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Intelligent Traffic Routing and Congestion Relief

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***ABSTRACT* — Traffic is a major problem mainly in metropolitan cities leading to a waste of resources and time. Countering traffic is in the best interest of everyone. With this paper, we propose a plan to tackle traffic through traffic light modulation. The duration of the signals is modified based on the real-time data obtained and processed at junctions. Thus, an informed decision is taken and this has the potential to limit traffic caused due to lengthy signals. The system uses powerful image & video processing algorithms in order to process data. The anticipated outcome of the system was met satisfactorily. The system proposed in the paper can be considered as a simplified system upon which other features can be designed. It has ample of scope to improve in future. Image processing can help empower signals to identify accidents and emergency vehicles too. The system has the potential to solve a plethora of problems related to traffic.**

KEYWORDS — traffic, signal, intelligent traffic, traffic routing system, image processing

1. INTRODUCTION

In metropolitan cities, traffic is a major issue. Millions of people worldwide spend extensive amounts of time in traffic. Even though traffic signals and stop signs have been optimized in order to alleviate traffic, the problem still persists. We believe that the main reason why traffic persists is the inability of the established systems to take into account real-time data. Although systems might have been designed for a specific purpose, they should have the ability to adapt. Traffic can be majorly caused due to improper management by signals. Therefore, we aim to target signals and make them intelligent enough to adjust according to traffic. Powered by real-time data and powerful algorithms, the problem of congestion can be resolved to an extent. With sensors and systems monitoring the situation at every instant, the enormous data collected will be useful in better predictions and problem-solving techniques by the algorithms. Through the power of image processing, virtually every part of a road can be monitored.

This project sets out to solve the problem of traffic at stoplights and the countless issues caused by it. The problem will be solved by modulation of the traffic lights at intersections.

1.1 Plan of Implementation

The system is designed in demarcated phases. The first phase dealt with the design of the processing part of the system. The processing part involves image and video processing in order to determine valuable data. The first phase mainly involved software. Image and video processing comprise of the crux of this system and will require dedicated systems that are resilient. It is also necessary to extensively test this software in order to determine the accuracy of it.

The second and the final phase of the project dealt with the interfacing of the software routines developed in first phase with relevant hardware. Mechanisms responsible for the modulation of the signal duration is integrated with the processing part of the system. Dedicated microprocessor is used to integrate the hardware with the software.

2. LITERATURE SURVEY

In the paper [1] highlight an approach for vehicle detection and tracking entirely based on the Block Matching Algorithm (BMA). BMA is a standard matching algorithm used in MPEG compression. In order to estimate blocks displacement (between two successive frames), the small BMA partitions and fixed size blocks are matched from the previous frame. BMA is a common and rudimentary algorithm to detect vehicles that has its fair share of drawbacks. The assumption that the inter-frame motion is small characterizes BMAs. So, in case the inter-frame motion is large, or fast, it will virtually be undetectable. The margin for errors and introduction of redundancies is also significant. Computational load appears to be the worst drawback with BMA.

In the paper [2] the authors describe how MATLAB and ATMEGA 328 can be used to create a traffic system control using Image Processing. This paper highlights use of "Low Level process" and "Segmentation". A low-level cycle is portrayed by the way that the information and yield are pictures. The primitive operations are image processing to reduce noise, contrast enhancement and image shaping. Segmentation involves separating an image into two regions corresponding to objects. MATLAB uses C/C++ language for computation. But in near future Python will dominate the programming field so using OpenCV was the better option.

The main objective of the paper [3] was to develop an OpenCV/Python code using Haar Cascade algorithm for object and face detection. Cascade object detector function and vision is used by the algorithm. To train the algorithm Train function is used. Reduced processing time is the main advantage of this code. The Python code was tried with the assistance of accessible information based on video and pictures, the output was confirmed. OpenCV provides libraries like cvBlob or OpenCV BlobsLib which helps in easier detection of vehicles.

In the paper [4] the authors proposed to design a vehicle tracking system that works utilizing GPS and GSM technology, which could be a fairly cheap source of vehicle tracking and it would work as anti-theft system using AT89C51 microcontroller.

3. SYSTEM OVERVIEW

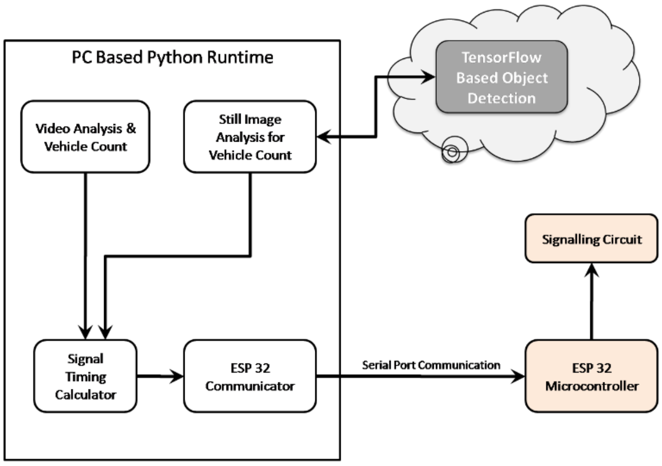

Fig-1 block diagram

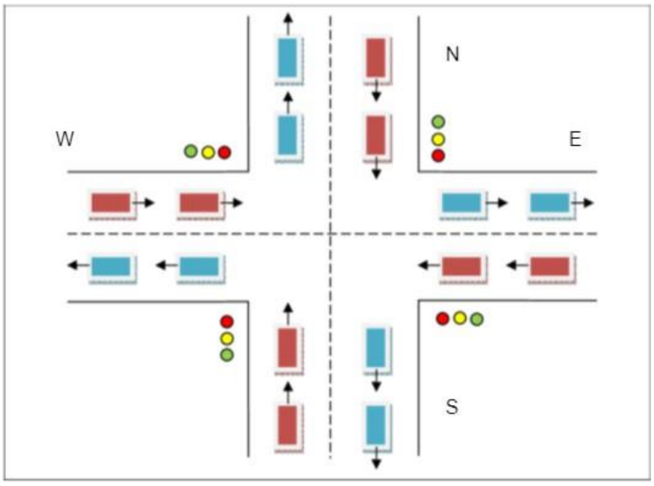

Fig-2 intersection considered

3.1 Traffic Signal Camera View and Object Detection

The Traffic signal cameras have the best view of the moving and non-moving traffic on a road. These cameras are placed at such angles that capture the maximum view of the intersection. These cameras are powerful enough to read a number plate of a vehicle. Now imagine using these cameras to count the number of vehicles on that road. Detecting and recognizing a certain object is the main basis of this project. Vehicles on a road can be detected and counted using the cameras placed on the traffic signals. Algorithms like Haar-Cascade[3] can be used to detect cars.

3.2 Image Processing and Vehicle Detection

Image processing is a technology used to convert images into digital format so that various operations can be performed on them to get some useful information. Performing operations like Haar-Cascade on an image to detect a vehicle is easy but we want to expand this to a video too. Calculating the number of vehicles in a video can be achieved by dividing the video into frames and performing the same functions on each frame. The number of vehicles can be determined by drawing a rectangle over moving objects and increase the count into a variable whenever the centers of these rectangles pass a line drawn in the video. These all functions can be implemented using the OpenCV libraries.

Vehicle detection is also possible through the use of TensorFlow [5]. TensorFlow is developed by Google, used in deep learning applications. It can be used with Python for object detection. Using the 'cvlib.object_detection' library, vehicle detection becomes easier.

3.3 Implementation of Algorithms

In this project we have used both the methods to calculate the number of vehicles on two roads. We have used Haar-Cascade algorithm on the NS road as shown in **Fig-2** with moving traffic i.e. calculating number of vehicles from a video depicting a green signal view. And TensorFlow in the WE road as shown in **Fig-1** with halted traffic i.e. depicting a red signal view.

3.4 Time calculation and Varying signals

The next part is using the data collected through image processing to vary the timing of signals.

A simple code is written using Python to use the data collected and vary the timings of red light and green light of the signal at an intersection. The time is varied to get the most optimized control over the traffic at the intersection. The timings of red and green light are sent serially onto the microcontroller using the serial port.

3.5 Serial Communication

Using the 'Serial' libraries in Python we can send the data onto the microcontroller using the Serial Port. The microcontroller may be programmed the use of IDE (Arduino IDE used on this project). The microcontroller is programmed to get the signal time and change the actual ON time of the respective signal.

4. Results and Discussions

We have considered an intersection of two roads (see Fig 2) to implement this project. Since the ON time for first signal is the OFF time for second signal, the timings of only one signal need to be changed. We have considered an average time of 45 seconds of Green and Red light. This table shows the green and red-light time signal pairings for different conditions.

Table -1**:** signal duration decision table

Video Flow Rate / Still Vehicle Density	<80 per minute	80 to 120 per minute	>120 per minute
<40	30,30	30,45	30,60
40 to 60	45,30	45,45	45,60
>60	60,30	60,45	60,60

The output of the video processing can be seen in Fig. 3.

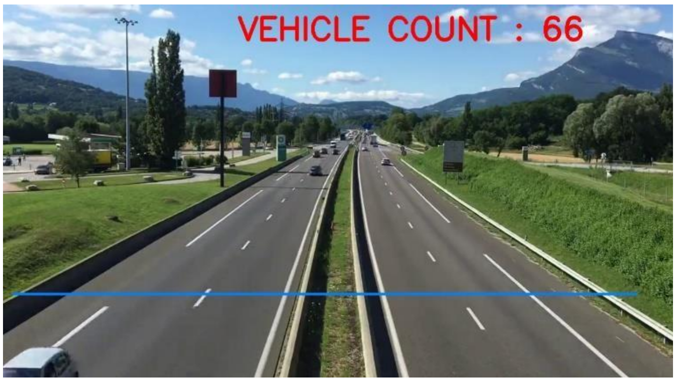

Fig -3: counting vehicles from video

Calculation process of the count from the image can be seen in Fig. 4

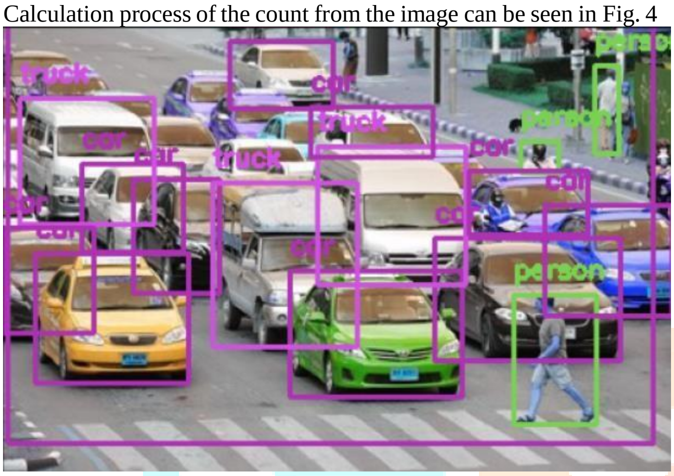

Fig -4: counting vehicles using TensorFlow

5. CONCLUSION

Intelligent Traffic Routing System refers to the communication technology that improves transport outcomes such as transport productivity, reliability, informed travel choices, environmental performance and network operation resilience. This project has been attempted on a much smaller scale than expected. When the system is to be implemented in real time, we will have to use current gain amplifiers to produce enough current to light up signal lights. The time interval between every scan can be customized as per requirement. The signal time calculation limits can also be changed as per requirement. This project can be used for intersections of more than 2 roads. The proposed system will help all travelers get where they need to go on time. Intelligent Traffic Routing System will provide higher coordination and performance to the prevailing version through decreasing the time between site visitors alerts through tracking site visitors on all lanes. Since the traffic coordination is efficient, fuel consumption is minimized. Intelligent Traffic Routing System will help focus the transport system on meeting the needs of all.

6. FUTURE SCOPE

This paper proposes a system of providing Intelligent Traffic Routing and Congestion relief which we believe will bring about a significant change. The proposed system can be increased to cover much more congested junctions and also traffic signals that include multiple turns and exit points. Real time monitoring of traffic using high quality cameras and varying time of traffic signals accordingly can be done. A potential beneficial application would be developing a system where emergency vehicles are tracked. Tracking the emergency vehicles would allow signals to provide priorities to certain lanes that have the emergency vehicle stuck in it. It can help rerouting the traffic so as to prefer the safe and quick passage of the emergency vehicle.

Accident detection is also a feature that could be productive. Detecting sites where vehicles have broken down can help other signals communicate and reroute the traffic accordingly.

Another potential application that could help tackle traffic is the synchronization of signals on a road. Multiple signals on the same road can be synchronized according to the modulation done to the initial signal (main junction signal) on the road. Considering that the flow of traffic wouldn't change drastically, synchronization would help save power, resources and computation time.

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