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A Literature Survey on an Improved Smart Traffic Signal Using Computer Vision and Artificial Intelligence

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ABSTRACT: Nowadays people waste nearly 480 crore hours each year in jam which could be used productively. In urban areas, traffic management is largely governed by traffic police and signal lights that contribute to the exorbitant long wait for vehicles due to an inefficient configuration. In many urban areas, most of the traffic signal lights are based on a fixed cycle protocol, which is a reason for the inefficient configuration. Thus, there is an immoderate need to enhance and automate these traffic systems. The establishment of a mixed technique of artificial intelligence (AI) and computer vision can be desirable to develop an authenticate and scalable traffic system which can aid to solve such problems. In addition to that, the proposed system will identify the vehicle, its speed, an emergency (in the case of the ambulance) and two closest signals will synchronously share the information to make a reliable decision. AI and Vision-based technologies have the potential to cover all these parameters. This paper provides an insight into how these technologies can be applied and the difficulties which we will have to face.

KEYWORDS: Computer Vision, Synchronous Traffic Signals, Object Detection, Artificial Intelligence, Multiline Reference, Image Processing.

I. INTRODUCTION

The goal of transportation research is to optimize the transportation flow of people and goods. As the growing population, the number of travellers constantly increases while resources provided by current Infrastructures are not sufficient for this, therefore intelligent control of traffic became a really serious issue. Traffic in the urban areas is generally based on fixed cycle traffic signal lights, which is not properly configured in many cases and causes unnecessary extra waiting times for the vehicles [1]. The traditional traffic signal monitoring techniques include fix-interval monitoring, day time monitoring, vehicle actuated and semi-actuated monitoring, green wave monitoring, area dynamic monitoring and area static monitoring. However, there is no system which we can call a capable and effective system or can be adopted in real-world effectively. This is because the traffic control system is non-linear, non-deterministic and fuzzy, and thus established methods of modelling and control cannot work very well. In order to answer the above-mentioned problem, there are numerous researchers' groups have performed a lot of studies. In recent years the application of image processing methods in automated traffic monitoring and control system has been reviewed to optimize methodologies for traffic controls. We also have the ever-increasing problem of the traffic violation. Minimizing the number of violations brings more order and reduces the number of accidents. Currently, the monitoring approaches of traffic violation are not effective and good enough in the majority of the cases. In some other cases, radar guns are used. But these guns cannot target short-range and multiple vehicles [2]. Hence we can use computer vision technology to aid humans to prevent these violations with traffic monitoring. Instead of a regular traffic cop monitoring the vehicles, we can use cameras to improve efficiency and decrease the dependence on humans. This provides greater scope for automation. Detecting vehicles in surveillance data is one of the most sought after problems in computer vision. Here we have made an attempt to detect the actual vehicle and count and detect the speed of the same. These observations are not limited to a single traffic signal. We introduce a new concept of synchronous

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data sharing with the same directional backwards-forward traffic signals that provide better results for automation. We not only determine the violations but also detect the actual vehicle that provides extra information regarding the emergency (in case of a vehicle is an ambulance) in the traffic and jam situation in the respective area. It can be used to determine the peak hours and plan the traffic management layout according to the overall analysis of the system data. We receive the feed from the cameras positioned at the top view and use the footage as input. Though there is an overhead of installing cameras at the region of interest, it is a one-time investment and more durable than passive sensors used to determine the density of the lane because sensors get deteriorated as they are directly installed onto the pavements. Hence cameras give the system great installation flexibility and increase the durability, efficiency and portability of the system.

This paper aims to propose an intelligent synchronised traffic signal monitoring system to improve traffic monitoring and enhance the way we are dealing with some other problems and the situations related to transportation. It will be in the intelligent traffic system. Thus, an intelligent traffic monitoring system will be formed of two segments (or subsystems): a control system and a monitoring system will be able to be integrated together to help the traffic system to take the smart decisions efficiently. This research will be examining the additional component (monitoring system) by using synchronous data sharing between its control system. This system will be capable to identify a different type of vehicles, their speed, and determine the crowded street case, normal street case and empty street case. The input of this system will be a sequence of images of vehicles of the crossing to be monitored. Technically, the proposed method has two stages: training stage and recognition stage which uses one video camera to every crossing of the area. These cameras fixed in a suitable position and use multi-connect architecture based multi-line reference techniques [3] to detect the level of the crowd in the lane.

II. COMPUTER VISION AND MACHINE LEARNING

The most rudimentary objective of computer vision is to make sense of what a computer can see. there are many progressive technologies in the field of cameras which gives high-quality pictures with higher megapixels and resolution. But have not delivered scene to all machine. Maximum machines in the world are still blind. [4] Today there is no need to drive cars manually only because of computer vision based self-driving cars. Without this technology, they cannot understand the difference between crumpled paper and rock. Where they can run over and where should be avoided. Computer vision helps the machine to understand anything like we humans do from identifying people, naming objects, understanding relations, actions, intentions and emotions. Computers learn from data set of images as self-training data and design a model which help to predict. This data set is where huge data information helps the machine to train itself and learn in time. Today humans upload a vast number of images daily on the internet that images can be used for the prediction or machine training. Recognising or classifying an object is different and to make a prognostication is something different. For which high-level algorithms of machine learning are required. The traffic management system consists of CCTV's and sensors that can improve computer performance to make real-time decisions. The CCTV could identify the number of vehicles, lightweight vehicles and high weight vehicles. These can assist in determining the peak time in which there is a higher possibility of traffic.

Over the past several decennaries, an enormous amount of standard transformations have been encountered in the field of computing. Earlier, everything was built on logic and mathematical problems. This logic cannot be used to solve real-world intricacies. An improved system is to be designed which will learn by itself and take decisions at the real-time. Machine learning can be categorized into sections based on the learning methods used. These are supervised learning, unsupervised learning, reinforcement learning, artificial neural networks, pattern recognition and probabilistic machine learning. [5] A combination of these techniques is required to design a reliable and efficient system. This is a progressive procedure, building a somewhat better system than the earlier one.

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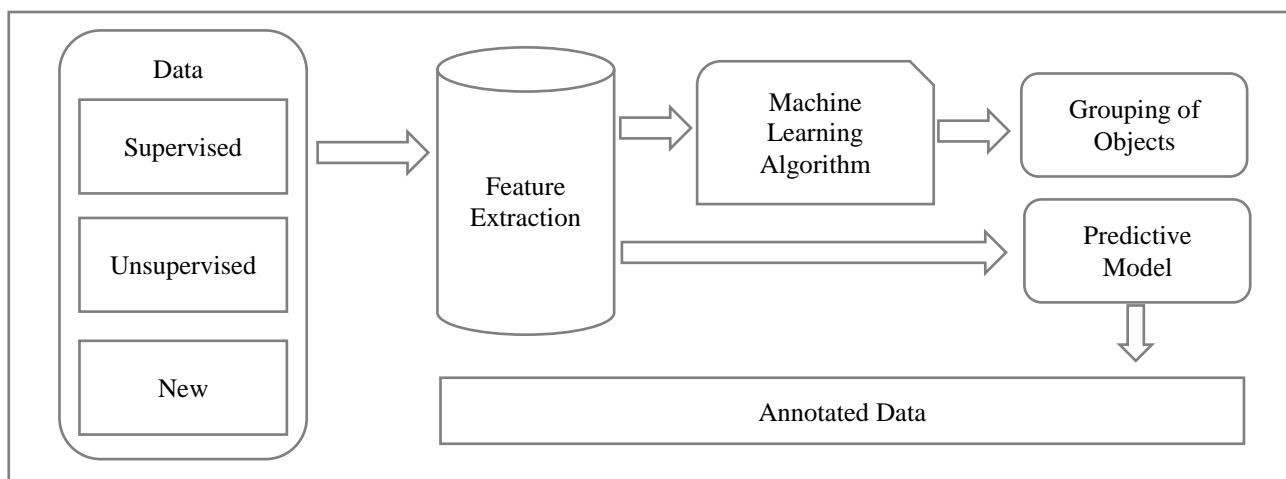


Fig. 1 Workflow of Machine Learning

Machine learning is a part of artificial intelligence which is able to develop machines that can learn from their surroundings from people and from mistakes. Recommendation systems, Autopilot system for planes, translating one language to another using computers and maps are all examples of the systems which are developed by machine learning. With the extraordinary capabilities of these technologies, our synchronous traffic monitoring system will outperform and give the effective result.

III. RELATED WORK

The model-based tracking, as proposed by Koller [6] uses a parameterized vehicle model for an intra-frame matching strategy. Initially, an image segmentation component identifies potential moving vehicles by identifying the moving features in the image. The next approach is also known as region-based tracking [7] used a technique to identify connected regions in the image associated with each vehicle and tracks them. The strategy commonly uses a background subtraction technique. This approach, however, fails in congested traffic conditions when vehicles partially occlude each other, this makes the technique detect the vehicles as one large blob in the foreground image reducing the accuracy. The Kalman filter based approach helps the background estimate to evolve as the lighting, time or weather of the day changes. Another approach based on Active-Contour tracking uses tracking of active contour models. This technique has a reduced computational complexity. The next approach tracks sub-features in the image which can be of distinguishable importance [8]. The advantages of this approach are that even when partial occlusion occurs some of the features of the moving object are distinguishable. [9] and [10] used a Haar-like feature detector with good accuracy for the detection of vehicles. A Haar-like feature takes into consideration adjacent rectangular regions, sums up the pixel intensities in each region and takes the difference between these sums. This will be used to classify sections of the image. Another approach uses a fuzzy logic system started by Zadeh [11]. Also, there are techniques for using Artificial Neural networks wherein decisions are made based upon the accumulated previous knowledge. Finally, there are also hybrid systems as developed by Patel et al. [12] for urban traffic control applications. In [13] Pena-Gonzalez et.al invented a scheme to track vehicles in real time and thereby classify them by involving a vision-based system. An HD-RGB camera is placed on the road to acquire data. At the same time, clustering and classification algorithms are used to process information. Their method yielded an efficiency score of over 95% in test cases. Also, the system achieves 30 fps in image processing with a resolution of 1280x720. Another method was applied by Bhaskar et. al [14] for-Image Processing based vehicle tracking and identification. Blob Detection methods and Gaussian mixture model are used to develop a unique algorithm which is able to track vehicle and recognize vehicle data at real-time. the proposed algorithm was a view to doing improvements. Although it is a highly efficient method, it is not enough to control the high volume of traffic congestion. In the [15] [16], Ali et. al and Kanungo et. al presented an alternative

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approach to intelligent traffic control switching algorithm. Traffic recognition was achieved using cascade classifier for vehicle recognition utilizing Open CV and Visual Studio. A comparison is drawn between conventional traffic management and their proposed scheme.

TABLE I
RECENT ACADEMIC STUDIES IN VEHICLE DETECTION AND TRAFFIC LIGHT SYSTEM

Paper	Year	Method	Feature	Classification	Tracking
[17]	2018	Deep Convolutional Neural Networks	Colour point	Pixel calculation	Space tracking
[18]	2016	Computer vision techniques, including thresholding, hole filling and adaptive morphology operations	Grayscale comparison	Gaussian mixture	Reference line model
[19]	2015	Probabilistic prior maps and dense HoG	Colour	Majority pixel count	Hidden markov model
[20]	2014	Colour thresholding, BLOB analysis	HoG	Support vector machine	Correlation tracking
[21]	2012	BLOB analysis	2D Gabor wavelet	Nearest neighbour	-
[22]	2012	Colour difference enhancement, neighbourhood image filling, radial symmetry	Colour	Colour	Spatial-temporal consistency check
[23]	2011	Prior knowledge based state detection of vehicle	LBP feature	Support vector machine	-
[24]	2010	Colour thresholding, morphological operations	Haar feature	AdaBoost trained classifier	CAMSHIFT
[25]	2009	Gaussian-distributed classifier, BLOB analysis, temporal information	Colour	Global contradiction solving scheme	Temporal filtering / decision scheme

IV. PROPOSED SYSTEM AND CHALLENGES

To automate traffic signal monitoring system, we building a new system using artificial intelligence and computer vision technologies which outperform together. Cameras mounted on every traffic signal records thousands of hours of footage daily, which contain very useful information and can be used to reduce the overcrowding on the streets. With the help of the video footage data, data set of traffic videos and machine learning algorithms, it is probable to make the prediction on traffic situations. Pattern recognition can be used to identify the vehicle type, count number of vehicles, and categorizing lightweight and heavy vehicles. This would improve the system to imagine traffic at each street and control the traffic lights accordingly to decrease the traffic. The machine learning algorithm can perform better as the training data sets contain enough data to predict. These data sets are growing every day which can help our system to determine traffic situations by observing everyday data. Sometimes during the overcrowding situations, signals based on hard-coded time interval technique does not provide excellent results. This is because of the fixed time interval, every street can have different traffic situation every hour even every minute which fails time-based signals and can result in traffic bottleneck. Applying machines to do this job can be very effective and reliable. The proposed system analyses predicting future traffic and current traffic that help to make decisions on which time and where a signal release operation should be performed.

The proposed system will be a synchronised intelligent traffic signal monitoring which will improve the way of traffic monitoring and enhance the way we are dealing with other problems and the situations related to transportation. The proposed model will be composed of two components: a monitoring system and a control system. Both components are able to integrate together and use data of the same directional backward signals simultaneously to take intelligent decisions efficiently. Fig 2 shows the proposed model architecture.

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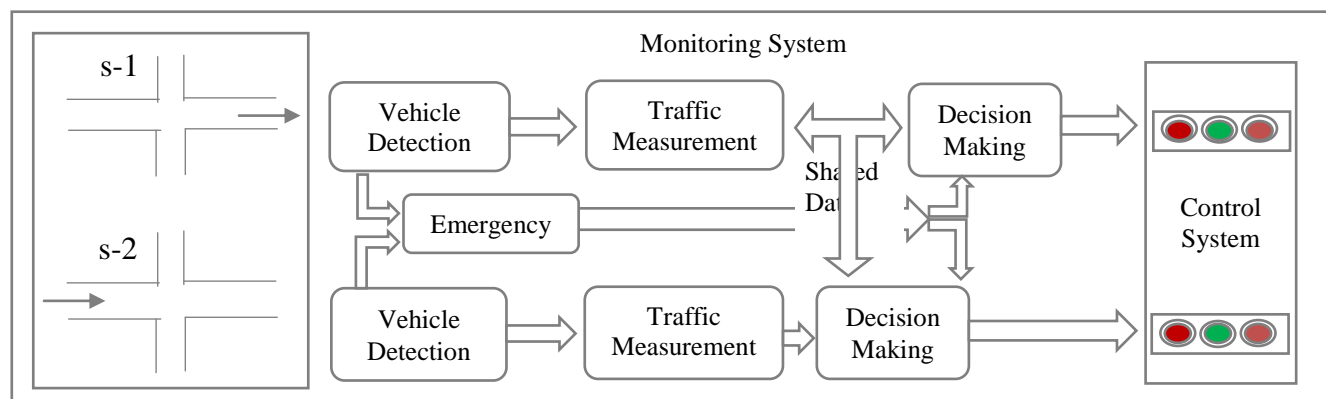


Fig. 2 Proposed Model

The proposed model will give good results in the traffic monitoring but there are some challenges that should be discussed.

- 1) The initial cost of such a system will be high, right from installation to maintenance everything will require a lot of expenditure.
- 2) The system must be first tested on less busy streets and then only it can be implemented on busy junctions. This might take a significant amount of time.
- 3) Changes in road conditions, inclement weather will change the pattern in which the traffic moves. Such unexpected occurrences would directly affect the accuracy of traffic prediction.
- 4) Dynamic computation will require high-end processors which can compute in a fraction of seconds without any room for error.
- 5) Minute error in the system may cause an accident, the design of the system should be flawless as human life is on stake.

V. CONCLUSIONS

In a nutshell, it is possible to create a system which can solve one of our daily urban problems in an effective way by combining major developing fields of computer science. The proposed model here is expected to perform better with time, as the amount of data collected increases, it will be possible to make better predictions. Thus, a reliable and large data set will help in efficient estimations. Moreover, the only collection of data is not enough, one must be able to validate, connect and access data dynamically to extract meaningful information and implement it in real time which will help to predict trends in traffic and regulate traffic efficiently. Thus, the most useful and powerful technology nowadays, machine learning and computer vision will help us to automate our traffic systems.

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