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# Efficient GWR Solution by TR and CA

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**Abstract.** One of the major source of global warming is the increasing use of automobiles which contributes to 30% in developed countries and 20% in developing countries. Globally, 15% of man made carbon dioxide comes from cars, trucks and other vehicles. Reducing transportation emissions is one of the most vital steps in fighting global warming and solutions to the transportation problem include usage of green vehicles and public transport modes. The traffic congestion and the delays in signals are the major causes for increasing pollution's. The solution to this problem is presented in this paper. The effective use of big data analytic to analyze the emission rate and the time delays and total difference of a vehicles alternate path distance is calculated and the emission difference for the alternate path is calculated using machine learning algorithms. The optimized route must be efficient in reducing the time to reach and reduction of pollution, which is calculated for a route from source to destination in soft real-time using the map reduce technique. The standard emissions of vehicles are used to calculate the idle emissions and the running emissions of the vehicles for the current path with the congestion and also the alternative path to analyze the emissions in total to determine the path with least emissions. This paper proposes techniques for regulating the traffic by a dynamic signaling system as well as a new personalized alternate route alert system form a source to the destination.

**Keywords:** Big data · Gaussian filtering · Machine learning · Markov fields · Vehicular adhoc Networks (VANETs) · Traffic Reduction (TR) · Congestion Avoidance (CA)

## 1 Introduction

India shows a prominent increase in terms of Automobile usage. During 2010 the number of vehicles on road hit a mark of hundred million and by 2016 the number of vehicles nearly doubled and hit a mark of 210 million and is expected to hit a mark of 225 million vehicles by the year 2018. The increasing number of vehicles pose a great threat to the environment due to the amount of emissions by the

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automobiles. The increasing automobile population is major cause for the traffic congestions. Whenever there is a traffic congestion, the pollution increases and is a threat i.e. global warming. Traffic congestion in city will create pollutions leading to environmental problems and has a greater impact on the society. The drivers of the vehicle in traffic conditions are prone to stress and delayed arrival to their destinations. This stress may change into lack of concentration in driving and leads to problems like road raging and increases the probability of facing a road accident. The economic cost of traffic congestion is also very high. The average delay per person is approximately 30 h per year in traffic for normal cities and exceeds 70 h in the metropolitan cities. These congestions not only cause a loss of time, also include the wasted fossil fuels due to road congestion. The traffic congestion will also impact the environment by the emissions. The longer the time the vehicles are in congestions, the more fossil fuels are burnt, resulting in increased $CO_2$ emissions and acts as a high risk factor to the inhabitant's health while at congestions. In order to reduce the traffic congestion problem, engineers use the recent development of data collection and communication techniques to develop an intelligent transportation systems (ITS) using artificial intelligence techniques and help in the analysis of the traffic information to direct the traffic flow smoothly. The ITS have become more and more popular in the recent years due to the larger number of congestions. Intelligent transport system has two strategies in avoiding traffic congestion. One is to change the path of the vehicles moving towards areas which are prone to congestions and another method is to alter the traffic lights to efficiently make use of roads. The low emission vehicles are being introduced in the recent years to minimize the pollution rates. In cities like delhi, the pollution rate has gone extreme that the people are suffering severe lung disorders due to the pollution particles which is accumulated as a smog. One of the reason for these conditions is the heavy traffic congestions. The pollution by the road traffic can be controlled by environmental optimization of the Traffic signal timings and introduction of green vehicles [1]. There are several case studies for analyzing the consequences of traffic on $CO_2$ and Black carbon emissions. These studies [3] describe the amount of emissions caused due to the lack of the intelligent transport systems which are capable of sensing the traffic congestions and dynamic signalling systems.

## 2 Literature Review

A Unified Framework for Vehicle Rerouting and Traffic Light Control to Reduce Traffic Congestion was proposed in [2]. Digital pheromones of vehicles are constructed over the route of travel, while roadside agents are deployed to collect the data and will combine them to analyze the real-time traffic. These results are used to predict the road congestions that may develop. This analysis will help in the process of regulating the traffic by adjusting the signals for optimal movement of the vehicles. Once congestion is predicted, the vehicles are selected according to the distance to the road where congestion is identified and their driving destiny, and a probabilistic strategy is used and local pheromone is used to change the path of the vehicles. Based on the traffic conditions, two pheromone-based strategies are used to automatically control traffic lights to minimize the level of the traffic congestion. A multi-agent system for handling the unexpected urban traffic congestion using next road rerouting was developed in [4]. The system helps drivers in selecting the alternate choice of road to avoid congestions ahead. A heuristic re-routing decision is made based on a cost model that analyses the driver's destination and local traffic conditions. The positive rerouting is dependent on four factors, namely the vehicle density, the travel time, distance to the destination and the alternate path closeness. This system suffers a problem of clearing a certain level of congestion by the dynamic change of the signals. A guidance system combined with a personalized re-routing system for reducing travelling time of vehicles in cities was proposed in [7], which uses a rank based approach to rank the vehicles that are to be re-routed according to a criteria, effective link travel time to alternate route for each vehicle is computed. The system is updated whenever a vehicle is re-routed on same route to compute the impact of this vehicle on the following alternate paths. The system also has a high chance of reducing the travel time and also does not make the alternate path to become congested creating more delays. An adaptive and VANETS-based system for unexpected traffic congestion avoidance was proposed by [4]. This system has a vehicle re-routing strategy which can adapt to road traffic conditions. This involves a smart calibration of the system without any need for traffic constables. A coefficient of variation is used to calculate the weight values involved in the routing cost function and uses the k-means algorithm to choose the number of agents. This adaptive-NRR strategy is combined with the vehicular ad-hoc networks (VANETs) technology to provide a traffic aware system which can sense the traffic information at much faster rate and has larger coverage. A traffic prediction algorithm by comparing the current traffic data with historical data proposed in [10]. These traffic prediction results are used to create a routing technique which provides intelligent route services for dynamic routing. The algorithms were implemented for the complex urban areas and congested cities. The route selection algorithm gives the adaptive routes based on the traffic conditions, also based on the user's preferences. Wenbin Hu et al tested an actual urban traffic simulation model (AUTM) to predict the traffic and also reduce the traffic congestions. The model includes three key components, one to get the actual cellular spaces, an optimized spatial evolution rules that make simulation of vehicular dynamics better, and a congestion-avoidance algorithm to dynamically change the routes from the current locations to the destination. VANET based congestion avoidance systems use the current local traffic situation to the other vehicles to optimize the traffic. A wireless vehicle to vehicle communication used by the system to identify routes by avoiding the congestions proposed in [13]. Each vehicle transmits its average speed to other vehicles nearby. These nearby vehicles will recalculate the alternate routes based on the possible speed that the vehicle can move in the roads ahead. However the transmission of data by nearby vehicles can be disturbed by the buildings near the streets and also loss of data due to several data transfers. A multi-agent based approach, for avoiding Congestion and Alternate Route Allocation using Virtual Agent Negotiation (CARAVAN) developed in [14]. Vehicles communicate at decision points in their route and the route-allocation is done at the junctions. Inter-vehicular communication is used to transmit information to the other vehicles and also uses distributed processing. Vehicles exchange the route preference information to identify the initial routes. The identified routes are improved using virtual negotiation deals. No physical communication is made and hence communication latency is reduced. This system creates a fast and best route allocation and with less communication overhead. A multi-agent centralized technique for optimizing traffic for signal control system developed in [15]. They used evolutionary strategy and the total vehicle mean delay is reduced by using this strategy. The green signal time was optimized based on the algorithm and produce better results.

## 3 Proposed System

The proposed system has two modules namely prediction of vehicles movement and the alternate route determination based on the minimized $CO_2$ emissions. The input video is taken from the traffic cameras mounted at the signals on the road. The input video is preprocessed first to remove the noise and background and foreground sub-traction process is carried out. This approach uses the Gaussian filtering technique to enhance the input video streams that come from the traffic cameras. The Gaussian features are useful for the process of enhancing the video frames or the edge detection process once the enhancing process is completed. Video surveillance processing algorithm uses the Gaussian function to remove the noise in the video files. The noise reduction process using Gaussian function first filters in the x-direction and then it is filtered by a filter in a direction that is non-orthogonal. Now the images are free from the noises that can be a potential threat in the process of vehicle detection and prediction of the flow of the vehicles. The Markov Random Field (MRF) background subtraction method is used to separate a moving object as a foreground from the background. The segmentation of the foreground object such as a vehicle from a traffic scene from a traffic surveillance camera is to be done in order to complete the process of tracking a vehicle. The surveillance camera could be static or dynamic in case of a Pan Tilt and Zoom (PTZ) camera. Hence the background subtraction process has to detect the objects moving from the difference observed between the current frame and the reference frame using a pixel by pixel method or a block by block method. This reference frame is known to be the background image or background model. Indian traffic has a change in dynamic traffic scenes and requires a good background model and has to adapt to dynamic scenes. The background information update process is done in periodic intervals to update the background information whenever there is a change in the background. Foreground objects in a video stream are identified using the background subtraction method. The most important stage in surveillance application is to detect the vehicles accurately only after which the analysis can be done. A background algorithm like Markov Random Field (MRF) is used to enhance the performance of the objects classification and detection process. The proposed classification process has a feature extraction process and a scene classification process. The surveillance system uses the feature sets obtained by the convolution of the local mask patterns with the object from video file. These masks have been introduced for determining the position of the object in a video. A different number of samples in each scene is used to train scene-specific classifier in order to differentiate the foreground object from the background. With different distribution of training images, the system is capable of getting better results to track the objects. The probability values are calculated based on the movement of the vehicles. The density of the traffic is noted from the count of the vehicles at any particular time. These values are combined together to get the details of the congestion. Once a congestion is detected, the alternate path (AP) algorithm is initiated. The alternate path algorithm is a two phase algorithm where the alternate path to the congested path is detected first and then the second phase for the calculation of the emission of the vehicle in the current path and the alternate path. The standard emissions of vehicles are used to calculate the idle emissions and the running emissions of the vehicles for the current path with the congestion and also the alternative path to analyze the emissions in total to determine the path with least emissions. There are several techniques to calculate the emissions of $CO_2$ which include a gas tester which involves more cost and less feasibility for testing. The visual analysis of emissions by a camera involves less cost but it is an inaccurate solution. The proposed method uses the standard emissions values that are used to define the actual idle time emissions and the run-time emissions. The total duration of the travel along several paths will be calculated and the one with low emissions is likely to be taken by the user as it will be a less time consuming travel which also has less driver stress than the other routes. The alternate path for the destination is searched using the Google maps functionality. The map image of the route is now taken as the input and the areas of congestion are found using the colour codes. Now the system estimates the time to reach the destination using the current path and also the alternate paths. The time parameter is stored for the two paths. Using the distance of the current path and the alternate path, the difference in the distance to the destination is computed. The alternate path algorithm combines the results of the distance and the time to compute the vehicle idle time and the running time for the alternate path and the current path. When the computed values of the alternate path is less than the current path, the values are used to calculate the amount of the emission reduction and time saved. These values are displayed to the user to make the decisions. Whenever the emissions of the alternate path is more than the percentage of the emissions in the current path, the user is advised to continue in the same route. The system will compute the data for each and every place where the congestion are detected so that whenever there is a chance of taking an alternate path can be taken.

*Experimental Results.* The system is tested based on the sample videos available online and the implementations are done using the Matlab software. The results of the object detection process are shown in Figs. 1 and 2 depicts the prediction of movement of the vehicles based on the probability values. The object which is detected using the proposed algorithm is identified and a box is drawn to depict the vehicle identified. The numerical value on the figure below shows the probability value for the prediction of the movement of the vehicle. Table 1 shows the details of the moving vehicles. The vehicles are numbered and the vehicle speed detected with the prediction probability and direction of movement of the vehicles is tabulated. The predicted values are 86% accurate compared to the actual movement and speed of the vehicles.

**Table 1.** Details of moving vehicles in the input video.

| Car | Direction | Prediction | Speed (Kmph) |
|---|---|---|---|
| 1 | **'Left'** | 0.88889 | 55.019 |
| 2 | **'Left'** | 0.88889 | 74.904 |
| 3 | **'Straight'** | 0.77778 | 2.081 |
| 4 | **'Left'** | 0.88889 | 21.144 |
| 5 | **'Right'** | 0.66667 | 3.441 |
| 6 | **'Right'** | 0.55556 | 13.317 |
| 7 | **'Right'** | 0.66667 | 3.5572 |
| 8 | **'Straight'** | 0.77778 | 3.4731 |

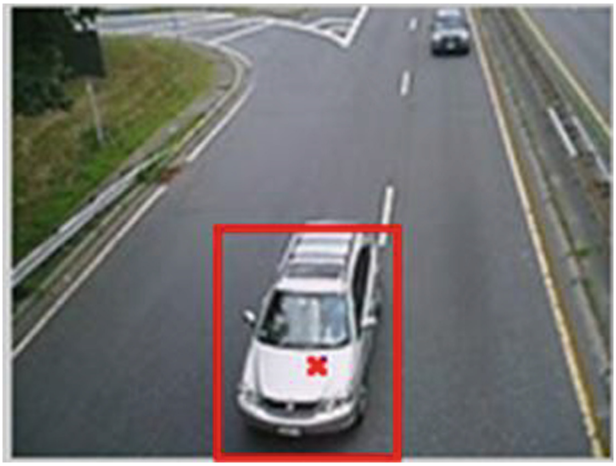

**Fig. 1.** Object detection.

The alternate path algorithm is based on the congestion and hence only when the congestion are identified, the system computes the alternate paths to the

**Fig. 2.** Movement prediction result for the proposed methodology.

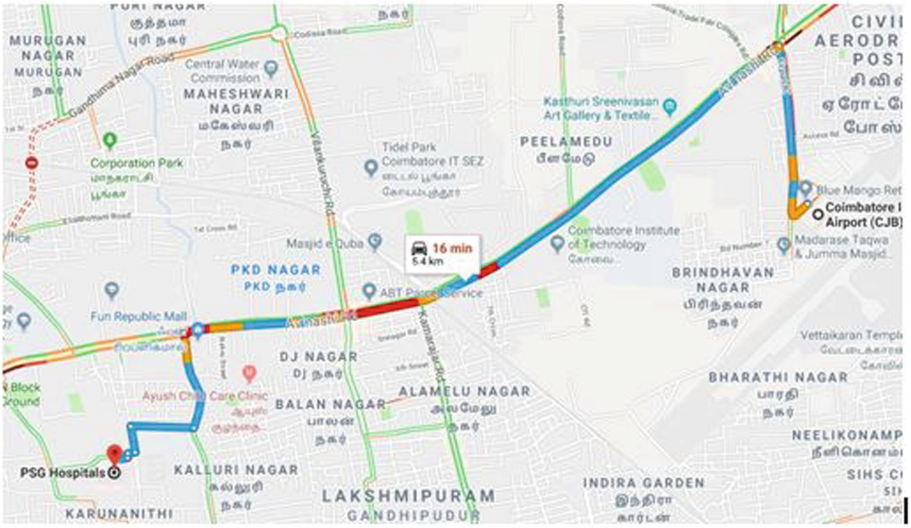


**Fig. 3.** Traffic found in a route.

destination based on the current values of the GPS coordinates. Figure 3 shows the route from the current position to the destination where traffic congestion is detected. The alternate path that is identified using the AP algorithm is shown in the Fig. 4. The alternate paths identified by the algorithm must be a lower emission path; only then the route will be suggested to the user.

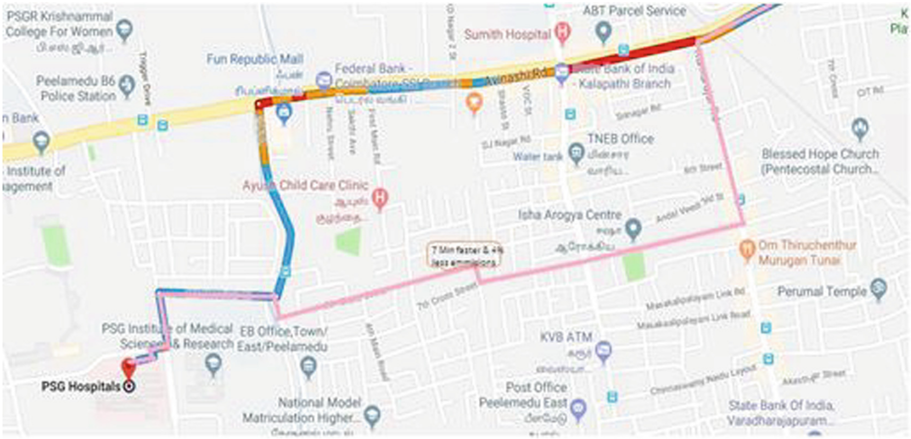


**Fig. 4.** Alternate path to the destination using AP algorithm.

## 4 Conclusion and Future Works

The paper proposed an intelligent traffic control system which helps the vehicles to avoid the traffic congestion and thereby reduce the $CO_2$ emissions by taking the alternate route and also utilizes the prediction of vehicles movement to predict the future traffic. The alternate paths are recommended based on the traffic and the amount of reduced emissions in the alternate path. Hence this system not only helps the drivers relieved from tensions over long waiting and pollution in traffic, but also reduces the total emissions by choosing the best alternate path. As a future work, the system can be integrated with the VANETs to communicate the information's about the speed and congestions ahead of start of the journey.

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