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Object Detection and Classification for Self-Driving Cars

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Abstract

With the advancement in image processing, object detection has been one of the interesting topics due to its spectrum of applications in real time. For past 10 years Advanced Driving Assistance System (ADAS) has rapidly grown. Recently not only luxury cars but some entry level cars are equipped with ADAS applications, such as Automated Emergency Braking System (AEBS).ADAS systems are used for assisting the drivers by providing advice and warnings when necessary.Visual recognition tasks, such as image classification, localization, and detection, are the core building blocks of many of these applications, and recent developments in Convolutional Neural Networks (CNNs) have led to outstanding performance in these state-of-the-art visual recognition tasks and systems.This application is for multiple object detection and classification in a given video based on Open Computer Vision (OpenCV) libraries. The application also uses MobileNet architecture, SSD (Single Shot Detectors) framework and Caffe (Convolutional Architecture for Fast Feature Embedding) model to get the predictions.The system is used as one of the features in ADAS system for collision avoidance by detecting and classifying the objects such as vehicles and pedestrian.

*Keywords—***ADAS, OpenCV, CNN, MobileNet, SSD, Caffe.**

I.   INTRODUCTION

Driverless cars were once just the stuff of science fiction. But in recent years, they've become a reality and they're now hitting the streets in a number of U.S. cities. Companies like Uber, Google, and Ford recently started testing hundreds of self-driving vehicles on public roads. Supporters of driverless cars say the vehicles will make roads safer by cutting down on the number of crashes caused by distracted driving or other human errors.

In recent years, deep Convolutional Networks (ConvNets) have become the most popular architecture for large-scale image recognition tasks. The field of computer vision has been pushed to a fast, scalable and end-to-end learning framework, which can provide outstanding performance results on object recognition, object detection, scene recognition, semantic segmentation, action recognition, object tracking and many other tasks. With the explosion of computer vision research, Advanced

Driver Assistance System (ADAS) has also become a main stream technology in the automotive industry. Autonomous vehicles, such as Google's self-driving cars, are evolving and becoming reality. A key component is vision-based machine intelligence that can provide information to the control system or the driver to manoeuvre a vehicle properly based on the surrounding and road conditions. There have been many research works reported in traffic sign recognition, lane departure warning, pedestrian detection, and etc. This application is confined to detect objects on the road using MobileNet architecture and Single Shot Detectors (SSD) framework. Unlike other object detection techniques like RCNN's or YOLO, SSD's are more accurate and fast. The application uses Caffe model to get the predictions.

II. RELATED WORK

An integrated real-time approach was developed for detecting objects in the captured images of self-driving vehicles. Object detection is modelled as a regression problem on the predicted bounding boxes and their class probabilities. Unified neural network has been performed on the whole image which could predict the bounding boxes and class probabilities at the same time. [1]

An improved frame-difference method was introduced, which can shorten the running time and improve the accuracy of the object detection. The results of the experiment show that after adding the improved frame-difference method, the detection speed is increased by 21.06 times, the image detection accuracy is improved about 8%. The algorithm is robust and it can be adapted to different scenes including indoor and outdoor. [2]
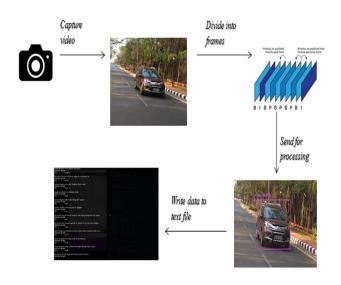
Another method uses haar-like features of the images and AdaBoost classifier for detectionwhich provides a very fast detection rate. In order to predict the class of a vehicle, a feature based method is proposed. HOG, SIFT, SURF all are well represented feature for image classification. [3]

Works have been carried out using Region Proposal Network (RPN), a fully convolutional network that simultaneously predict's object bounds and scores at each position. The RPN was trained end-to-end to generate high-quality region proposals, which were used by Fast R-CNN for detection. Furthermore RPN and Fast R-CNN were merged into a single network by sharing their convolutional features.Their accuracy is high but computational rate is slow. [4]

III. PROPOSED SYSTEM

In this system an input video is taken where objects are detected and the data of the detected objects is sent to a text file. To achieve a balance between accuracy and speed, our system uses Single Shot Detectors (SSD) along with MobileNet architecture and Caffe model.

Figure 1 shows the system design and its implementation will be explained in the subsequent chapters.

Fig. 1 Block diagram

IV. IMPLEMENTATION

The implementation is divided into three modules:

A) Camera module

B) Processing module

C) Data Module

A) *Camera Module:*

OpenCV is a software toolkit for processing real-time image and video, as well as providing analytics, and machine learning capabilities.The camera module consists of a input video which is captured using an OpenCV function VideoCapture(). The read() function of OpenCV is then used on the input video object to divide it into frames.

B) *Processing Module:*

The system uses MobileNet architecture that is a class of Convolutional Neural Networks (CNN). They are based on a streamlined architecture that uses depth-wise separable convolutions and point-wise convolutions to build light weight deep neural networks. This reduces the burden on the first few layers of the CNN, hence making the network fast.

Single Shot Detector (SSD) is used for object detection and classification together with MobileNet architecture. It runs a convolutional network on input image only once and calculates a feature map. It then runs a small 3×3 sized convolutional kernel on this feature map to predict the bounding boxes and classification probability. Each convolutional layer operates at a different scale hence it is able to detect objects of various scales.SSD achieves a good balance between speed and accuracy.

CAFFE (Convolutional Architecture for Fast Feature Embedding) is a deep learning framework, which is used to train our model. Caffe supports many different types of deep learning architectures geared towards image classification and image segmentation. It supports CNN, RCNN, and fully connected neural network designs.

C) *Data Module:*

In this module the system sends the data of the detected objects to a text file. The data includes class of the object, probability of detection and co-ordinates of its bounding box. This data can be used to take further decisions by the ADAS system.

V. RESULT AND DISCUSSION

Working of the project is depicted through snapshots as follows.
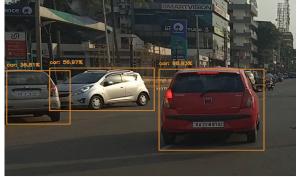

Fig. 2(a) Object detection
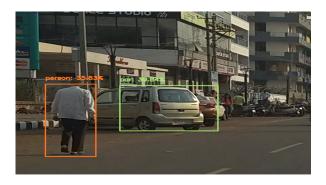

Fig. 2(b) Object detection

Fig. 2(c) Object detection

The following fig.3 shows the snapshot of the text file where the data of the detected objects are sent.

Fig. 3 Data sent to the text file

CONCLUSION

Trust in autonomous technology is the key to a driverless future. A vision-based object detection system for on-road obstacles is realized using Single Shot Detectors (SDD) and MobileNet architecture. This proposed work is used to categorize the moving objects like pedestrians, cars, motorbikes etc. into their respective classes and locate them by drawing bounding boxes around them. The resulting bounding boxes of detected objects and their classes are useful for subsequent motion planning and control subsystems of self-driving cars.

ACKNOWLEDGMENT

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