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Perception of Traffic Light with Image Processing and Machine Learning

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Abstract:

In perception of traffic light, detect various lights from image and then recognize traffic light from that lights, then give the status of the light signal. Automaticdetection and recognition of traffic light is an important perception function for advanced driver assistance system (ADAS) or an autonomous vehicle. Computationtime, varying illumination conditions and false positives are three key challenges.In our approach, perception of traffic light is done from the video and accuratelyclassified using machine learning from frames. A multiclass classifier is adopted toreduce number of false positives. In order to overcome the challenging problemsin traffic light recognition, we have proposed a real-time traffic light perceptionsystem based on image processing and machine learning.

Keywords **—Traffic signal, traffic light recognition, image processing, machine learning, advanced driver assistance system, multiclass classifier.**

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INTRODUCTION

As population is increased traffic problem is one of the most dangerous problem. To overcome this problem traffic light recognition is very important for advance driver assistance car or autonomous vehicle. A driver from normal vehicle or car can easily recognize traffic light, but it is difficult for ADAS cars to recognize traffic light from the traffic signs, pedestrian, temporary road signs which have similar colour with traffic light. For perception of traffic light, traffic light recognition is important task. After the traffic light recognition determination of traffic signal is also important.

Perception of traffic light helps an autonomous car to take decision for further movement. Also according to status of traffic signal that car decides either continue or stop. Perception of traffic light also helps to reduce the rate of road accidents which occurs due to limitation in recognition of traffic light. In future, this system will also stop those who can break the traffic signal. Perception of traffic light is effective way for traffic control. For traffic light recognition consideration of different environmental conditions such as lightning is important.

It is easy to recognize traffic light form the dark frame, but as we have to recognize the traffic light from the bright frame various false positives are introduced such as traffic signs, pedestrian, temporary road signs which have similar colour with traffic light. For that firstly the bright frame is converted to the dark frame and then from that dark frame traffic light is recognized. If traffic light is not present or not get detected from the frame then go for the next frame otherwise state the status of traffic light. After this car has to take decision to continue or to stop based on the status of traffic light.

Machine learning is very efficient method in which object is correctly classified or grouped or stated using different kind of methods or machine learning models. From that CNN model of deep learning is very useful model for multiclass classification. There are also some other models but the efficiency of CNN is more than other. We are taking the dataset for designing the CNN model, so the input for model is an image as per dataset. If not in that form, then we have to convert it into suitable format. In this, rather than converting image into dataset format create the model from set of images rather than the dataset.

Traffic light is recognized from other lights due to its intensities and the position. Traffic signal is made up of small LED's of red, green and amber colour. As LED's of particular colour glows we observe signal with particular colour. The meaning of traffic signal get change as colour changes. The meaning of red light is the vehicle has to stop, yellow light is ready to stop or go and green light means vehicle can go forward. Colourcombination of traffic signal may be different as per country or location. So while designing the system consideration of all these conditions is necessary.

LITERATURE SURVEY

Recognition of traffic light or signal and estimating the status of that signal is the main problem in autonomous cars. To overcome this problem we proposed a traffic light perception system. This system is consists of different algorithms studied from various reference papers. A region of interest is a subset of an image or a dataset identified for a particular purpose. Region of interest is identified by the boundaries of an object. The boundaries of object may be defined on an image, for the purpose of measuring its size. The concept of a ROI is commonly used in many application areas. The region of interest method is effective in feature extraction but inefficient because it is sensitive to illumination changes. In geographical information systems (GIS), a ROI can be taken literally as a polygonal selection from a 2D map. In many applications, symbolic (textual) labels are added to a ROI, to describe its content in a compact manner.

In saliency map filtering majority of existing methods utilize various colour spaces and tuned colour threshold to detect colour blobs of traffic light. The colour is primarily used for finding region of interest and classifying traffic light states. Instead of RGB colour space, other colour spaces are considered because colour and intensity are mixed in three channels of the RGB colour space. The input image is first abstracted into perceptually homogeneous elements. Colour of the pixels of each element is represented. In this, saliency value is assigned to each pixel. Saliency refers to unique features (pixels, resolution etc.) of the image in the context of visual processing. Saliency map is a topographical representation of them.

In multiple exposure images based traffic light recognition multiple exposure images consist of two images with different exposure times that are captured sequentially. We propose a colour detection method based on multiple exposure images to solve the saturation problem. This method has two advantages first the colour threshold region can be determined as narrow therefore false positives are reduced then saturation problems do not occur because of the brief exposure of low exposure images to light. This paper propose a multiple exposure images based traffic light recognition method. Colour segmentation is widely used to detect traffic light signals in traffic light recognition system. Multiple

exposure technique which enhances the robustness of colour segmentation and recognition accuracy by integrating both low and normal exposure images.

CNN to classify the presence of the object within that region. Faster RCNN replaces selective search with a very small convolutional network called Region Proposal Network to generate regions of Interests. R-CNN models first select several proposed regions from an image and then label their categories and bounding boxes. Then, they use a CNN to overcome false positives. Here we use the features of each proposed region to predict their categories and bounding boxes. The output dense layer consists of the features extracted from the image and the extracted features are fed into an SVM to classify the traffic signal within candidate region proposal.

The support vector machine employed to classify the status of the traffic lights is widely used to solve classification problem. The most important factors of SVM classification are to define vectors that can represent each category. The HOG descriptor is selected as the feature vector for the traffic light classification. SVM is a linear model for classification problems. It can solve linear and non-linear problems and work well for many practical problems. The idea of SVM is simple, the algorithm creates a line or a hyperplane which separates the data into classes.

METHODOLOGY

The main purpose of the system is to recognize traffic light from an image and state the status of traffic light. In this firstly CNN (Convolutional Neural Network) model is designed. CNN is machine (deep) learning model which is used for multiclass classification. Here we have to classify the Traffic light status. For classification we use dataset having various instances. Pre-processing of the dataset is done using various steps as following:

1. Import libraries.
2. Import the dataset.
3. Taking care of missing data in dataset.
4. Encoding categorical data.
5. Splitting the dataset into training dataset and testing dataset.
6. Feature scaling.

After pre-processing CNN model is designed on training dataset, then for performance measurement testing dataset is used. The architecture of the system is as follows:

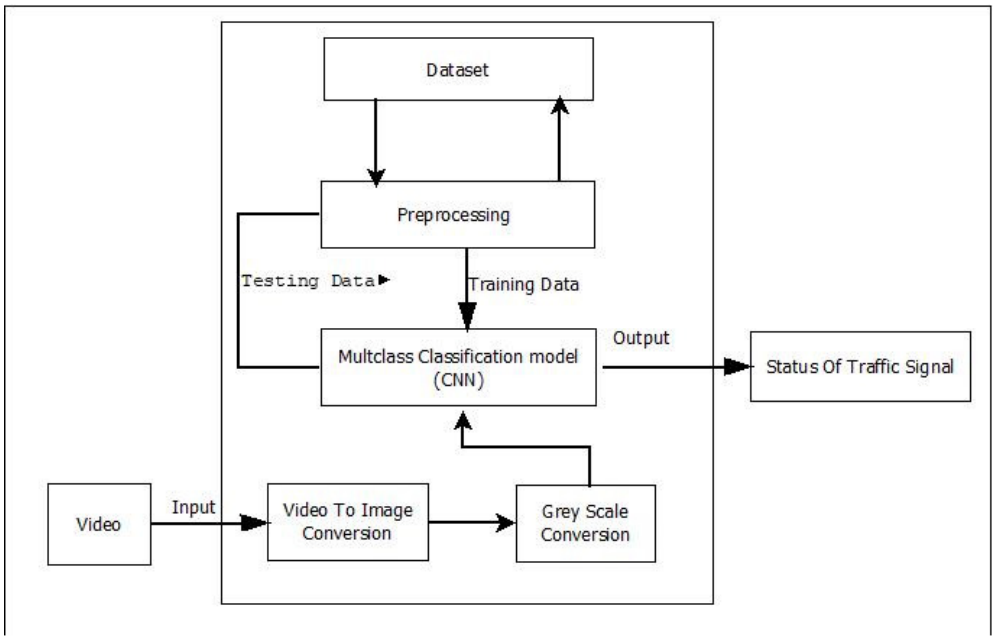


Fig. Diagram of proposed traffic light perception system

Convolutional Neural Network is a neural network model and designed for work with two-dimensional image. Converted tolinear arrayCNN is used for object detection and recognition.CNN classification of image takes input as image apply process on it and classify under different categories.It contain future extractionand classification. In feature extraction apply pooling operation during which feature is detect from image and during classification connected layerwill act as classifier and assign probability for the object on image. CNN contain three steps:

1.Convolutional
2.Polling
3.Flattening

Purpose of convolutional is extract feature from input image and keep relationship of each pixel from input image. Each image considered as matrix of each pixel values this matrix is known as feature map. Pooling reduce dimensions of every feature map but keep important information.After pooling comes flattening matrix is converted into linear array.After that all steps layer of neural network apply probability for object on image.

A video is taken as input and then image processing is performed on it.Image processing starts with finding the region of interest in which object detection is the main part. For detecting object from image open CV function is used. Filter an image to get grayscale image. After greyscale conversion an object is detected from image using CNN function. Detect and recognize traffic light from the image using object detection.

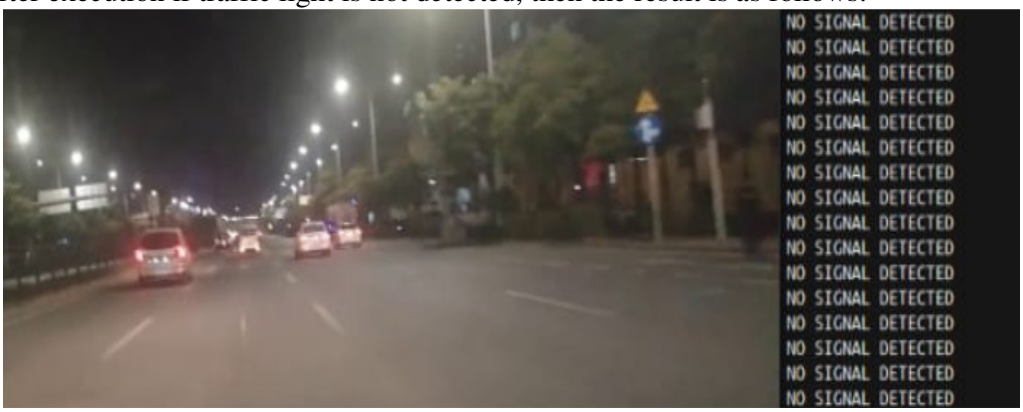
For recognition of traffic light there are some false positives such as traffic signs, pedestrian, temporary road signs which have similar colour with traffic light. These false positives are overcome using CNN. After overcoming these false positives traffic light is correctly recognized. After recognition we have to state the status of traffic light. If there is no traffic light present in image then go for the next image. If traffic light is recognized then go for classification.

Grey scale image from which traffic light is detected is added to dataset as single instance. All pre-processing operations done as per on dataset. This instance is given as input to CNN model. Draw confusion matrix for the model. After successful designing of machine learning model check the performance of the model. Also calculate the precision, recall, accuracy and error of the model. The system gives traffic light status as output.

EXPERIMENTAL REULTS

The accuracy of this model is achieved up to 92.6% to 97%. This uses CNN, so the machine learns using results and penalty. So it gives high accuracy compared to other machine learning algorithms. As quality of video improves the accuracy of the model increases. Accuracy also depends on the size of dataset, as dataset size is more accuracy is also high.

After execution if traffic light is not detected, then the result is as follows:



After execution if traffic light is detected the signal is red, then the result is as follows:

After execution if traffic light is detected the signal is green, then the result is as follows:

CONCLUSIONS

In order to overcome the challenging problems in traffic light recognition, we have proposed traffic light recognition system based on image processing and machine learning in this paper. From video we detect traffic light efficiently using object detection which is part of image processing. To overcome false positives caused by the traffic signs, pedestrian, temporary road signs which have similar colour with traffic light CNN is used. For determining status of traffic signal CNN model of machine(deep) learning is designed successfully. It is very efficient system for controlling the traffic and minimizing the road accidents.

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