams.

2.2 Objectives

The main goals of smart traffic management are:

1. Improving overall traffic capacity through the integration of the Internet of Things (IoT)
2. Reducing the delay of emergency vehicles
3. Improving the management of parking places
4. Managing traffic signals based on real-time traffic.

3 Existing Methodology

3.1 Image Processing in Light Traffic Control

In this case, image processing is used to control the traffic management system [14]. Instead of electronic sensors, the system will generate images. In addition to the traffic light, there will be a camera mounted to record the vehicles. The image sequences are analyzed using digital image processing to detect vehicles and control the traffic signals. Figure 2 shows the traffic light image processing.

3.2 LASER Tracking Technology

Lasers are used to measure the distance of an object. The distance of a laser is measured by the reflected laser beam. The laser interferometer calculates the distance using the reflected laser beam [15]. The laser system works well in a stable working environment. However, due to atmospheric effects, the accuracy of the laser system is affected. One disadvantage of laser system is that the laser travel in straight line path means that it cannot track multiple objects. However, this method is expensive.

3.3 Inductive Loop

The loop structure is composed of three loops ranging from small to generous size to detect all types of vehicles as shown in Fig. 3. The first loop (loop1) detects small vehicles like bicycles, etc. The second loop (loop2) detects larger vehicles such as buses, trucks, or cars. The third loop (loop3) detects both small and large vehicles as well. When a small vehicle passes through Loop2, there is no meaningful change in the loop inductance. However, when a large vehicle passes through Loop3, there is a meaningful change in the inductance. This may result in missing detection. However, Loop3 provides the relative change induction when both small and large vehicles pass through it.

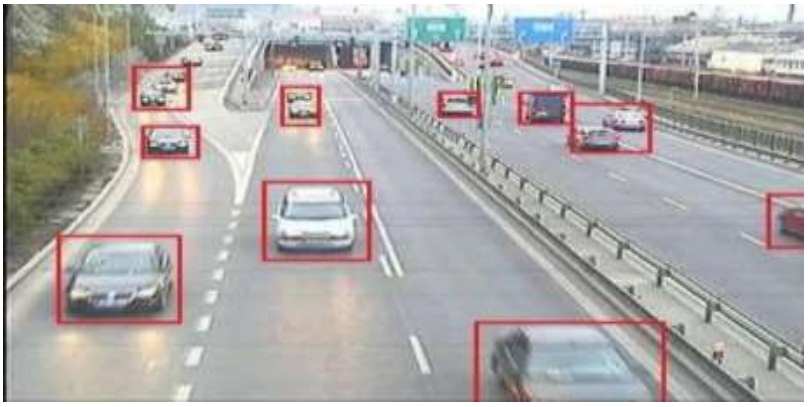

Figure 3: Image Processing in Light Traffic Control

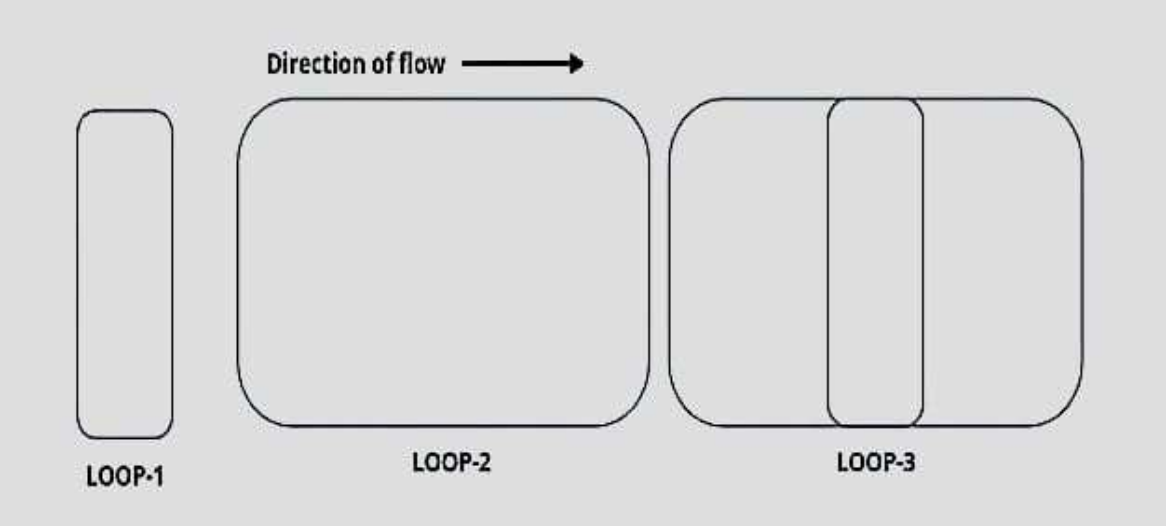

Figure 4: Flow chart

Category	CO2	CO	SO2	PM
Bus	28748.16	207.26	79.24	31.36
Omni Buses	8508.42	60.94	23.45	9.28
2-Wheelers	8701.08	719.64	04.25	16.36
LMV (Passengers)	4378.10	370.29	2.11	14.52
LMV (Goods)	44654.58	442.04	123.02	17.33
Cars and Jeep	23901.22	212.30	5.67	3.22
Taxi	2367.08	10.23	117.05	80
Others	5705.22	57.41	32.19	3.98

Table 1: Emission from different vehicles in India

4 Traffic Statistics

The increase in urban population and the lack of public transport have resulted in an increase in the number of cars on the roads, resulting in extremely elevated levels of air pollution (17-19). The combustion of vehicles produces emissions of carbon dioxide (CO2), SiO2, and nitrous oxide (NO2).

5 CIRCUIT AND WORKING

We designed four road junctions (East, West, North, South) with directions East, west, north, and south. East and west direction roads are considered main roads and north and south direction roads are considered side roads. Side roads usually have less traffic when compared to main roads. To measure traffic density, we installed ultrasonic sonic sensors in all directions as shown below in Figure 5. Ultrasonic sensors are connected via IP network. The proposed system provides range of traffic density Timer values of traffic lights updated based on traffic density View of the system architecture in Figure 4 View of the prototype in Figure 5 Position of Infrared Sensors in Crossroads. Ultrasonic sensors are used to predict traffic flow. The green light on time depends on the traffic density in a specific direction. The traffic density is determined by ultrasonic sensors installed in each direction. The density of vehicles in a specific direction is determined by ultrasonic sensors.

6 APPLICATIONS

6.1 Automatic billing of toll

RFID can also be used in conjunction with an existing system to automatically bill tolls. The RFID sticker is installed on the vehicle, whereas the RFID reader is located at the toll booth [16]. When the reader detects the vehicle, it automatically deducts a specific amount from the vehicle instead of standing in a queue.

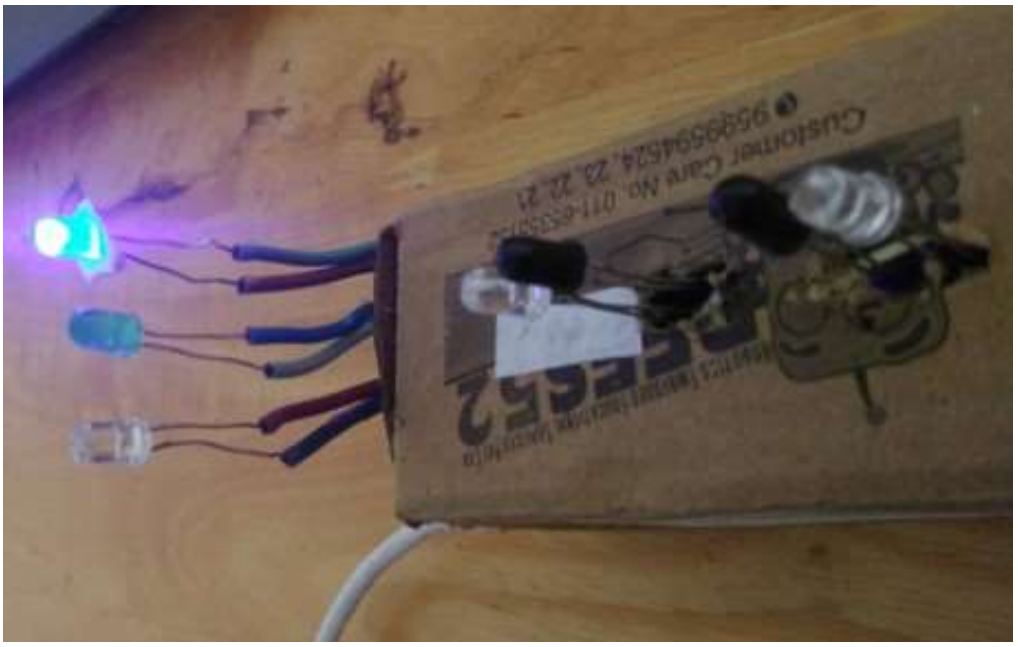

Figure 5: Prototype of proposed system

6.1.1 Speed limit infraction

By integrating RFID technology with this system, any vehicle that exceeds the speed limit will automatically be registered in the database, and an alert will be sent to the nearest traffic police to catch the violator. The fine will then be determined and sent to the violator's address.

6.1.2 C. Identification and governance of Traffic

A standalone server can be used and the collected data from the microcontroller is fed into the database. The primary objective is to calculate round-trip time for each vehicle and determine the rerouting route during congested traffic. Vehicles that violate signalized crossings can be identified.

7 CONCLUSION AND FUTURE SCOPE

The proposed system uses Infrared technology which surpasses the limitations of the current method- ologies. The system is efficient in traffic management and can cope with some challenging environmental- mental conditions.

In addition, this paper discusses the challenges in smart city areas due to traffic

congestion and related issues. One of the reasons for the delay of emergency vehicles is the clogging of traffic. Congestionis a major problem in metropolitan cities.

8 Experimental Aspects

Based on the congestion detected by the output of infrared sensors, the project is implemented, and traffic lights are controlled accordingly. In this case, infrared sensors are used to measure the numberof vehicles and green light is turned on based on the density of vehicles in that direction.

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