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Traffic Sign Detection and Recognition for Automated Driverless Cars Based on SSD

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ABSTRACT

Self-driving vehicles are cars or trucks in which human drivers are never required to take control to safely operate the vehicle. They can possibly reform urban portability by giving maintainable, protected, and advantageous, clog free transportability. The issues like reliably perceiving traffic lights, signs, indistinct path markings can be overwhelmed by utilizing the innovative improvement in the fields of Deep Learning (DL). Here, Faster Region Based Convolution Neural Network (F-RCNN) is proposed for detection and recognition of Traffic Lights (TL) and signs by utilizing transfer learning. The input can be taken from the dataset containing various images of traffic signals and signs as per Indian Traffic Signals. The model achieves its target by distinguishing the traffic light and signs with its right class type. The proposed framework can likewise be upgraded for safe driving in spite of hazy path markings.

KEYWORDS: *Traffic Light (TL), Faster Region Based Convolution Neural Network (F-RCNN), Deep Learning (DL)*

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INTRODUCTION

The road traffic scenes are usually complex and it is difficult to extract the traffic parameters and detect the traffic anomaly with the existing methods, therefore deep leaning based approach is proposed to overcome these external factors. A deep neural network based model is proposed for reliable detection and recognition of traffic signs and lights using transfer learning. The method incorporates use of faster region based convolutional network (R-CNN) Inception V2 model in Tensor Flow for transfer learning. Transfer learning is a machine learning technique where there is enhancement in learning of a new task by channeling the knowledge through a related task that has formerly been learned. SSD algorithm is used for object detection with a deep neural network and training a high capacity model by using F-RCNN is able to recognize the category in which the detected object belongs. For the Traffic Sign detection considering the application requirement and available computational resources, Faster R-CNN Inception-V2 model is used which serves the accuracy and speed trade-off.

RELATEDWORKS

Various studies and related works can be done in the case of objection detection and recognition. Strategies for TL location are regularly delegated image preparing based, AI based or map-based methods [5]. In the picture handling based technique, a solitary or numerous measures of activities or tasks are performed on the picture so as to accomplish a specific resultant.

In the paper [3] AbduladhemAbdulkareem Ali, Hussein Alaa Hussein proposed a method which is alternative to image processing systems. This system is based on passive Radio Frequency Identification (RFID) technology. Autonomous driving vehicles have become a trend in the vehicle industry. Many driver assistance systems (DAS) have been presented to support these automatic cars. Traffic light Recognition plays an important role in these systems. This paper presents a RFID based system is used to recognize traffic lights status. The proposed approach avoids the issues that usually appear with the ordinary traffic lights recognition systems, especially with Systems that employ image processing techniques to recognize the traffic lights status. The approach provides a high performance and a low-cost system and also presents a RFID based system used to recognize road signs. This system is based on passive Radio Frequency Identification (RFID) technology. Using this technology, complex processing algorithms are not required because the signal has a small RFID Tag that carries all information needed for the inventory. A wireless transmission device such as the X-Bee is adopted in this paper. Furthermore, RFID technology has few other advantages, they are considered as low-cost and low-power devices, which mean that the RFID passive tags can be operating for many years without battery. In order to prove

the systems perform properly, the system has been experimentally tested for both based traffic light system and road signs. During run tests all signals are recognized correctly

In the paper [4] Shraddha Mane, Prof. Supriya Mangala proposed a method for moving object detection using Tensor Flow object detection API .In this system, the video is feed to the system as an input. Frames are extracted for further processing. The two main algorithms object detection and object tracking is process through deep learning methods. The object detection using computer vision algorithm is affected by different aspects like light variation, illumination, occlusion and system has difficulty to detect the multiple objects. Here, Tensor flow based object detection algorithm has been used. TensorFlow based object detection API is an open source platform. It is built on the top of TensorFlow which make simple to construct, train and detection models. In this approach, firstly the necessary libraries are imported. Then import the pre-trained object detection model. The weights are initializing along with box and tensor class. After initialization of all the parameters of the tensor flow model, the image in which object to be detected is read. Apply the loaded tensor flow model on the image, the TensorFlow based model test the image and return the location (x, y, w, h) of the object in the image. This is the process of object detection of TensorFlow object detection algorithm. The success rate of this approach is better and it is applicable to RGB images. After detecting the object, their locations are important to start the tracking process. After detecting the object, their locations are important to start the tracking process. Instead of using conventional computer vision based algorithm, in this approach Convolutional Neural Network (CNN) based tracking algorithm is used.

The quality of life of people is increasing together with the developing technologies. One of the most important factors affecting daily life is smart cities. The quality of life of people is positively affected by emerging this concept in recent years. Autonomous vehicles confront with the term of the smart city and have become even more popular in recent years. In this study[4], a system of traffic lights detection and recognition is performed in order to reduce the accidents caused by traffic lights. In the paper [5] Ziya Ozcelik, Canan Tastimur, Mehmet Karakose, Erhan Akin proposed a method which has divided into two sections. Each of these parts requires hardware. The first part requires a camera to get the image. The other part requires a computer to process the received images. In the proposed method, images have been taken using CCD camera in the first step.Image processing techniques are performed step by step to detect the traffic lights in the received image through the computer. When traffic lights are detected, the received RGB image is converted into HSV format to perform chromatic separation from uniform and non-chromatic elements in the image. By performing a color based segmentation process on the obtained HSV format image, the locations of traffic lights in the image are easily detected. The color of the traffic light is easily determined through the SVM (Support Vector Machines) classification model which is a machine learning algorithm prepared beforehand, after the location of the traffic lights is determined in the image

In the paper [6] Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun presents Region Proposal Network (RPN) that shares full-image convolutional features with the detection network, thus enabling nearly cost-free region proposals. State-of-the-art object detection networks depend on region proposal algorithms to hypothesize object locations. Advances like SPPnet and Fast R-CNN have reduced the running time of these detection networks, exposing region proposal computation as a bottleneck. In this work, we introduce a Region Proposal Network (RPN) that shares full-image convolutional features with the detection network, thus enabling nearly cost-free region proposals. An RPN is a fully convolutional network that simultaneously predicts object bounds and objectness scores at each position. The RPN is trained end-to-end to generate high-quality region proposals, which are used by Fast R-CNN for detection. We further merge RPN and Fast R-CNN into a single network by sharing their convolutional features—using the recently popular terminology of neural networks with "attention" mechanisms, the RPN component tells the unified network where to look.

Dwi H. Widyantoro and Kevin I. Saputra accomplished TL discovery and acknowledgment with the assistance of Color Segmentation and Circle Hough Transform [8] while Guo Mu accomplished the equivalent with RGB to HSV change, sifting, histogram of situated slopes (HOG) highlights and bolster vector machine (SVM) [9]. Swathy S Pillai built a framework identifying tail lights for breaking down traffic during late evening utilizing different morphological tasks like thresholding, separating, extraction, and so on [21]. Zhenwei Shi talked about Adaptive Background Suppression channels as a quick and hearty technique for TL discovery under various brightening conditions [22].In spite of the fact that picture handling approach is very straight and straightforward, it experiences basic stages, for example, thresholding, separating. Fine miscounts or slight deviations from measures in these stages may prompt equivocal results which is carefully unfortunate in delicate instances of TL location. To handle this entanglement, AI based strategies and calculations are attempted over separately or in blend with abundant preparing procedures to prune the deceptive headings. For instance, Keyu Lu proposed Generalized Haar Filter based Convolution Neural Network (CNN) plausible to be conveyed for object location in rush hour gridlock scenes [15]. Seokwoo Jung created CNN-based traffic sign acknowledgment calculation where extraction of traffic sign up-and-comers is acted in first stage and grouping with LeNet-5 CNN engineering happens in further stage [16]. Gwang-Gook. LEE and Byung Kwan PARK accomplished steadfast results for TL acknowledgment by consolidating ordinary methodology of picture handling with Deep Neural Network (DNN) as a promising classifier [17]. Likewise, Karsten Behrendt set forth profound learning approach consolidating sound system vision and vehicle odometry for TL discovery, following and arrangement [18]. Masamitsu Tsuchiya uncovered an effective Hybrid Transfer Learning strategy for object identification offering helps to release the untried learning techniques [19].

In the paper [9] Sang-Hyuk Lee, Jung-Hawn Kim, Yong-Jin Lim and Joonhong Lim proposed an algorithm for traffic light detection and recognition based on Haar-like features. Haar-like features are used to learn about the traffic light image and detect the candidate area based on the learning data. The detected candidate image is verified by the pre-learned SVM (Support Vector Machine) classifier, and binarization and

morphology operations are performed on the verified candidate image for detection of the traffic light object. The detected traffic light is divided into respective signal areas to determine the current on/off status of traffic lights. The signal signs in the respective areas are defined by regulation and the sign of traffic lights can be recognized by recognizing on/off of the signals in the respective areas.

In the paper [10] Priyanka D, Dharani K, Anirudh C, Akshay K presents a Traffic Sign Recognition system to regulate traffic signs, warn a driver and command certain actions. Fast robust and real-time automatic traffic sign detection and recognition can support the driver and significantly increase driving safety. Automatic recognition of traffic signs is also important for an automated intelligent driving vehicle or for a driver assistance system. This is a visual based project i.e., the input to the system is video data which is continuously captured from the webcam is interfaced to the Raspberry Pi.Images are pre-processed with several image processing techniques such as; Hue, Saturation and Value (HSV) color space model technique is employed for traffic light detection, for sign detection again HSV color space model and Contour Algorithm has been used. The signs are detected based on Region of Interest (ROI).The ROI is detected based on the features like geometric shape and color of the object in the image containing the traffic signs. The experimental results show highly accurate classifications of traffic sign patterns with complex background images as well as the results accomplish in reducing the computational cost of this proposed method.

In the paper [11] Chunhe Yu, Chuan Huang, Yao Lang presents a method using image processing technology .In order to reduce accident at traffic intersections during day and night, the algorithm of traffic lights detection which is applied in a vehicle driver assistance system is designed by using the image processing technology. The system of traffic light detection includes three parts: a CCD camera, an image acquisition card, and a PC. Based on RGB color space, the algorithm extracts red, green, and yellow objects in the image firstly; For the purpose of eliminating disturbance in the environment, the features of traffic lights are used to verify the object identity, and then the types of traffic signals are judged. The results of experiments show that the algorithm is stable and reliable. The work process is as follows: As a vehicle travels at non-intersection (no traffic lights in the scene), the program of road curb detection operates, while it travels at intersection (traffic lights in the scene), the program of pedestrian detection operates, and if there is a hazardous event occurring, the assistance driver system give a warning signal to the driver.

In the paper [12] presents a software technique based on HSV color model. Automatic traffic light violation detection system relies on color detection of traffic light appeared in video frames. Presence of red light in video frame triggers detection software routine to identify vehicles violating traffic light. Detection of red light in video frames can be difficult due to: fading or dimming of red light, obscurity from large vehicles and flare. Here ,a software technique based on HSV (Hue, Saturation, Value) color model is proposed to eliminate difficulties in red light detection mentioned above and is able to identify all colors of traffic light which gives 96% detection accuracy. The proposed scheme includes 3 Methods: First method Converts video frames to grayscale image, and then followed by thresholding which yields binary images. All three colors of traffic light are compared with predefined pattern to determine which one is on. If there are more than one color of traffic light found to be on, the threshold value is adjusted and the process is repeated. Method 2: Convert video frames from RGB to HSV color system, then compare value of hue to determine color of traffic light. Method 3: Combine result of above methods. The color of traffic light is produced when the results from two methods are identical.

In the paper [13] Zhenwei Shi, Member, IEEE, Zhengxia Zou, and Changshui Zhang proposed A novel vision-based traffic light detection method for driving vehicles, which is fast and robust under different illumination conditions. The proposed method contains two stages: the candidate extraction stage and the recognition stage. On the candidate extraction stage, we propose an adaptive background suppression algorithm to highlight the traffic light candidate regions while suppressing the undesired backgrounds. On the recognition stage, each candidate region is verified and is further classified into different traffic light semantic classes. We evaluate our method on video sequences (more than 5000 frames and labels) captured from urban streets and suburb roads in varying illumination and compared with other vision based traffic detection approaches.

In the paper [14] Ying Li, Lingfei Ma, Yuchun Huang, Jonathon Li presents a segment-based traffic sign detection method by using vehicle-borne mobile laser scanning (MLS) data. This method has three steps: road scene segmentation, clustering and traffic sign detection. The non-ground points are firstly segmented from raw MLS data by estimating road ranges based on vehicle trajectory and geometric features of roads (e.g., surface normals and planarity). The ground points are then removed followed by obtaining non-ground points where traffic signs are contained. Secondly, clustering is conducted to detect the traffic sign segments (or candidates) from the non-ground points. Finally, these segments are classified to specified classes. Shape, elevation, intensity, 2D and 3D geometric and structural features of traffic sign patches are learned by the support vector machine (SVM) algorithm to detect traffic signs among segments. The proposed algorithm has been tested on a MLS point cloud dataset acquired by a Leador system in the urban environment. The results demonstrate the applicability of the proposed algorithm for detecting traffic signs in MLS point clouds.

METHEDOLOGY

The proposed system is mainly used for detection and recognition of Traffic Light with the help of object detection method and faster region based convolution neural network (F-RCNN).Convolution Neural Network (CNN) is one of the most popular ways of doing object recognition. It is widely used and most state-of-the-art neural networks used this method for various object recognition related tasks such as image classification. This F-RCNN network takes an image as input and outputs the probability of the different classes. If the object present in the image then its output probability is high else the output probability of the rest of classes is either negligible or low.

The input must be an image and the goalis:

1. Dataset Preparation
2. Loading to Tensor Flow

3. Input custom image
4. Object Detection
5. Traffic Light Detection in Tensor Flow
6. Display Output

There are Four modules in this project, Data Preparation Module, Making Inception Model, Object Detection , Traffic Light Recognition.

A. Data Preparation Module

The first part of the proposed system is data preparation module. For deep learning natural language project first of all we can convert the input documents as integers. The first part of the proposed system is data preparation module. The deep learning system, in both its training and operational modes, begins with the input of a Traffic Light image that defines the object to be classified. The Traffic Light images with almost same resolution are used as the input for the easiness of proper training and testing.

B. Making Inception Model

Transfer learning is a machine learning method which utilizes a pre-trained neural network. For example, the image recognition model called Inception-v3 model, is a convolutional neural network that is trained on more than a million images from the Image Net database. The network is 48 layers deep and can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals and here it will be classified into RED, GREEN, YELLOW, GO SLOW, SPEED LIMIT 80, NO PARKING, ZEBRA CROSSING etc.. . In transfer learning, when we build a new model to classify our original dataset, we reuse the feature extraction part and re-train the classification part with our dataset.

C. Object Detection

Single Shot MultiBox Detector (SSD) is designed for object detection in real time. Faster R-CNN uses a region proposal network to create boundary boxes and utilizes those boxes to classify objects. While it is considered the start-of-the-art in accuracy, the whole process runs at 7 frames per second. SSD speeds up the process by eliminating the need of the region proposal network. To recover the drop in accuracy, SSD applies a few improvements including multi-scale features and default boxes. These improvements allow SSD to match the Faster R-CNN's accuracy using lower resolution images, which further pushes the speed higher, it achieves the real time processing speed.

D. Traffic Light Detection

Faster RCNN is an object detection architecture that uses convolution neural networks like YOLO and SSD. Faster RCNN is formed from 3 parts: In convolution layers we train filters to extract the appropriate features from the image, for example we are going to train those filters to extract the appropriate features for a traffic light, sign and then those filters are going to learn through training shapes and colors that only exist in the traffic light related image. Pooling consists of decreasing quantity of features in the features map by eliminating pixels with low values.RPN is small neural network sliding on the last feature map of the convolution layers and predict whether there is an object or not and also predict the bounding box of those objects. Now we use other fully connected neural networks that takes as an input the regions proposed by the RPNand predict object class (classification) and Bounding boxes (Regression).

EXPERIMENTAL RESULTS

A. Results

This section discusses the experimental results of the proposed system. The proposed system is using LIZA traffic light dataset which are taken from kaggle for results assessment. Here the dataset taken contains 25 categories of images with traffic light and signs. For each category it should contain more than 40 images otherwise it may cause issues. First we upload an image.

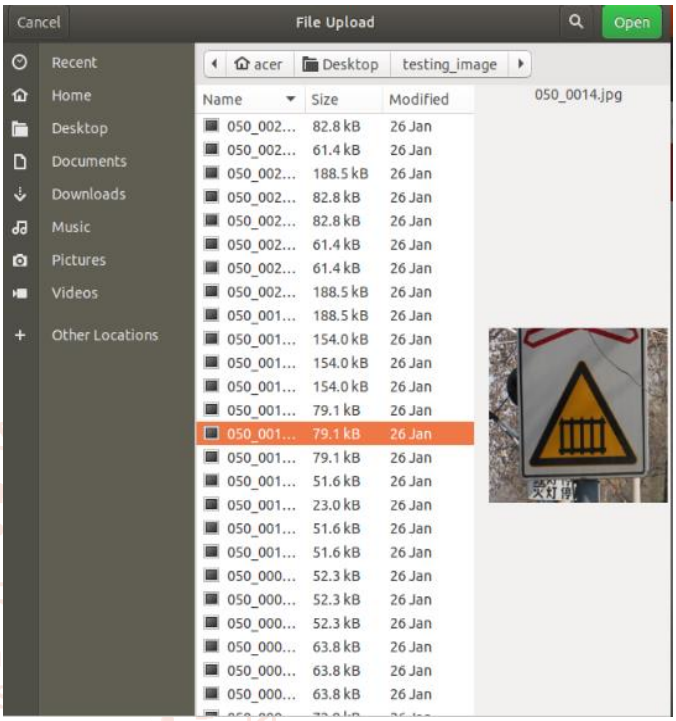

Figure 1. Selecting Image to upload

Image uploaded successfully, and the uploaded image first checks out if it is traffic light, sign or not and the detection is carried out by using SSD After detection of Traffic Light, it will pass to the Inception Model in order to find in which category the detected object belongs.

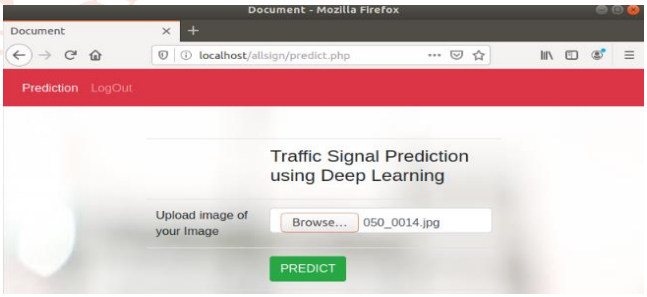

Figure 2. Image Uploaded Successfully

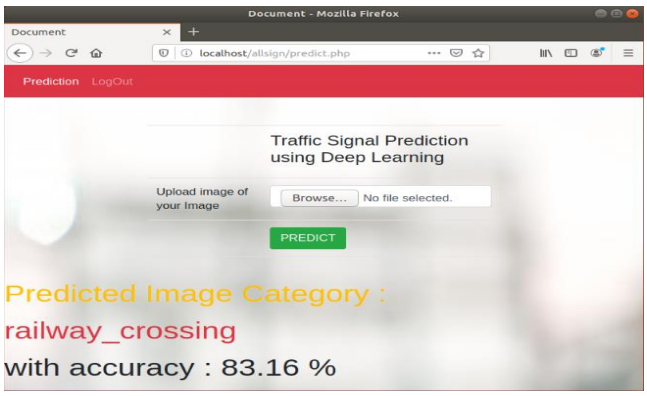

Figure 3: Predicted Image Category

For those objects which have the maximum probability value is taken as its final class category. Here the model successfully detects the traffic sign "**RAILWAY CROSSING"** with accuracy 83.16%. Experimental results show that the proposed SSD method produces an overall accuracy of 96.6%.

PERFORMANCEREQUIREMENTS

Performance requirements describe all the hardware specification of the system. For deep learning project, the minimum system requirement is, it needs i3 or above processor. Mostly deep learning projects used 64 bit Ubuntu operating system. Here we used a Mac OS with 51.8 GHz Intel Core i5 processor for this project (For Mac OS only 10.12.6 Sierra or later os versions must be used). Our Mac OS contains 4GB RAM, 160GB or above hard drive space.

CONCLUSION

A driverless car is a vehicle capable of sensing its environment and operating without human involvement. An autonomous car can go anywhere a traditional cargoes and do everything that an experienced human driver does. In the field of self-driving vehicles, the proposed work fills in as a module for navigation system. For driverless cars, Traffic light object detection is to be out carried out and they can be implemented by using deep learning approach. The use of Faster R-CNN Inception-V2 model via transfer learning improves the accuracy which makes the system reliable for real time application. The outcomes with bounding boxes provide guidelines for real time control actions of the vehicle. In this project only a dataset with 25 categories is selected for processing. The dataset created for the system covers various images of traffic light according to the Indian Traffic System. In advancement to this, the system can also be optimized for safe driving despite unclear lane markings. Also, it can be equipped with the ability to respond to spoken commands or hand signals from law enforcement or highway safety employees.

Acknowledgment

I undersigned hereby declare that the project "Traffic Sign Detection and Recognition for automated Driverless cars based on SSD", submitted for partial fulfillment of the requirements for the award of degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Ms. Veena S Nair. This submission represents my ideas in my own words and where ideas or words of others have been included; I have an adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not have not misrepresented or fabricated any data or idea or fact or source in my submission.

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