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Smart Traffic Controller Using Machine Learning

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Abstract

Traffic signals play a vital role in managing vehicular traffic, which can lead to severe congestions if mismanaged. It is designed to improve the efficiency and the effectiveness of the pre-existing system which is managed by traffic wardens. The system will be able to manage traffic independently, ensuring that there is a free flow of traffic at all times of the day. It employs two basic components, namely OpenCV which is a computer vision library which primarily deals with the video-source and preprocessing, followed by which, the feed is processed by TensorFlow Object Detection API, which detects the number of cars in a given frame of video. The system then determines the density of traffic at a given intersection and grants the signal which can clear maximum traffic for a given point in time. Implementation of such a system not only reduces the traffic by a large extent but also reduces the manpower required to manage the intersections. Thus, the implementation of an automated system is the need of the hour to ensure that the rising traffic density is effectively managed.

Keywords: *Computer Vision ,Object Detection, Smart Traffic Management System, Tensorflow*

1. Introduction

Traffic in urban cities and towns have been a serious problem which deserves high priority and deserves to be resolved at the earliest. Traditional traffic management was done using traffic lights or hand- signals given by the traffic warden, have been mostly ineffective or mismanaged when the warden is away from his kiosk. This problem can be addressed effectively and efficiently by a Smart Traffic Management System, which employs the usage of neural networks and video processing to determine the traffic at any given point of time at a given intersection to determine the traffic density and grant the required signal to ensure that the traffic is cleared, efficiently.

The system employs the usage of a mini-computer which is capable of communicating through a LAN and a computer with high-performance to process the video and provide the signals to the former to display as the signal for the prevailing traffic situation. The project employs two basic elements for processing the video-feed, namely OpenCV and TensorFlow, which are responsible for processing the live video stream from a traffic intersection and determining the traffic density based on which, a signal-cycle is granted. Thus, the designed system can solve the ever growing problem of mismanagement of traffic at intersections

2. Literature Survey

The traditional system involves the usage of traffic lights which are manned by the traffic warden who determines the duration up to which the signals must be cycled among various lanes in the intersection. In case of a pre-timed scenario, vehicles must wait for the signal in their lane to turn green even if there is less traffic density on roads, Authors in [1] have used surveillance systems to determine traffic density and determine the rate of flow of traffic. Authors in [2], authors have used images from CCTV cameras to determine the density of traffic prevailing at the intersection. Authors in [3] have developed a program to determine the signal to be granted

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using the images taken at intersections . In [4], authors have compared the two techniques, namely machine learning and image processing techniques to build the system. Authors in [5] have discussed about a system which accepts the video feed to determine the density of traffic.

3. Proposed System

The proposed system will consist of a router, to send packets to the remote computer which controls the traffic lights from the computer, which processes the video feed. The system is designed in a way to reduce both, cost and complexity. The OpenCV module provides a platform to retrieve and pre-process the live-video feed, obtained from the camera, followed by which, the feed is fed to TensorFlow Object Detection API to determine the density of traffic by identifying the number of cars in the video frame. The model which is employed to identify objects in a frame of the received video feed is ssd_mobilenet_v1_coco which has mAP (Mean Average Precision) of 21. The camera will continuously provide the video feed to the system. As the number of cars are determined by the system, the required duration of stop and proceed signals are determined, which are most suitable to clear majority of the traffic. The packet to control the signal is sent over a LAN to the remote computer, which will be controlling the signaler using the GPIO (General Purpose Input-Output) through a network-pipe. The object detection classifier has been trained using 400 images, out of which 320 images have been used for training the classifier and 80 images have been used for testing the classifier for over fifty thousand steps.

4. Methodology

The system is set up at an intersection with its camera positioned in such a way that it can obtain a bird's eye view of traffic entering and exiting the frame. The feed which is obtained, is processed by the OpenCV module which captures the live video-stream and converts them to respective n- dimensional arrays. Once the pre-processing is completed, the next step associated with the video is the detection and counting of vehicles present in the frame and subsequently, the number of vehicles is related to the prevailing density of traffic at the intersection. Based on the number of vehicles identified, the system determines the signal which is best suited to clear traffic, efficiently and the signal is sent over to the controller, which is connected to the same Local Area Network, and the corresponding signals are then activated by the controller through the switching on and off of the GPIO pins. The camera constantly provides the system with the video feed therefore, the system provides the best signal cycle associated for the prevailing traffic situation. The traffic data is also stored locally on a .csv file for analytics.

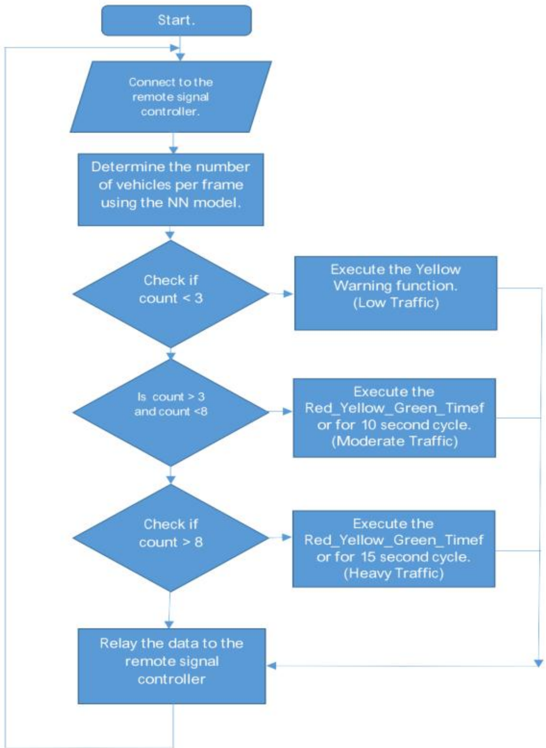

Figure 1: Flowchart of how the traffic signal is determined.

5. System Architecture

The system will consist of a high definition camera to provide the live video-stream to the computer through either an IP-route or the USB port. The obtained feed is then processed by a computer with good compute capability, in order to identify and determine the number of vehicles present in the video frame. The number of vehicles determine the signal which needs to be granted to clear majority of the traffic. The signal is sent over a LAN to the remote computer which controls the signaler via router. As the signal is received by the remote computer, the specific signals are granted at the intersection.

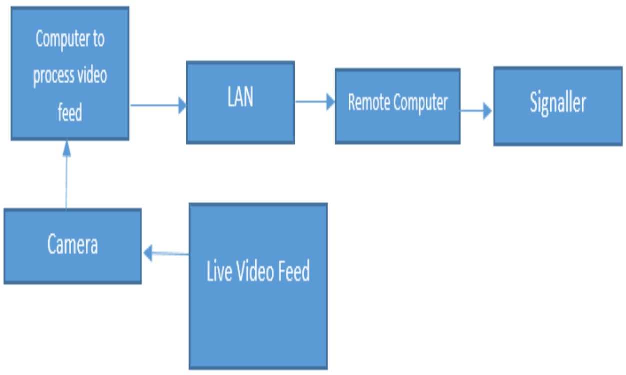

Figure 2: Architecture of the Smart Traffic Controller

6. Applications

The designed system can be employed in any intersection in order to manage the traffic, throughout the day irrespective of the weather conditions or availability of man-power. Thus, easing up the stress mounted on traffic wardens. As the system determines the best signal-cycle for a given point of time, it ensures that maximum traffic can be cleared throughout the day without delay.

7. Conclusion and Future Scope

The developed system will play a vital role in automating the traffic signals in an efficient manner, with the reduction of workforce required to manage the same. As the system works on the real-time video feed to determine the traffic density and then provide the signal, it ensures that the best traffic signal cycle is granted. The system can further be enhanced to identify those who commit traffic offences and fine them accordingly.

8. Results

The system was set up and was tested on a scaled-down model of cars, in which the system was correctly able to identify the cars and count them, to determine the traffic density. The results obtained are represented in pictures. The system was able to adapt itself according to various traffic densities and grant the required signal to ensure maximum flow of traffic through the road. When compared with the existing system, which employed the usage of HAAR cascades, the system can also be trained to adapt itself during the event of rain, smog, fog, dawn and dusk and manage traffic efficiently without human intervention. The outputs and results obtained are represented below.

Figure 3: Identification of Cars in low density traffic

No of cars detected : 2
Activating Low Density - 5 Seconds
If cars density ranging from 0 to 4 then it activates 5 - sec
If cars 5 to 7 then 10 sec,if cars >8 15 - sec

Figure 4: Identification of cars in high traffic density

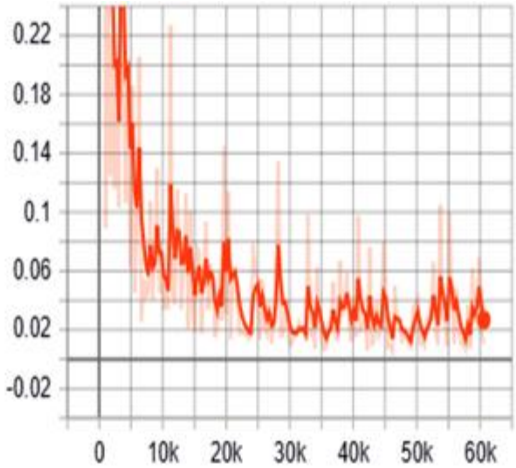

Figure 5: Loss graph

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No. of cars detected: 5
Activating Medium Traffic Density Cycle -10 Seconds
No. of cars detected: 1
Activating Warning lights - 5 Seconds
No. of cars detected: 3
Activating Low Traffic Density Cycle -5 Seconds
No. of cars detected: 8
Activating Severe Traffic Density Cycle -15 Seconds
No. of cars detected: 4
Activating Low Traffic Density Cycle -5 Seconds
No. of cars detected: 4
Activating Low Traffic Density Cycle -5 Seconds
No. of cars detected: 0
Activating Warning lights - 5 Seconds
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Figure 6: Output Window

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