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Adaptive / Intelligent Traffic Light Management System Based On Real-Time Traffic Density Data

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ABSTRACT

Traffic congestion is one of the major problems that have arisen in the modern era. To reduce traffic, we use traffic light systems based on a predefined logic or timer, because of this we have to wait until a certain time, even if there are very few vehicles in the lane. We proposed an Adaptive/Intelligent Traffic Light Management System that will work based on real-time traffic data, and it will allocate estimated time by analyzing the congestion to traffic lights in order to manage traffic and reduce congestion. We have proposed 3 real-time methodologies to implement our system that will collect data either from the Google Map API or by detecting vehicles from traffic cameras. The main goal of this study is to reduce urban traffic with a dynamically changing traffic light system based on traffic density. With this system, vehicle waiting times and accidents caused by traffic congestion can be reduced. If the proposed system is used in today's era, we will always save time in every case, and also always achieve positive results.

Key Words : Adaptive System, Google Maps API, Image Processing, Intelligent System, OpenCV, Python, Real Time Data, Traffic Congestion, Traffic Light, Traffic Signal', Vehicles Detection

1. INTRODUCTION

The population of vehicles in the world is growing rapidly. The increase in the number of vehicles on the roads leads to congestion, road blockages, longer travel times and loss of valuable time. Traffic congestion is one of the major issues that have arisen in the modern era.

Congestion often occurs during the peak hours on highways when the people going to work or returning home. The average person spends 30 minutes to 2 hours a day in driving and the most of this time they spent in traffic jams.

However, in order to reduce the traffic, almost every cities used traffic light systems. The traffic light system controls the flow of vehicles at an intersection, pedestrian crossing, or other special places. In today's era, traffic lights cannot control or reduce this traffic by using predetermined logic or timer. In most the cases, traffic police officers adjust these traffic lights manually. This is inappropriate, and city traffic will increase day by day. To avoid this problem, most of the modern countries use automated lane change systems. They will open lanes of traffic where there are many vehicles. However, the cost of developing this type of system is very high.

The proposed solution is expected to avoid or reduce this unnecessary congestion by analyzing real-time traffic data and dynamically changing signal waiting times. In addition, with flexibility of this system, it can be use directly to existing traffic signal systems. In this research, we propose an Adaptive Traffic Light Management System where traffic lights can dynamically change based on traffic density using real-time data. The system will analyze the traffic conditions on the roads and, in accordance with the detected traffic density, it allot duration of time to traffic light.

1.1 PROBLEM STATEMENT

As shown in Fig.1.1, which represents a blueprint of 4 way road that have total 8 lanes with the combination of ups and downs in all 4 directions.

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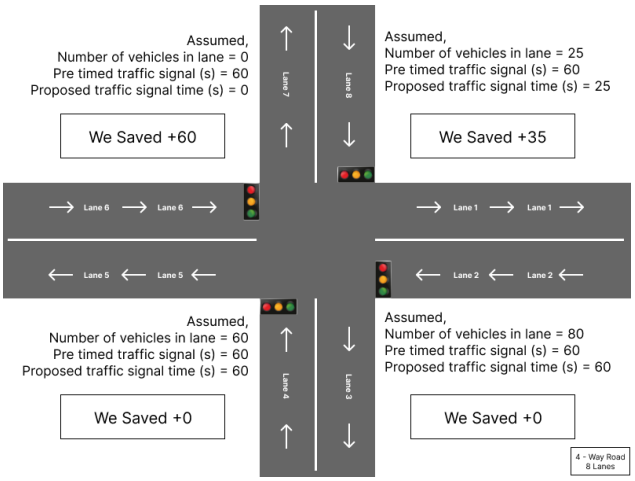

Fig.1.1 Current System

In the current system, the signal time is already predetermined. For example, let's assume 60 seconds time for all lanes and for all cities or areas. To mitigate traffic, constant signal time is not an optimistic solution for all cities or areas. Instead of constant signal time, Currently based on the previous traffic density history in any city/area, the traffic light time is determined for that city/area and controlled by a nearby traffic controller through an authorized person. This will reduce a bit of traffic, but is not an optimal solution.

1.2 PROPOSED SYSTEM

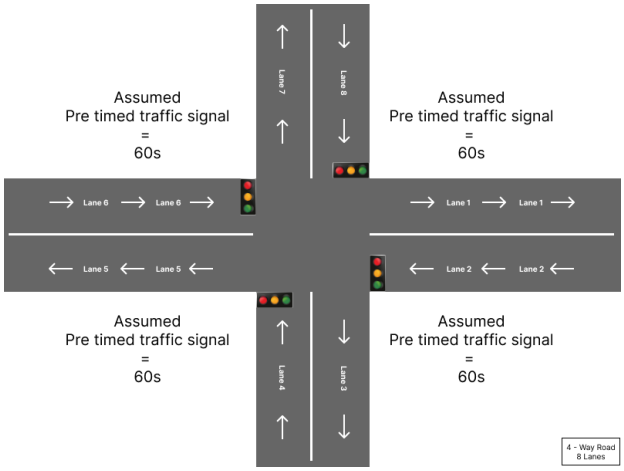

Fig.1.2 Proposed System

The current system works based on past data and manually assigns time to traffic light areas. But in this paper, we are proposing an adaptive traffic light management system that will work based on real-time data and will also automatically assign signal time based on traffic density.

In Fig.1.2, we have shown 4 cases of comparison between the current system and the proposed one.

Let us first consider the best case, suppose the number of vehicles in lane 6 is 0, if we consider the current system, then 60 seconds will be allocated to that traffic light even if there are no vehicles in that lane, but if we consider a proposed one that works with real time data, 0 seconds will be assigned to that signal. So here we save the all 60 seconds and this is much more optimal for mitigating traffic congestion.

Now, let's consider the worst case, suppose the number of vehicles in lane 2 is 80, through current system, 60 seconds will be allocated to that traffic signal, and if proposed one is considered, normally have to allocate 80 seconds, but that will create overhead, that's why we come up with the concept of upper limit, as if we apply a certain limit to the system, so that if the time exceeds the upper limit, we will assign only upper limit time to the signals. So here suppose we have set a limit of 60 seconds, the system will allocate 60 seconds. And we save 0 seconds, and this is equal to the current system.

For the rest of the case, as shown in Fig.1.2, if the number of vehicles in lane 8 is 25, it will save 35 seconds with our proposed system. In general, if we go with the proposed system, we will always save time on every case and obtain positive results.

2. LITERATURE REVIEW

[1] The Proposed Android app was created using Android Studio with Java as a programming language. It is capable of fetching the traffic status directly from google maps, analyzing the traffic status and providing a information to the routes where the traffic is more. The system is supervised by traffic police at every time to keep an eye on emergency cases which cannot be recognized by Google maps like an ambulance passing or a fire brigade truck passing the signal. Thus, also the signal can be changed manually. All the data about the timings of the signal and traffic density is saved on the database

[2] A research project that used the Google Maps API using JavaScript, which gives real-time traffic information about delays due to traffic congestion for a specific route. The API data response will store in the cloud server for traffic congestion analysis. Once analysis is completed, the status of the congestion is sent to the local transport authority. And an authorized person will be able to determine the appropriate time for this signal and change by using the roadside Unit (RSU) through a Wi-Fi module.

Here, they have used some logic software to simulate the proposed model. Successfully demonstrated MISC Algorithm Simulation and SISC Algorithm Simulation for calculating congestion on the server.

[3] The proposed system that uses an image processing algorithm to calculate traffic congestion using CCTV cameras. The proposed algorithm that can also able to analyze with traffic images from low-resolution CCTV cameras feeds. Based on the results of this algorithm, they introduced a traffic congestion protocol that manages traffic signals in a small area and can prevent the area from congestion problem..

[4] A research project called "Automated control of traffic signals for roads" proposed a system based on a fuzzy controller by studying fuzzy logic. In this system, the proposed fuzzy controller will regularly control traffic conditions in order to control traffic lights. A fuzzy based traffic control system is more efficient as compared to the current system for reducing traffic congestion.

3. METHODOLOGY

We are proposing 2 methodologies, as shown in Fig. 3.1, We need real-time data to make our system accurate and adaptive. To do this, we can receive real time data, either from Google map or from Traffic camera.

After receiving data, that will be analyzed, where we will find out the traffic congestion statistics in lane and based on that the system will set the time and control the traffic lights.

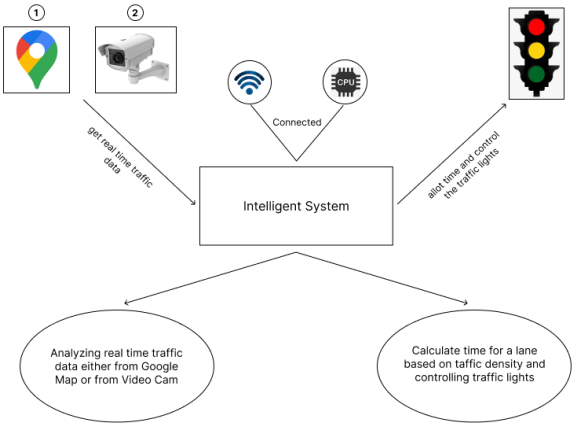

Fig.3.1 Methodology Flow Chart

3.1 Collecting Real Time Data From Google Map API

3.1.1 Using Distance Matrix API

Here We use the Google Map Distance Matrix API, Which can be used to determine the duration between two coordinates with including traffic congestion. With this API, we can estimate the traffic congestion by analyzing API response duration values.

When requesting data, we can specify the traffic_model parameter as best_guess(default) / pessimistic / optimistic. This setting returned the predicted time for traffic based on historical estimates.in duration_in_traffic field in the response.[8]

3.1.2 Using Image Processing on the Google Map Snapshot

Google Maps uses four types of color codes that indicate the speed of traffic on the road.
1. Green – No traffic delays
2. Orange – Medium amount of traffic delays
3. Red – Traffic Delays
4. Dark Red – Slower the speed of traffic on the road, Huge traffic delays.

And Gray or blue lines on the map show your routes.[6]

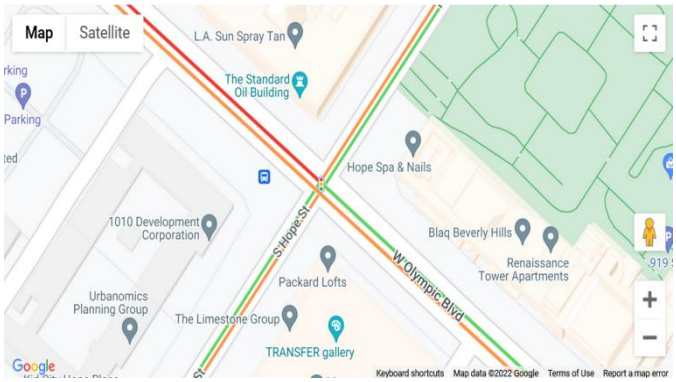

Fig.3.2 Google Map Traffic Color Codes [7]

It shows the traffic conditions of the road in each direction.

In this methodology, We will download a real-time snapshot of a Google map with traffic layers through a Python script that is publicly available on GitHub (link available in the reference materials). After downloading snapshot. we do some image processing on this image,
1. Using Canny edge detection and Hough transform, we extract traffic lines on the road.
2. Using selective color segmentation, we extract the number of different colors of lines present.[5]

The resulting color of each lane is used to estimate congestion in that lane.

3.2 Collecting Real Time Data From Traffic Cameras

We have already developed a system (Fig.3.3) that will count vehicles in any lane. The system, developed using the OpenCV library and the Python language, it detects vehicle objects using the machine learning model of the Haar Cascade classifier with an accuracy of approximately 90%. This system uses video surveillance, which is an optimal, highly accurate and widely used method for traffic surveillance. It will monitor the traffic camera feeds in real time, and detect each vehicle passing through its area of view. It also maintains the record of vehicles in the database. And this will help to determine the traffic congestion statistics in that lane.

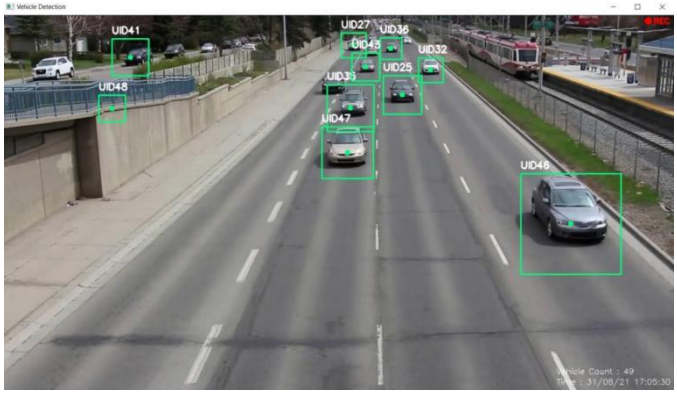

Fig.3.3 Vehicles Detection System

Using this system, we can create an API that will give vehicles count in real time in any lane, and based on this, the proposed system will set the time and control traffic lights.

The basic code for this system is available on several sites.

4. RESULTS AND DISCUSSION

Since, we have proposed 3 real-time data collection methodologies to implement our system,

There is no direct traffic API that provides traffic congestion statistics directly, so the API based methodology is not full proof. The first one is where we collect data from the Google Map Density API, this is not a free API, Google charges based on the number of requests. That's why we can't test this API. but according to google documentation as shown in Fig.4.1, we get a duration value in response, based on which we can estimate the traffic density.

Fig.4.1 Google Map Traffic Density API Example [10]

In the second method, we have successfully downloaded a Google Map Snapshot with Traffic Layer using a python script, Fig.4.2 shows the code execution and snapshot of the location which we gave. Now after that we can extract these traffic colors using image processing and calculate congestion density

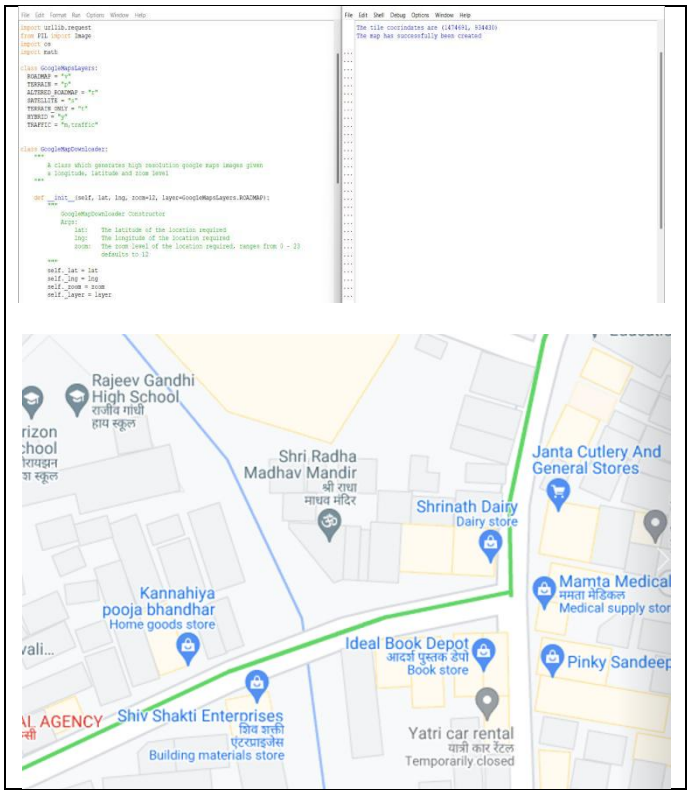

Fig.4.2 Google Map Traffic Snapshot Using Script

In the last methodology Fig.3.3, we have successfully tested the detection system by providing a recorded sample traffic video. It detects vehicles with 90% accuracy and also keeps a vehicle count. with the help of this parameter, we can estimate and allot time to the traffic signal.

After analysis, we found that out of all three methodologies, the last one i.e. real-time data collection with video cameras is highly expensive, but more accurate compared to others, and also reliable in implementation. The other two

methodologies are based on the Google API's, which are the cost-effective method but less accurate than the video camera methodology.

CONCLUSION

The main objective of this study is to reduce urban traffic with a dynamically changing traffic light system based on traffic density. This system does not require any infrastructure as there is no need to create any sensors or a large number of roadside devices to collect traffic information if we use the Google Maps API.

In this paper, we proposed a system for analyzing the traffic congestion in any lane and based on that allot the estimated time to traffic light to manage traffic and reduce congestion. With the help of this system, waiting times for vehicles and accidents caused by traffic congestion can be mitigated. If the proposed system is used in today's era, we will always save time in every case, and also always achieve positive results.

REFERENCES

[1] Kunjan Chauhan1 and Rishab Bajaj. "Automated Traffic Signal Control System." International Research Journal of Engineering and Technology (IRJET) 8.9 (2021): 1822-1830.
[2] Adhish P, Abhijith K, and Sree Ram M. "Adaptive Traffic Light Control using Google Maps API at Multiple Road Intersections." International Journal of Engineering and Advanced Technology (IJEAT) 9.2 (2019): 1802-1806.
[3] Jain, V., Sharma, A., & Subramanian, L. (2012). Road traffic congestion in the developing world. In Proceedings of the 2nd ACM Symposium on Computing for Development, DEV 2012 (Proceedings of the 2nd ACM Symposium on Computing for Development, DEV 2012). https://doi.org/10.1145/2160601.2160616.
[4] Jain, P. (2011). Automatic Traffic Signal Controller for Roads by Exploiting Fuzzy Logic. In: Das, V.V., Stephen, J., Chaba, Y. (eds) Computer Networks and Information Technologies. CNC 2011. Communications in Computer and Information Science, vol 142. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-19542-6_46
[5] Neethu John, B. Anusha, and Krishnan Kutty, "A reliable method for detecting road regions from a single image based on color distribution and vanishing point location", Procedia
[6] https://support.google.com/maps/answer/3092439?hl=en&co=GENIE.Platform%3DDesktop#zippy=%2Ctraffic
[7] https://developers.google.com/maps/documentation/javascript/examples/layer-traffic
[8] https://developers.google.com/maps/documentation/distance-matrix/distance-matrix#traffic_model
[9] https://gist.github.com/sebastianleonte/617628973f88792cd097941220110233#file-googlemapdownloader-py
[10] https://developers.google.com/maps/documentation/distance-matrix/start#json