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A Framework to Reduce Road Congestion by means of Data Analytics

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ARTICLE DETAILS	ABSTRACT
History: Accepted 23 March 2021 Available Online March 2021	<i>The density of vehicles on the road especially in urban areas keeps on increasing to large amount day by day. Especially during the peak hours of the day, large amount of people wastes much of their time in traffic signals. Not only they waste energy by burning excess fuel and releasing CO₂ emissions in the environment as well as their time and money. An idea has been proposed to monitor the traffic congestion by means of data analytics on image data and solve the critical traffic congestion issue. The CCTV or surveillance cameras installed at the top points on the roads acts as a medium to provide image data as an input to analyze road traffic congestion by counting the number of vehicles under specified interval of time. Monitoring of traffic congestion using image processing techniques is very useful for the future urban road planning such as: 1) if there is a need to make the road wider, 2) if there is a need to add more lanes on the road, 3) if there is need to make flyover or a bridge to control the traffic on the roads. It will help municipalities to structure and expansion of the roads.</i>
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1. Introduction

In recent times, there is a growing interest in solving traffic congestion problem, with the increase in the population of the world. The number of vehicles on the roads is also increasing day by day. People now days are migrating in the cities and hence the percentage of the population in urban areas is increasing rapidly than in the rural areas. Due to this, traffic jams and traffic congestion is a very common problem on the hand. The problem of traffic congestion spreads widely in urban areas as compared to rural areas.

There is a pressing need to advance the condition of the flow of traffic in urban areas. Traffic tribulations now days are growing because of the increasing quantity of vehicles and the inadequate capital provided by present infrastructures. One simplest way of scheming traffic is through intelligent controlling of traffic lights by means of an electronic sensor in order to sense vehicles and produce a signal. Since, maintenance of traffic on the roads is a huge issue and needs a solution. We proposed a system by using data analytics through image processing to solve the issue of traffic congestion, and traffic jams on the road. In addition, by collecting information through data analytics we can properly manage the traffic issues on long term basis such as: where there is a need to make the road wider, if there is a need to add more lanes on the road, need to make a flyover or a bridge to control the traffic on the roads. Data analytics through image processing can helps us to build a priority queue that to solve traffic congestion problem efficiently. This information can be used by city planning and management team to manage their budget efficiently and effectively, and one can make the planning of next 10 to 15 years easily. In order to find out if the roads are being overcrowded, the simplest approach is to count the number of automobiles in a certain amount of time by using the surveillance cameras installed at the roads as a constant input. Traffic analysis becomes a demanding predicament as well as the desired one to control the traffic in upright and secure style. The traffic signals are regulated by a predefined preset program or by a regulator or may be operated manually by the traffic sergeants on demand. The worst case is when there is no vehicle in the preferred road, the time will be tumbled for the other vehicles which are all waiting on the other side and leads to congestion. Image processing techniques such as background differencing, threshold and filters are used to detect vehicles on the road traffic. Information retrieved from surveillance cameras is useful. Manually reviewing a huge quantity of data from a video camera is not practical. With the raise in the number of cameras, the mission becomes even trickier. Automatic detecting of vehicles in video surveillance records is a very demanding problem. One of the flexible techniques for regular analysis of road traffic flow parameters is Digital Image Processing which helps in extracting constructive information on traffic from the video. To recognize the vehicles, background subtraction method is used in our system. In this approach, dissimilarity between the extracted image frame from a security camera and the equivalent background image is performed to spot foreground objects. The result is then processed through a series of image processing procedures such as Thresholding, Erosion and Dilation are performed in order to eliminate noise and separate the moving automobiles from the background. The number of vehicles is then counted conveniently and also useful for future planning and management of traffic (Abubakar, 2012; Bezdek, Ehrlich, & Full, 1984; Blumenstein & Verma, 1998; Hasan, Saha, Hoque, & Majumder, 2014; Indira & Ramesh, 2011; Kaur & Kaur, 2014; Lim & Isa, 2012; Lindeberg & Li, 1997; Sathya & Manavalan, 2011; Seal, Das, & Sen, 2015; Sliz & Mikulka, 2016; Srisha & Khan, 2013; Wagstaff, Cardie, Rogers, & Schroedl, 2001; Zhang, 2006).

2. Related Work

In (Han, Wang, & Shaw, 2006) methods of visualization, which are suitable for image analysis of the Intelligent transportation system facts are used to determine patterns of traffic and data relations veiled in the enormous data sets. Intelligent transportation systems (ITS), used to civilize effectiveness of transport systems by means of the real-time data sensors and modern computing, over cutting-edge communication technologies recommended as an alternative approach for running vehicles overcrowding troubles. To regulate timing of traffic signals and build a transportation strategy, the experts in transportation industry must take advantage of these techniques and extract precious patterns of traffic flow for estimating traffic situation and analyzing system performance etc. (Feng & Luo, 2016). London traffic sensor networks is composed of thousands of sensors, and to count the number of cars passing an intersection in a certain amount of time these sensors detect the vehicles and gap between them by the interval of 250ms as well as their average speed. Road congestion level can be

computed by the data from Transport for London (TfL) in this method during the red-green interval (90 seconds) the 60 seconds for green signal and 30 seconds for the red signal by denoting n for the number of moving vehicles in the intersection we can find four cases for different values of n . If the value of n is less than or equal to 20 then low congestion. If value of n is greater than 20 but less than or equal to 60 then there is moderate congestion. If the value of n is greater than 60 but less than or equal to 100 then there is high congestion. But if a value of n is greater than 100 then there is very high congestion (Chiariotti, Condoluci, Mahmoodi, & Zanella, 2016; Kurniawan, Sajati, & Dinartyanto, 2017). TRAZER is an offline image processing system, developed to gather mixed traffic congestion data and it is able to capture lateral movements of vehicles this system become highly accurate by aligned video camera on central lane at certain altitude accuracy will be decreased if camera deviate from central lane, this approach allows to calculate both microscopic and macroscopic traffic properties over a certain length of road (Mallikarjuna, Phanindra, & Rao, 2009). In (Maharjan & Shrestha, 2015; Wei & Hong-ying, 2016) traffic overcrowding statistics collects from the roads and provided to users all the way through Open street map. The inspection cameras installed on the roads provide input without any gap to the arrangement which determines congestion in the street by including the number of vehicles on the path in a permanent interval of time. In (Sujatha, Devi, & Bragadeesh, 2017) a suggestion of creating a mobile application named as "Best Route Analyzer" which provides best route with less waiting time to the user if user enter information about their destination point and initial point has been proposed. In (Osuto, Ouma, & Ndung'u, 2016) an approach used for estimating the number of vehicles per unit area of the road section. Traffic density on roads during daytime using computer vision and image processing algorithms is presented. In order to reduce the burden on the system as well as to reduce the size of data it is suggested that traffic image and video data can be stored on different divisions of data centers and providing centralized access to it across application systems, equipment and traffic management facilities. This methodology provides easy and fast access to the stored data which is easy to use for future work (Al-Sabaawi, 2017). In (Fathy & Siyal, 1998) a novel approach describes a technique, to measure traffic parameters which eliminates the need of a background frame for measuring road traffic. In this approach edge-detection method applied to the key regions of the image. Dynamic threshold selection has been employed to choose the threshold value automatically. To determine essential traffic parameters like traffic volume, type of vehicles image processing algorithm has been purposeful by analyzing traffic image through the edge-detection technique shows that some surfaces and characteristics of vehicles shows significant edges, which can be seen while they are passing during the system window. Some vehicles reflect more light having same color as that of the road surface color, can also be easily detected by this method. In (Aubert, 1996) the idea proposed is to get much denser, richer and more accurate information by using the video sensors, surrounding environment and condition, about the traffic. However, the inductive loop sensors on cross-roads are too local to picture the pin-point view of vehicular information. Another technique in this system is the novelties of the scheme to decide the length of the queue in real time, by using only frame grabber on a PC, 6 images in a second without specific hardware. In (Cucchiara, Piccardi, & Mello, 2000) spatio-temporal technique used to analysis moving templates in daytime images through the image processing modules. Temporal, because extracted by comparative divergence among consecutive frames in the image progression and it uses the moving points information. The zone where movements get captured the luminance variations are taken into the account as Spatial. The double-difference image operator is used to segment tough moving points of factual travelling items, morphological analysis of night images for headlight of vehicles and performing threshold difference among three frames. The system mentioned is designed to detect automobiles with attributes such as direction, pattern, area etc. and elucidating a set of perceived patterns and rules of city roads traffic conditions. In (Lo & Velastin, 2001) to detect the congestion on London roads and underground station platforms the designed system used the existing CCTV system for robotic passenger monitoring. The

variance filter used to remove the back ground pixels of the image. The geometric transformation was applied for rectifying the perspective distortion, as well as for background removal the background subtraction was performed on the image. In (Tostes, de L. P. Duarte-Figueiredo, Assunção, Salles, & Loureiro, 2013) Chicago area considered as a study case. A prediction model designed to find out the upcoming flow traffic for an intention road or most crowded streets of the cities. A traffic stream attainment methodology relies on Geographical Information structure abbreviated as GIS proposed which can be used for mounting upcoming mobility models for an enhanced assessment of protocols. A methodology used Bing maps and Google maps etc. to find out the flow intensities from map services. According to the significance of the streets to investigate the flow strength they were aggregated in four categories as according to their importance. A metric was applied to find out shocks in the system. In (Jun & Luo, 2010) to obtain throughput on traffic images the idea of using cluster computing is proposed. To exploit parallelism on mostly used image processing algorithms a detailed examination is discussed. Numerous copies of an algorithm can be accomplished by the equivalent performing on diverse portions or subdivisions of the representation. Object detection or identification, in image and video data is very common task in image processing. In road congestion, vehicle detection, count, position, speed, direction etc. are the most important parameters for data analysis, prediction and control as stated by (Demchak et al., 2008; Gavrila & Philomin, 1999; Khanke & Kulkarni, 2014; Lienhart & Maydt, 2002; McKenna, Gong, & Raja, 1998; Papageorgiou & Poggio, 2000; Piccardi, 2004; Redmon, Divvala, Girshick, & Farhadi, 2016; Viola & Jones, 2001; Ye, 2012).

3. Proposed Model

Here is the proposed scheme for the detection of number of vehicles on the road which can be used to solve the problem of traffic congestion increasing day by day in urban areas.

Figure 1: Proposed Scheme

3.1 Extract Frames from Video Camera

For frame extraction from a video code of Open CV 3.0 is used that is an open-source computer vision library written in different languages but in proposed scheme C++ language is used by creating object of fgMaskMOG2 and using method process video as shown in Figure 2.

Figure 2: Extracted Images

3.2 Extracted Frames Filtering

For image filtering MPEG Streamclip tool is used. We'll then get the options panel. In Format, choose Image Sequence. Click on the Options button to its right as shown in Figure 3 below.

Figure 3: Frame Filtering

There also an option to set a frame size. There is no point of making a frame size larger than the original video size. It is better to leave the size of frame at either the default unsealed option or making it smaller.

We can also specify our image format and interval. In this example image format is JPGs. In the Frames per second, using 0.2 to extract a new image every 5 seconds. We can also set it at 1 frame per second or whatever we want to extract at specific interval of time as shown in Figure 4 below.

Figure 4: Frame Filtering Setting

Click OK and we'll go back to the main option panel. Once made all the settings with that settings just hit the OK button every time for the next day processing. We then simply choose which folder we want our image sequence to go in. It's generally very quick, and ends up with a series of image files, like this as shown in fig below.

3.3 Masked Frame and Vehicle Detection

Next process is to get masked images from original images which is the back ground subtraction of image it is a technique in the fields of image processing and computer vision where an image's foreground is extracted for further processing object recognition etc. is done by processing original images through open cv using MOG (Mixture of Gaussian). it is an algorithm for background or foreground segmentation. and after that masked image processed through MATLAB or open cv to detect objects in masked frame and display the number of objects present in that particular masked image.

Figure 5: Object Detection using MATLAB

4. Results and Discussion

This part momentarily describes the projected approach of exertion which will be followed. Detection results show the detail of Image like:

- Input Image Name
- Image Size
- Image Type
- Input Image Dimensions
- Image Detected Vehicles etc.

TABLE 1: OBJECT DETECTION RESULT 1

Original image	Masked image	Detected image	Detection result
<pre>c:\users\mahant\documents\visual studio 2012\Projects\CarndetApp1> This program shows how to detect vehicle objects in a frame OpenCV. You can process both videos (-vid) and images (-img). Usage: ./bin [-vid <video filename>] [-img <image filename>] For example: ./bin -vid video.avi or: ./bin -img /data/images/traffic.png Input File Name: mask_1428 Input File Type: png Input File Size: 1.15 kb Input Image Dimensions: 256 X 344 Image Detected Vehicles: 1</pre>
<pre>c:\users\mahant\documents\visual studio 2012\Projects\CarndetApp1> This program shows how to detect vehicle objects in a frame OpenCV. You can process both videos (-vid) and images (-img). Usage: ./bin [-vid <video filename>] [-img <image filename>] For example: ./bin -vid video.avi or: ./bin -img /data/images/traffic.png Input File Name: mask_1556 Input File Type: png Input File Size: 1.15 kb Input Image Dimensions: 256 X 344 Image Detected Vehicles: 1</pre>

TABLE 2: OBJECT DETECTION RESULT 2

<pre>c:\users\mahant\documents\visual studio 2012\Projects\CarndetApp1> This program shows how to detect vehicle objects in a frame OpenCV. You can process both videos (-vid) and images (-img). Usage: ./bin [-vid <video filename>] [-img <image filename>] For example: ./bin -vid video.avi or: ./bin -img /data/images/traffic.png Input File Name: mask_1625 Input File Type: png Input File Size: 1.38 kb Input Image Dimensions: 256 X 344 Image Detected Vehicles: 1</pre>
<pre>c:\users\mahant\documents\visual studio 2012\Projects\CarndetApp1> This program shows how to detect vehicle objects in a frame OpenCV. You can process both videos (-vid) and images (-img). Usage: ./bin [-vid <video filename>] [-img <image filename>] For example: ./bin -vid video.avi or: ./bin -img /data/images/traffic.png Input File Name: mask_2125 Input File Type: png Input File Size: 1.58 kb Input Image Dimensions: 256 X 344 Image Detected Vehicles: 2</pre>
<pre>c:\users\mahant\documents\visual studio 2012\Projects\CarndetApp1> This program shows how to detect vehicle objects in a frame OpenCV. You can process both videos (-vid) and images (-img). Usage: ./bin [-vid <video filename>] [-img <image filename>] For example: ./bin -vid video.avi or: ./bin -img /data/images/traffic.png Input File Name: mask_2127 Input File Type: png Input File Size: 1.57 kb Input Image Dimensions: 256 X 344 Image Detected Vehicles: 2</pre>

TABLE 3. OBJECT DETECTION RESULT 3

Original image	Masked image	Detected image	Detection result

TABLE 4. OBJECT DETECTION RESULT 4

Original image	Masked image	Detected image	Detection result

5. Conclusion

The project is entirely software based and self-sufficient i.e. no feeler and transducer are positioned. Main task of the project is achieved. The camera sited at peak of road gives enhanced exposure of the road so the coordination created improved consequence in this case. The project is not completely proficient up till now because there is constantly a space remains for advance upgrading. This proposal can surely be implemented in urban areas acting as a reliable medium of information about traffic overcrowding situation of roads, to the citizens travelling around the city. The information of road traffic concentration can be further used to robotically organize traffic light by replacing manual road traffic supervision by an automatic system.

6. Future Work

Due to the overcrowding of traffic, there seems an Overlapping of vehicles on the road, so during the processing of image software consider that overlapping of two or more vehicles into a single vehicle and generate results according to that situation. There is need to work on the improvement of this situation so that software can differentiate between single vehicle and overlapping of vehicles, shape of vehicles, reflection from glass panels etc.

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