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Solution to Traffic Congestions: An IOT Based Development Perspective

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Abstract: ***Vehicular traffic congestion is a problem that is dominant in metropolitan cites across the globe. Its ill effects are not limited to increase in the amount of travel time, but on a wider range deteriorates the mental and physical well being of commuters who are regularly subjected to it. The adverse environmental effect of increased carbon emissions from stalled vehicles no matter how severe is almost unaccounted for least of all eliminated. This paper provides a solution with the potential to not only reduce but to an extent eliminate traffic congestion and cease its further detrimental side effects. By using the concept of internet of things the situations that evidently leads traffic congestion can be tremendously reduced in their frequency of occurrence. And this paper provides a simple yet innovative technique to achieve the same.***

Keywords: traffic, congestion, transportation, imageprocessing, opencv, Siddhant, Mumbai, India, vidyalnakar, background subtraction, foreground modelling, decision science, smart cities, smart traffic systems

1. Introduction

Traffic congestion occurs in a majority of cases for the following reasons.

1) Too many cars for the roadway due to inadequate mass transit options or other reasons.
2) Obstacles in the road causing a blockage and merger. These can be any of the following:
   - Double parking.
   - On road construction activities.
   - Lane closure due to utility work.
   - Bottlenecks due to irregular planning of the lanes.
   - Accidents.
3) Too many pedestrians crossing not permitting cars to turn.
4) Too many trucks on the road due to inadequate rail freight opportunities.
5) Overdevelopment in areas where the mass transit system is already overcrowded and the road system is inadequate.

In most cases the above problems are difficult to be eradicated completely or at times just unavoidable. There however exists one variable that is nowhere beyond our control. And that is the system that regulates the entire flow of traffic itself. The traffic signals. Traffic signals are perhaps the most controllable aspect of any transportation system. The technology that is paper demonstrates is built with a simple objective to optimise the capabilities of the traffic signals to serve the needs of the traffic.

Instead of the traditional traffic lights which are set to a fixed time slot between the various indicators (red, green, yellow, blue, etc.). There exists a better way of controlling the flow of traffic and that is by using dynamic signalling. Simply implying that based on the requirements of the traffic flow the signal should be able to alter its timing so that the chances of traffic congestion are reduced.

For this there is a need of a system that can sense the density of traffic on a street and suggest the changes to the signal timing. This can be obtained by the approach of internet of things that is by sensing the environment for traffic itself and then using the mathematical data obtained to define the need to alter signal timing.

The methodology is to use a video camera that overlooking the street under observation. The camera will provide video as an input feed to an OpenCV software application installed on the Brainbox (a local computer with an operating system that supports OpenCV software builds and other applications of regular usage like internet browsers and software program compilers. Mentioned as bb in this paper) The OpenCV application runs will help identify the volume of traffic (number of vehicles passing through a point per unit time). If the number exceeds the critical value for optimum traffic flow then the signal time is automatically altered by a pre programmed mechanism to provide the street more run time (Run time means the time for which vehicles on the street will receive the signal to keep moving. Green in most countries.) The signal time remains altered until the volume of traffic has dropped below the critical value.

This method will deployed at a junction (intersection of multiple streets) where the conditions will be appropriate for one street having high volume of traffic as compared to other streets.

For convenience streets having volume of traffic more than critical value will be regarded as hot and the ones with lower than critical value will be regarded as cold.

2. Technical Requirement and Implementations

Hardware Requirements
720p video camera

The camera will provide a live video feed as input to the Open CV software module on the bb. The feed will then be used to determine the volume of traffic and hence the need to alter signal timings.

The camera should exhibit the capability to provide clear imagery during low light conditions. For better results and accurate video reproduction the cameras can be paired with infrared sensors to increase the accuracy in the input feed by reverification. Another method for re-verification can be deployed by the use of already available traffic data from google maps. The inconsistency that can arise in the use of maps should be taken into account during this re-verification process.

Alternatively a more expensive yet convenient option is to use cameras with built in infrared instruments for videography in low light conditions. The camera will be connected to the bb via a usb port. This is the most preferred and widely available option.

Software requirements:

Brainbox (bb)

The Brainbox is a computer that is installed inside the signal pole on which the camera the installed or a nearby location as per the convenience of wired connectivity. The bb will run a operating system that supports the OpenCV software platform and other applications like browsers, media drivers, etc. However, it should have minimum hardware requirements as far as possible to limit the cost of hardware and keep the profile of the computer compact.

Functionalities of the bb:

A. OpenCV: OpenCV is a library of programming functions for computer vision applications. The OpenCV module installed on the bb will utilize a method called background subtraction to identify cars moving on the street.

The method generates a foreground mask that performs a subtraction between the current frame provided by the static camera and a model image to identify the differences between the two images and identify them as cars.

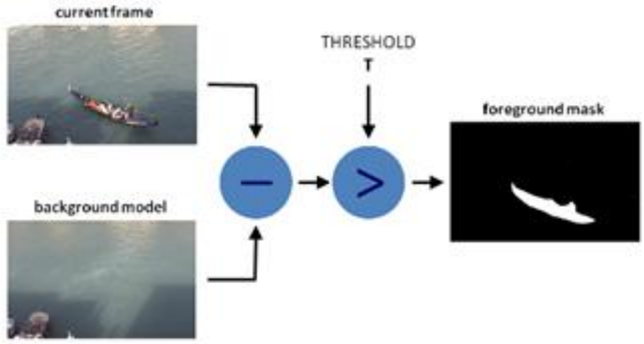

Image 1

The image depicts the background subtraction method in OpevCV being used to detect a boat.

The software can be enabled to recognise vehicles by implementing the MOG algorithm. And the frequency of vehicles per unit time that eventually account for the volume of traffic can be calculated using the haar cascades method which is well suited for OpenCV platform.

B. Other Applications of bb: The data about the data collected (meta data) and various decisions made by the bb are a essential resource for further developments in this technology. And therefore their storage and maintenance is essential. The bb can house applications like google drive, that can be utilised to store any required operational information and usage statistics in a secure location on the cloud servers. Making the knowledge available across a wide array of devices instantaneously. This will tremendously aid developers working on this and similar technologies.

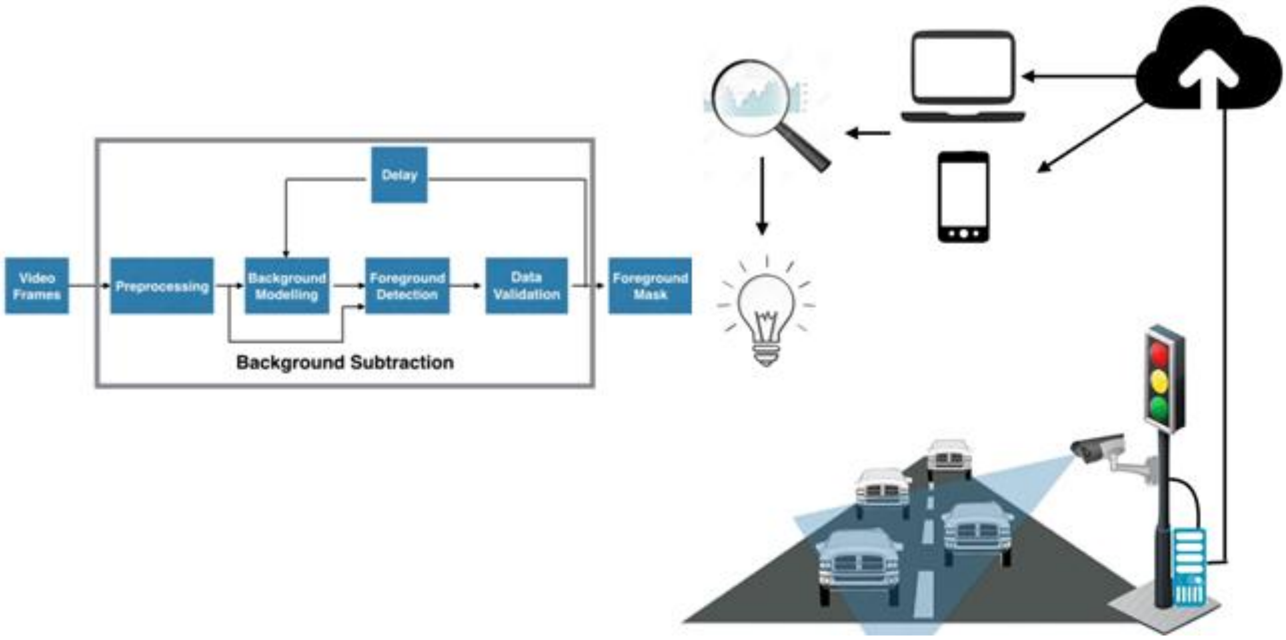

Image A: Process Diagram

3. Detailed Description of Software Methods

Image Processing

Image 2

Image 2depicts the Background Subtraction algorithm run by the OpenCV image processing module. The algorithm helps to isolate objects like vehicles from the input feed by superimposing the feed on a reference image pre-fed into the system.

To implement the background subtraction required a still image of the lane is captured (Note: The street needs to be void of vehicles for creating the reference image). The optimum contrast ratio and shadowing properties are used to prepare the image for better recognition by the OpenCV module. Now a live video feed from the installed camera will be provided by cable to the OpenCV module via respective hardware installation of i.o. peripherals. The OpenCV module wills runt the subtraction method identifying the variations in the live feed as compared to the reference image. The MOG method discussed earlier will be executed to track the moving distortion, which is actually a vehicle and help initialise the frequency counter to detect the exact quantity of vehicles passing through the frame per unit time.

The segmentation methods in OpenCV will help isolate the detected vehicles distantly, which will be of great need during heavy volume of traffic. After which a process called “Feature based automatic image registration” will be utilised to lock on every single vehicle and increase the accuracy of the frequency counter. These processes when executed simultaneously will generate a highly accurate numeric count of the traffic density. The count will then be compared with the critical limit identifying the lane as congested or not upon which further actions will be determined.

To increase the accuracy of foreground detection the reference image can be reset (updated) at regular intervals and either the updated image or the average foreground of all reference images until that instant can be used as a new reference image. This enhances the reliability of the system in varying light conditions but may cause reduction in processing speeds.

Decision Science

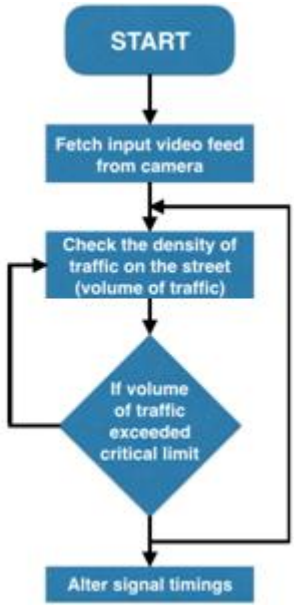

Image 3

Image 3 depicts the decision algorithm that decides the need to alter signal timings dynamically according to changing traffic conditions.

Observations made by traffic departments of numerous cites suggest that traffic congestion during peak hours primarily occurs as a selective number of streets that lead into major commercial areas are unable to handle the suddenly increasing number of vehicles that pour into them. Also across many cities the heaviest traffic spreads across in a distinct directions eg: North-South or East-West. This implies that if traffic movement on those selective streets can be enhanced then the result will lead to a considerable reduction in the clogging of major streets as well as the ensuing chain reaction of traffic jams that lead to city traffic congestion caused by excess volume of vehicles on narrow streets or slow moving lanes.

The solutions presented by this paper aims to use this situation to the best. If the dynamic signalling is implemented at major junctions (the ones that are along the route that leads to major commercial areas and the streets meeting at this particular junction carry heave volume of traffic in a distinct direction) then at every situation where two intersecting and near perpendicular streets exists such that one is hot and the other is cold. At this situation the dynamic signalling will provide more runtime for the hot street as compared to the cold street(s). Which holds true to the idea of this solution to match the demand of supply of runtime for vehicular movement.

Upscaling with Big Data

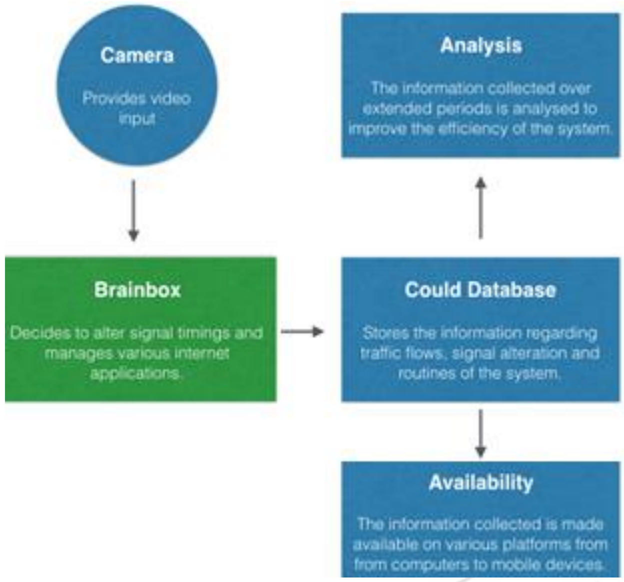

Image 4

Image 4 depicts the work flow of the entire process.

The solution provided by this paper is a technology that brings an instrumental change by bringing acute alterations in the already existing and overwhelmed traffic management systems.

Its efficiency is based upon the precision in deciding when the altering of signal time and to what extent is required to optimise traffic flow. A factor that will only be enhanced by inferences made from actual implementation of the technology.
Hence to draw actionable insights, the meta data about the entire operational proceedings will hold a key position in determining how much value add the system provides and how it can be optimised.

Data science and decision science are dependant on each other and their dependencies should be facilitated in the smoothest way as far as possible. Knowledge driven decisions are the core development pillar of this technology solution.

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