International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

Traffic Signal Timing Control Based on Vehicle Detection

Prachiti Limaye[1], Harshada Wani[2], Payal Chaudhari[3], Janaki Naik[4], Siddhivinayak Kulkarni[5]

[1]MITCOE, Computer Engineering

Abstract: ***Congestion of traffic is a major concern in many countries across the world. This problem has become a nightmare for the commuters in all cities across the world. This congestion on urban road networks has become increasingly problematic. In India, at every traffic signal, vehicles are stopped for a fixed period of time, which leads to traffic jam. Sometimes higher traffic density at one side of the road demands longer green signal time as compared to standard allotted time. This project focuses on object detection of images of vehicles on the road. The object detection in the traffic signal is processed and then its threshold is calculated. Based on this count, number of vehicles on the road is estimated. After calculating the number of vehicles on each side of the road, we will come to know on which side the density is high. According to density calculated, green signal time is estimated. The project also focuses on other concerns like applying strict traffic rules that ensures that citizens won't break traffic laws. Rules like monitoring traffic, analyzing vehicles that drive on wrong side and many more are integrated in this project. It is the need of hour to monitor vehicles that break traffic rules as it leads to severe problems like congestion, accidents and may cost lives.***

Keywords: Mathematical morphology, reinforcement learning, traffic congestion, simulation of urban mobility, monocular camera

1. Introduction

The most important causes that increase traffic congestion in cities are overpopulation, lack of planning of city road, signals and undisciplined behavior of drivers. As a result of these causes, there is a huge impact on the environment, human health and economy. Also, one of the most common traffic violations that drivers and riders commit is breaking the traffic signal and not following signal rules. Bikers and four-wheeler drivers rampantly try to pass the signal even when the red traffic light is on. Therefore, all these violations must be monitored and an efficient system must be developed to monitor that all traffic rules are thoroughly followed by the drivers.

In order to tackle this problem, we are developing a system to analyze, determine and monitor traffic conditions. Our system will be able to recognize traffic- related events like breaking rules and traffic laws. Further, we are integrating our system into a more complex traffic detection infrastructure.

Object recognition has different purposes. One such application of object recognition is object detection. Vehicle detection on roads is an example of object detection. This is used for traffic analysis, monitor and control. For controlling the traffic signal, an initial step is vehicle detection and classification using traffic measuring techniques. One of the most widely used techniques is used, which achieve this objective, by image processing technique. Many algorithms are connected with vehicle detection and classification technique. In, image segmentation and edge detection methods are employed. To isolate the vehicles, background extraction and estimation techniques are used. Similarly, vehicle detection can be achieved with the help of vehicles count.
This approach becomes difficult if shadows of other objects like overhead bridges overlap with the shadows of Classification of vehicles based on their sizes or shapes play an importation role in traffic management and flow control. Irrespective of the algorithm or technique, the quality of camera plays an important and critical role in vehicle detection. High altitude camera is an example of camera positioning, which is used for wide area coverage.

Traffic is growing day by day, with growing number of vehicle users. It is desirable to have a mechanism, by which people can know, in real time, about the traffic congestion. As a result, in recent times working on traffic monitoring has gained significant attention. In India, the traffic is highly unpredictable and chaotic.

One of the principal challenges, in traffic control is to accommodate the traffic in an efficient and safe way. Its principal objective to manage the movement of people and goods as safely and efficiently as possible.

2. Need for Study

Earlier, traffic monitoring was manageable, as there were a smaller number of vehicles owned by people. Thus, time required to travel was reduced. Fuel consumption was less which resulted in less amount of pollution. Coming back to 21st century, managing unsaturated traffic has become more complex as there is increase in number of vehicles causing traffic jam, high amount of pollution. Also, time required to reach the destination has increased. Traffic Signal rules are not being followed leading to a greater number of accidents. So here there is a need to monitor traffic. Therefore, to overcome this problem, we are developing a system that could manage and analyze the traffic by, counting the number of vehicles waiting at the signal and releasing them based on their average number of waiting count. The vehicles travelling on the wrong side and parking of vehicles in non-parking zone are also detected.

3. Review of literature

The purpose of literature review is to provide foundation of knowledge on our topic. Xiaoyuan Liang [1] conducted a

study to decide the traffic signals' duration based on the collected data from different sensors and vehicular networks. He proposed a deep reinforcement learning model to control the traffic light. In the model, he quantified the complex traffic scenario as states by collecting data and dividing the whole intersection into small grids. The timing changes of a traffic light were the actions, which were modeled as a high-dimension Markov decision process. The reward obtained was the cumulative waiting time difference between two cycles. To solve the model, a convolutional neural network was employed by him to map the states to rewards. To improve the performance the model includes various components, such as dueling network, target network, double Q-learning network, and prioritized experience replay. The model was evaluated via simulation in the Simulation of Urban Mobility (SUMO) in vehicular network, and the simulation results showed the efficiency of his model in controlling traffic lights.

Andrew J. Davison et.al [2] presented a real-time algorithm which could recover the 3D trajectory of a monocular camera, moving rapidly through a previously unknown scene. The system MonoSLAM, is a first successful application of the SLAM technique from mobile robotics to the "pure vision" of a single uncontrolled camera. Online creation of a sparse is the core of his approach but persistent map of natural landmarks within a probabilistic framework. Use of a general motion model for smooth camera movement, and solutions to monocular feature initialization and feature orientation estimation provide better ways for mapping and measurement. Together, his study and work added up to an extremely efficient and robust algorithm which could run at 30 Hz with standard PC and camera hardware. This work extended the range of robotic systems in which SLAM can be usefully applied, but also opens up new areas. Real-time 3D localization and mapping of a high-performance full-size humanoid robot and live augmented reality with a hand-held camera are the applications provided by MONOSLAM.

Hamid Reza et.al [3] presented a paper that proposed semi-automatic approach to extract different road types from high-resolution remote sensing images. The approach was based on edge detection and SVM and mathematical morphology method. First the outline of the road was detected based on canny operator. Then, Full Lambda Schedule merging method combined adjacent segments. Support Vector Machine (SVM) is used to classify entire image and various spatial, spectral, and texture attributes to form a road image. Using morphological operators, the quality of detected roads was improved. The algorithms were systematically evaluated on a variety of satellite images from Worldview, Quick Bird and UltraCam airborne Images.

Andrew Payne et.al [4] studied and presented a paper that proposed a new technique for the classification of indoor and outdoor images based on edge analysis. This technique was based on analyzing edge straightness in images. He made a approach in which indoor images have a more proportion of edges that are straight as compared to outdoor images, and use multi-resolution estimates on edge straightness to improve our results. He also considered this method's possible applications in a real-time system. He compared his proposed methodology with a many other technique that were published on indoor/outdoor classification of images and convincingly show on a large database that our method generates much higher accuracy.

Baher Abdulahi et.al [5] represented a paper which introduces Q-learning, a simple but powerful reinforcement learning algorithm, and displayed a case study involving application to traffic signal control. From the previous results of the application to an isolated traffic signal, particularly under variable traffic conditions, are presented. Integration with dynamic route guidance and including extension to linear and networked signal system, a broader research effort is outlined. Research includes control of heavily traffic jam for a two-dimensional road network—a challenging task for conventional traffic signal control methodologies.

Lisheng Jin1 et al [6] presented a system about vision driver assistance under good-natured weather conditions. Classification method is used to identify the type of optical characteristics for the purpose of making vision enhancement algorithms more efficient. Based on multiple weather features and supervised learning he derived multi-class weather classification method to improve machine vision in bad situations. Underlying visual features were extracted from multi-traffic scene images, and then the feature was expressed as an eight-dimension feature matrix. Second, five supervised learning algorithms were used to train classifiers. His analysis showed that the extracted features could accurately describe the image semantics, and the classifiers have high recognition accuracy rate and adaptive ability. This proposed method provided the basis for further enhancement of anterior vehicle detection during nighttime illumination, as well as enhancing the driver's field of vision on a foggy day.

Traffic sign detection, monitoring and recognition were studied for a long time. Also, traffic panel detection and recognition still a big challenge in computer vision because of its various types and the huge variability of the information depicted in them. The paper presented by Álvaro González et.al [7] describes a method to detect traffic panels in street-level images and to recognize the information contained on them, as an application to intelligent transportation systems (ITS). Hua Wei et.al [8] presented a paper in which he has proposed a more effective deep reinforcement learning model for traffic light control. He tested his method on a large-scale real traffic dataset obtained from surveillance cameras. He also showed some interesting case studies of policies learned from the real data.

Sahar Araghi et.al [9] presented a paper in that the he compared performance of the developed neural network with two traditional alternatives for controlling traffic lights. Simulation results indicate that the application of the proposed method greatly reduces total delay in network compared to other alternative methods.

From above research survey, we have identified the relationship of works in context of its contribution to our

topic and to other works. Also, we have identified some research gaps and conflicts to previous studies.

Our motive is to place our own research within the context of existing literature to make a case for why further study is needed. We are creating an integrated traffic monitoring system that not only monitors the number of vehicles at terminals and set green signal time accordingly, but also create an efficient traffic control system that will integrate multiple monitoring rules. The aim of our Traffic Violation Management solution is to maintain records of everyday traffic by precisely detecting and recording traffic violations through images and videos. The captured violation images and additional information can prove to be disputable proof for local authorities.

After detecting the vehicles, the system will also send a message to the user that informs him about the violation.

4. Problem definition and proposed system

Recently Social as well as Road networks have been employed as a source of information for event detection, with specific reference to road traffic activity like jamming, congestion and accidents. So, we implement a system to address traffic detection and released signal as per vehicles arrived. This system will be highly efficient, easy to implement with good usability and with advance integrated features. The system will solve real world traffic related problems and monitor traffic conditions and situations generated on daily basis. The system is divided into following modules.

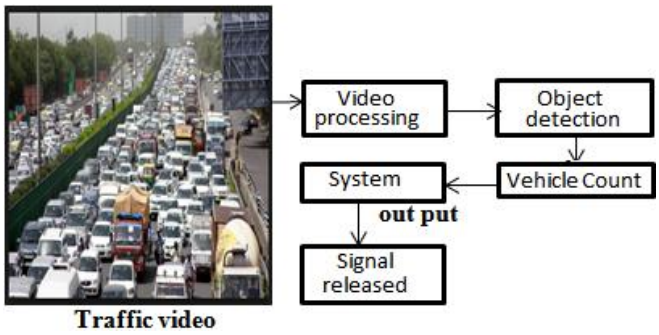


Figure 1: General Architecture of System

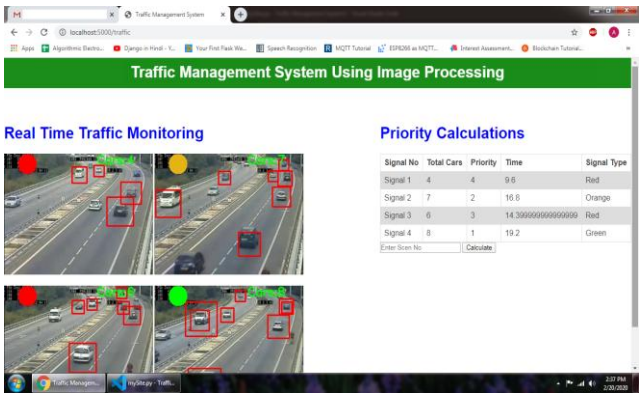
Signal management and release
The number of vehicles at all terminals is calculated. After calculations, a counter is maintained. This counter is provided to the system. On basis of this counter, green signal time for all sides of the road are estimated. Finally, vehicles are released in a sequential manner. Every set contains four images that represent four sides of the road. Then priorities are set to vehicles based on vehicle count. The side which has vehicles with maximum count is given first priority.

Detecting vehicles crossing zebra crossing when signal is red:
A Zebra crossing is the black and white stripes on either side of the roads. These markings indicate the drivers that there may be pedestrians crossing or waiting to cross the road. They also inform the drivers that they must give way to pedestrians on the crossing. However, drivers still tend to stop vehicles of zebra crossing. Hence, it is important to keep track of such vehicles. The system will capture images of vehicles that are parked on zebra crossing.

Sending messages to users who violate rules:
After detecting vehicles that violate traffic rules, messages will be sent to owners of those particular vehicles. This will notify them that they have violated a rule and then further actions can be taken.

Detecting vehicles travelling on opposite side of the road:
This system will also detect vehicles travelling on opposite side of the road. The vehicle count will be maintained and users will be notified.

For the above system, Database is used for storing images and videos: .csv and .xml files are required for training the data set. These files are taken an input, objects are detected, results are generated and modules are executed. The software platform used for project is python. Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is designed to be highly readable.



5. Project Scope

Due to the increased number of vehicles, it is necessary to take effective steps in order to control the traffic and hence avoid all types of loses that is caused due to traffic. Once we predict the high traffic density of a network segment, we can build strategies to avoid this problem. In case of a road network, navigation systems can try to bypass this critical zone. Further, any traffic control systems can inform the drivers about the traffic jam in order to guide them around the critical zone. To detect the traffic on roads different sensors are being used and different techniques are used to determine the traffic and hence solve the problem related to traffic.

6. Conclusion and future scope

We can integrate our system with an application for analyzing the official traffic signal, so as to capture traffic condition notifications in real-time. Thus, our system will be able to signal traffic-related events in the worst case at the same time of the result display by the console on the web sites. Further, we are investigating in future scope the integration of our system into a more complex traffic

detection infrastructure. This infrastructure may include both advanced physical sensors and social sensors such as streams of social media. Social sensors can provide a low-cost wide coverage of the road network, especially in the areas (e.g., urban and suburban) where traditional traffic sensors are not present.

Design a real-time detection system for traffic analysis.

1) Signal Timing change as per the vehicle arrival.
2) Remove manual work when traffic arrived.
3) System tack self-decision to change signal time as per vehicle count on that particular lane.
4) To avoid traffic related problem like traffic jam.

References

[1] Andrew J. Davison , Ian D. Reid , Nicholas D. Molton, Olivier Stasse, MonoSLAM: Real-Time Single Camera SLAM, IEEE Transactions on Pattern Analysis and Machine Intelligence, v.29 n.6, p.1052-1067, June 2007

[2] H. R. R. Bakhtiari, A. Abdollahi, H. Rezaeian, "Semi automatic road extraction from digital images", Egyptian J. Remote Sens. Space Sci., vol. 20, no. 1, pp. 117-123, Jun. 2017.

[3] Andrew Payne , Sameer Singh, Indoor vs. outdoor scene classification in digital photographs, Pattern Recognition, v.38 n.10, p.1533-1545,October 2005

[4] B. Abdulhai, R. Pringle, G. J. Karakoulas, "Reinforcement learning for the true adaptive traffic signal control", J. Transp. Eng., vol. 129, no. 3, pp. 278-285, May/Jun. 2003.

[5] Jin, L., Chen, M., Jiang, Y., Xia, H.: Multi-traffic scene perception based on supervised learning. IEEE Access 6, 4287–4296 (2018)

[6] Álvaro González, Luis M. Bergasa. IEEE Transactions on Intelligent Transportation Systems (Volume: 15)

[7] Hua Wei , Guanjie Zheng , Huaxiu Yao , Zhenhui Li, IntelliLight: A Reinforcement Learning Approach for Intelligent Traffic Light Control, Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, August 19-23, 2018, London, United Kingdom

[8] Sahar Araghi, Abbas Khosravi, Michael Johnstone, Doug Creighton SMC '13 Proceedings of the 2013 IEEE International Conference on Systems, Man, and Cybernetics October 13 - 16, 2013. IEEE Computer Society Washington, DC, USA ©2013, table of contents ISBN: 978-1-4799-0652-9

[9] Hoffmann, Ulrich & Vesin, Jean-Marc & Ebrahimi, Touradj. (2007). Recent Advances in Brain-Computer Interfaces. 10.1109/MMSP.2007.4412807.

[10] S. Vaid, P. Singh and C. Kaur, "EEG Signal Analysis for BCI Interface: A Review," 2015 Fifth International Conference on Advanced Computing & Communication Technologies, Haryana, 2015, pp. 143-147.

[11] F Gilbert, C Pham, Jnm Viaña & W. Gillam (2019) Increasing brain-computer interface media depictions: pressing ethical concerns, Brain-Computer Interfaces, 6:3, 49-70, DOI: 10.1080/2326263X.2019.1655837

[12] Yin, J.H., Mu, Z.D., Hu, J.F., 2014. Design of Identification System Based on BCI. Applied Mechanics and Materials 496–500, 1975–1978. https://doi.org/10.4028/www.scientific.net/amm.496-500.1975

[13] Ortega J, Asensio-Cubero J, Gan J Q and Ortiz A 2016 Classification of motor imagery tasks for BCI with multiresolution analysis and multiobjective feature selection Biomed. Eng. Online 15 (Suppl. 1)

[14] Pan S J and Yang Q 2010 A survey on transfer learning IEEE Trans. Knowl. Data Eng. 22 1345–59

[15] Panicker R C, Puthusserypady S and Sun Y 2010 Adaptation in P300 brain–computer interfaces: a twoclassifier cotraining approach IEEE Trans. Biomed. Eng. 57 2927–35

[16] Parzen E 1962 On estimation of a probability density function and mode Ann. Math. Stat. 33 1065–76

[17] Peng H, Long F and Ding C 2005 Feature selection based on mutual information: criteria of max-dependency, maxrelevance, and min-redundancy IEEE Trans. Pattern Anal. Mach. Intell. 27 1226–38

[18] Pfurtscheller G, Müller-Putz G, Scherer R and Neuper C 2008 Rehabilitation with brain–computer interface systems IEEE Comput. 41 58–65

[19] Phan A, Cichocki A, Tichavský P, Zdunek R and Lehky S 2013 From basis components to complex structural patterns IEEE Int. Conf. on Acoustics, Speech and Signal Processing (IEEE) pp 3228–32

[20] Phan A H and Cichocki A 2010 Tensor decompositions for feature extraction and classification of high dimensional datasets Nonlinear Theory Appl. 1 37–68

[21] Quinlan J R 1986 Induction of decision trees Mach. Learn. 1 81–106 [185] Ramoser H, Muller-Gerking J and Pfurtscheller G 2000 Optimal spatial filtering of single trial EEG during imagined hand movement IEEE Trans. Rehabil. Eng. 8 441–6