INTELLIGENT TRAFFIC CONTROL SYSTEM USING MACHINE LEARNING

[1]Christo Alias, [2]Muhsin Muhammed, [3]Jerin Peause, [4]Pranav S Nair, [5]Meenu Varghese
[1 2 3 4] Student, [5] Assistant professor
[1 2 3 4 5] Computer Science and Engineering, APJ Abdul Kalam Technological University
[1 2 3 4 5] Ilahia College Of Engineering Technology, Muvattupuzha, Kerala, India

Abstract: Efficient traffic control management is one of the foremost important challenges of our country. Several efforts are implemented within the country to manage traffic including road expansion, highway development, and application of several traffic schemes. one among the researches thrust being studied is that the solution to the limitation of traditional traffic signal systems. the answer to the present control problem should be ready to prioritize congested lanes consistent with corresponding traffic density. The proposed system discussed an approach in developing a traffic signaling system capable of prioritizing congested lanes supported Vehicle Counting System (VCS) and real-time traffic density data. The VCS uses computer vision technology which is a sub field of Machine Learning. The vehicle counting system is formed from three main components: a detector, tracker, and counter. The detector identifies vehicles within this frame of video and returns a listing of bounding boxes around the vehicles to the tracker. The tracker uses the bounding boxes to trace the vehicles in subsequent frames. The detector is additionally wont to update the trackers periodically to make sure that they're still tracking the vehicles correctly. The system works with CCTV cameras positioned at every lane of the intersection in each direction for the acquisition of traffic density data. This data is then used for deciding after processing and prediction. The system will effectively manage holdup by keeping the flow of traffic in each lane through real-time monitoring.

***Index Terms* – Traffic control management, Vehicle Counting System, Machine Learning, Vehicle Count, Prioritizing, Frames**

I. INTRODUCTION

Traffic congestion has always been a major concern of all time. This crisis primarily faced by the residents and the industry sectors of each country for decades and is becoming worst every year. This is becoming a worldwide phenomenon as the number of vehicles increases. In fact, according to, in the U.S. alone nearly $300 billion were spent in gas and time and almost $70 million per year lost due to traffic congestion in the business sector. A study by Japan International Cooperating Agency (JICA) cites that Metro Manila, Philippines is experiencing P3.5 billion in work hours and business opportunities lost per day, thanks to the worsening traffic congestion. Numerous efforts have been implemented in the country to regulate traffic problems including highway and road expansion, and the implementation of several traffic schemes. One of the researches thrusts being studied is the solution to the limitation of traditional traffic light systems.

The improvement of traffic efficiency has been the key goal of why the Intelligent Traffic Control System (ITCS) is introduced as a suggested substitute for conventional traffic light systems. To further optimized traffic efficiency, the traffic lights (or traffic signals) are used by altering signal lights for traffic flow control at road intersections, pedestrian crossings, and other places. Conventional traffic light systems, also known as the traditional traffic light system, are usually fixed-timed cycles which means that the signaling light switches from one another through regular intervals. It is inefficient given that a traffic situation is a variable event that is constantly changing due to different circumstances, i.e., peak hours, accidents or collisions, rallies, roadshows, etc. Due to these certain limitations, ITCS is introduced.

ITCS is designed to adaptively control traffic flow operation based on the real-time traffic situation. A typical class of intelligent traffic light systems is a traffic signaling system that can measure and calculate the traffic densities of each lane using cameras placed on the intersections, and prioritize lanes that are more congested and needed attention. However, a huge amount of human intervention is required for these types of systems to become fully functional and thus automated computer vision-based approaches were proposed. In, the research used a rotary camera placed at the center of the intersection to capture images from different lanes then process the image captured using image processing techniques based on edge detection. Traffic density and timing were computed for the operation and control of traffic signal lights.

II. RELATED WORKS

According to Intelligent Traffic Light System Using Computer Vision with Android Monitoring and Control [1], This system is to develop an intelligent traffic light system using computer vision to measure the traffic density which may operate no matter the time of day. The system employs CCTV cameras stationed at each lane of the intersection for the capturing of traffic images which can then be sent to the Raspberry Pi 3 microcontroller for traffic density calculation using image processing.

According to Prediction and Tracking of Moving Objects in Image Sequences [11], Tracking of moving objects is important for video surveillance while future frame prediction is used in video coding. Occluding and un-labeled regions are identified and classified within the context of a tracking algorithm. A few approaches are adopted for solving these problems. In an occlusion adaptive mesh is employed for tracking moving features over several frames. In other approaches, features are extracted from a set of frames, and afterward, they are tracked over the sequence. Kalman filters have been used for tracking. Objects are segmented based on clustering.

According to Detection and Classification of Vehicles [10], The system we propose consists Of, Segmentation: in this stage, the vehicles are separated from the background in the scene. Region Tracking: the results of the segmentation step may be a collection of connected regions. This stage tracks regions over a sequence of images employing a spatial matching method. Recovery of Vehicle Parameters: to enable accurate classification of the vehicles, the vehicle parameters such as length, width, and height need to be recovered from the 2-D projections of the vehicles. This stage uses information about the camera's location and makes use of the very fact that during a traffic scene, all motion is along the bottom plane. Vehicle Identification: our system assumes that a vehicle could also be made from multiple regions.

According to the real-time computer vision system for vehicle tracking and trace surveillance [12], The quest for better traffic information, and thus, an increasing reliance on traffic surveillance, has resulted in a need for better vehicle detection like wide-area detectors; while the high costs and safety risks related to lane closures has directed the search towards non-invasive detectors mounted beyond the edge of the pavement. One promising approach is vehicle tracking via video image processing, which may yield traditional traffic parameters like velocity, also as new parameters like lane changes and vehicle trajectories. Because the vehicle tracks, or trajectories, are measured over a length of roadway, instead of at one point, it's possible to live true density rather than simply recording detector occupancy.

According to the Intelligent Traffic Management System for Cross Section of Roads Using Computer Vision [3], In a cross-section of roads (junction) we see that one side has lower congestion than the opposite side, but because the lights are changing at fixed time intervals, the jam on the road which has higher congestion keeps getting worse. On the other hand, most of the traffic polices are unaware of the situation at places away from him/them. It is also very hard to seem at every side of a junction constantly by one person and choose correctly the way to guide the traffic. At present, there are two available approaches to control traffic. One is by sensing vehicles with pressure plates on road and therefore the other one is by using RFID tags on number plates and placing RFID readers on road

According to the Computer Vision-Based Vehicle Detection for Toll Collection System Using Embedded Linux [2], Initially, there were toll collection systems such as manual toll collection without generating computer receipts. This method is very inefficient. This method of payment was used to stop the vehicles at the toll station and wait for a relatively long time for their turn to come. This was causing congestion of traffic. The states of congestion and inefficiency prompted the government to plan and implement an Electronic Toll Collection (ETC) system which can remove out these problems and facilitate convenience for all who are involved in the process of toll collection directly or indirectly. ETC systems are designed and developed to cooperate within the operations of toll management through the utilization of technology. These systems gather data traffic, then they will classify the vehicles and collect the expected amount of fare.

According to Automatic Traffic Signs and Panels Inspection System Using Computer Vision [5], This system is the result of the collaboration between the Robe safe Research Group at the University of Alcala and a series of recognized and prestigious companies in road safety and inspection industries, such as Euroconsult, 3M-Spain, and Safe control. Visualize is a patented dynamic inspection system for traffic signs (including those panels above the road), mounted onboard a vehicle, which can perform inspection tasks at conventional driving speed using computer vision techniques.

According to Image Processing in Road Traffic Analysis, Nonlinear Analysis: Modelling and Control [7], The approach in this system focuses on methods of image processing, pattern recognition and computer vision. One of the most aspects was to switch these algorithms to suit to real-time road monitoring processes, and as a consequence the prototype of system for traffic analysis was developed. Technically this technique is predicated on stationary video cameras also as computers connected to wide area network. Capabilities of the system include vehicle tracking, vehicle speed measurement (without use of traditional sensors), and recognition of car place numbers of moving vehicles, lane jam detection.

According to Automated Intelligent Traffic Control System Using Sensors [4], Wireless sensor network technology to sense presence of Traffic near any circle or junction and then able to route the Traffic supported Traffic availability or we will say density in desire direction. This system doesn't require any system in vehicles so are often implemented in any Traffic system quite easily with less time and fewer expensive also.

According to Intelligent Traffic Light Flow Control System Using Wireless Sensors Networks [6], Many techniques have been used including, aboveground sensors like video image processing, microwave radar, laser radar, passive infrared, ultrasonic, and passive acoustic array. Another widely-used technique in conventional traffic surveillance systems is predicated on intrusive and non-intrusive sensors with inductive loop detectors, micro-loop probes, and pneumatic road tubes additionally to video cameras for the efficient management of public roads. However, intrusive sensors may cause disruption of traffic upon installation and repair, and should end in a high installation and maintenance cost.

III. Proposed System

The computer vision technique will be applied to identify vehicles approaching the junction from every direction. Machine vision cameras can be equipped for this purpose which provide the required data input for deciding the traffic signal status. Data collected from cameras include the vehicle count with corresponding time stamps from certain fixed locations on the road. This point from which the data is collected will be at a certain distance from the junction. Consider one of the roads and the data from the camera surveillance that road can help to calculate the expected traffic rate at the road for time 't'. Similarly, input from every other camera when compared to each other, the system will be able to identify the busiest road. Now the system is able to prioritize every road and the traffic signals for each road will be controlled on this basis. Roads will be given different priority accordingly. Signals will be controlled within a closed loop but with different intervals for different roads. Training the model for identifying emergency vehicles such as ambulances, fire engines etc can be used to specifically prioritize emergency situations and take actions accordingly.

The following are the important modules in our proposed work.

- Training data analysis
- Feature extraction

- Model training
- Sliding windows
- Eliminating false positives

Training data analysis

Training data is obtained from YOLOv3 and it consists of 720*1280 images which are pre-processed into 608*608 images. Training successfully helps to identify the vehicles. Automobiles would be identified individually with maximum accuracy. This object identification from camera footage happens in real time with moderate computational power.

Feature extraction

In order to detect a car in the image, we need to identify feature(s) which uniquely represent a car. We could try using simple template matching or relying on color features but these methods are not robust enough when it comes to changing perspectives and shapes of the object. While detecting emergency vehicles on the road, the task gets a little complex. The unique features of such vehicles like red alarm light, unique text on the body, etc can be used for feature extraction. In order to have a robust feature set and increase our accuracy rate we will be using Histogram of Oriented Gradients (HOG). This feature descriptor is much more resilient to the dynamics of the traffic.Scikit-image python library provides us with the necessary API for calculating HOG features.

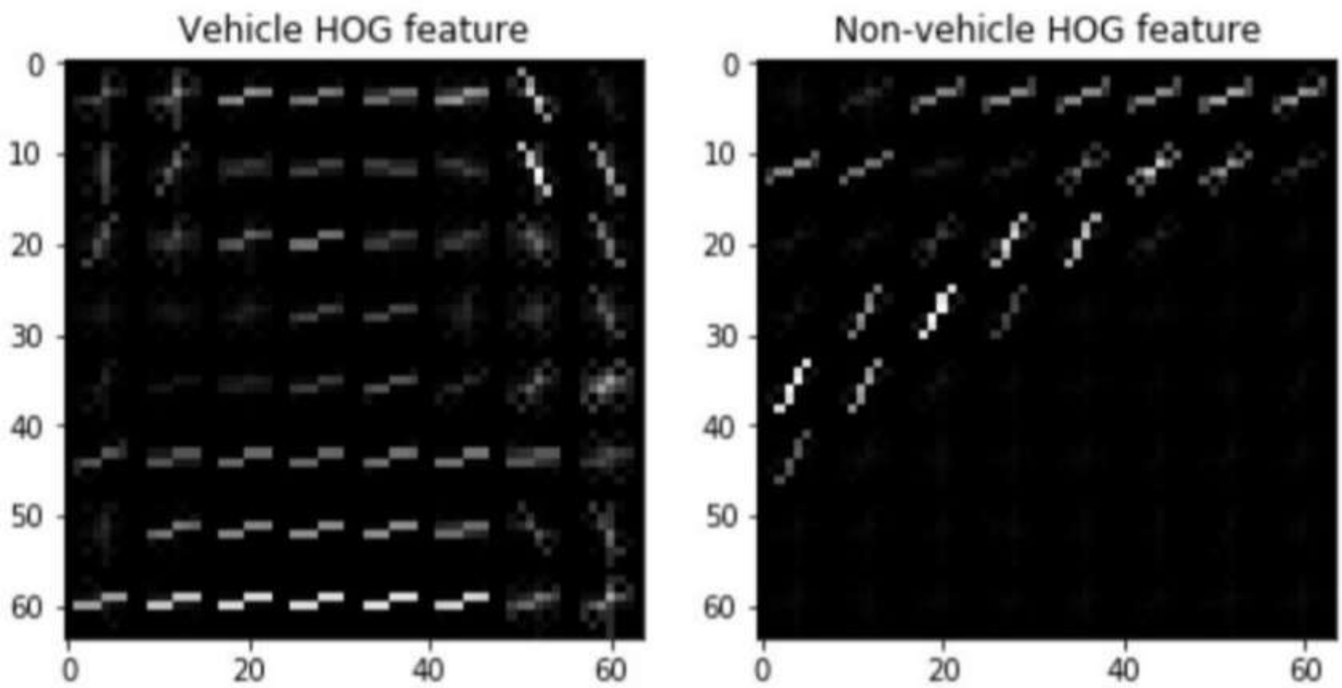

Figure1: Extracted HOG features from sample training data

Model training

In order to detect the car/emergency vehicle based on our feature set, we would need a prediction model. For this particular case we will be using Linear Support Vector Machines (Linear SVMs). It is a supervised learning model which will be able to classify whether something is a car or not after we train it. HOG features have been scaled to zero mean and unit variance using Standard Scaler. The data set is divided into a training set (80%) and a testing set (20%). Images have been shuffled as well before kicking off the training session. In the end Linear SVMs model with the extracted HOG features on YCrCb color space reached 98.06% accuracy rate.

Sliding windows

Once we have the prediction model, it's time to use it on our test images. Prediction model will be applied in a special technique called Sliding Windows. With this technique we will be running a prediction model on sub-regions of the images which are divided into a grid. In order to increase the robustness of this approach we will be adding multiple grids which will be traversed by the prediction model. We are doing this since cars can appear on the image in various sizes depending on its location on the road.

Eliminating false positives

In order to improve the accuracy of the final output we will be trying to find multiple hits for the object of interest in the similar area. This approach is equivalent to creating a heat map. The next step is introducing a threshold which needs to be met in order for a specific hit count from the heat map to be accepted as a detected car. In our case threshold has a value of 2.

IV. CONCLUSION

The development of the Intelligent Traffic Control System to an innovative approach in improving conventional traffic light system by integrating the latest advancement of ITCS with computer vision. Not only does the system be able to regulate the traffic flow operation through traffic density calculation tactic using image processing method but furthermore, it enables the traffic enforcers to effectively supervise the traffic situation present in the area via the utilization of the developed system. The use of computer vision has been successfully used for traffic density estimation incorporating it in an intelligent traffic light system. The developed system achieved a vehicle detection rate of 92.84% and 85.77% for daytime and nighttime operation respectively. Background Subtractor MOG is very powerful algorithm as it is robust and efficient enough so that it can be implemented on embedded platform. Robustness of algorithm can be verified from the tests. Results of all these tests are satisfactorily similar. there is hardly any effect of skipping of frames on the output. Tests on algorithm suggest that the threshold of variance between foreground and background is crucial parameter to look for. Currently the system uses fixed or predefined thresholds depending on the road to measure number of vehicles. System will be enhanced with machine learning abilities so that system itself can identify those thresholds. Currently the system runs on a single server for an individual network. It can be developed in such a way that system can run on a grid of servers to support multiple networks under a single system. Currently the components on the road run on external power. Devices on the traffic nodes can be powered by solar cell to increase power efficiency.

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