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Object Detection and Classification for vehicle ADAS

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Abstract:
With the advancement in Image Processing, Object detection is one of the interesting topics that can be considered due to its spectrum of applications in real time. Object detection technology has been driven by an amplifying power available in software and hardware in the project. In this paper, the application for multiple objects detection and classification is based on Open Computer Vision (Open CV) libraries. The porting and profiling of the application is into an embedded platform. This paper also presents an overview of the Cascade Algorithm as well as Support Vector Machine (local binary pattern feature) as a classifier. The system is used as one of the features in vehicle Advance Driver Assistance System for Collision Avoidance by detecting and classifying the objects such as Vehicles and Pedestrian.

I. INTRODUCTION

Object detection technology is to detect the specific location and size of a particular object in a database of image or a video scene. With the rising requirement of detection-based security and industrial applications mainly in the automotive field, the object detection in a fast and reliable manner has been attracting much scope and concern. Hence, more reliable and high accurate near real time objects detection application running on an embedded platform, is crucial and critical, due to the rising security concerns in the various fields. Designing a complete reliable system able to simultaneously detect multiple objects on a scene of image or video. The system presents an overview of the cascade object detection algorithm as well as Local Binary Pattern feature selection used by cascade classifier. Then, it proposes an Open CV-based solution for multiple object detection, and finally, presents the results of the comparison of performances in a regular platform and an embedded device.

II. OPEN CV

OpenCV is an open source computer vision library that is used in real time computer vision. OpenCV was developed by Intel and now supported by Willow Garage and Itseez. OpenCV is designed and optimized for real time applications, although it's developed in C and C++ languages, it's a cross platform library that runs on Linux, Windows and Mac OS. The OpenCV library contains hundreds functions that cover many areas in computer vision such as robotics, medical image processing, security.

OpenCV has several shared or static libraries and the modules are:

- Core functionality - a compact module defining basic data structures, including the dense multi-dimensional array Mat and basic functions used by all other modules.
- Image processing - an image processing module that includes linear and non-linear image filtering, geometrical image transformations (resize, affine and perspective warping, generic table-based remapping), color space conversion, histograms, and so on.
- Video - a video analysis module that includes motion estimation, background subtraction, and object tracking algorithms.
- Calib3d - basic multiple-view geometry algorithms, single and stereo camera calibration, object pose estimation, stereo correspondence algorithms, and elements of 3D reconstruction.
- Features2d - salient feature detectors, descriptors, and descriptor matchers.
- Objdetect - detection of objects and instances of the predefined classes (for example, faces, eyes, mugs, people, cars, and so on).
- HighGUI - an easy-to-use interface to simple UI capabilities.
- VideoIO - an easy-to-use interface to video capturing and video codecs.
- GPU - GPU-accelerated algorithms from different OpenCV modules.

III. CASCADE CLASSIFIER

Cascade classifier is a chain of weak classifiers for efficient classification of image regions. Its goal is to increase the performance of object detection and to reduce the computational time. Each node in the chain is a weak classifier and filter for one LBP feature. AdaBoost gives weights to the nodes, and the highest weighted node comes first. Processing of the image continues when the filter failed to pass certain regions of the image and that particular sub window is eliminated. It is then considered as a non-object. Meaning that the image regions processed, do not contain the object to be detected. This is very crucial to the performance of the classifier, since all or nearly all negative image sub-windows will be eliminated in the first stage. On the other hand, when image regions successfully passed the filter, they go to the following stage, which contains a more complex filter. Only regions that successfully pass all filters are considered to contain a match of the object. The regions of the image contain the object subject to detection. The reason behind the multi-stage classifier is to reject efficiently and rapidly the non-object sub-windows. Cascade classifiers are available in OpenCV, with pre-trained cascades for frontal faces and upper body. Training a new cascade in OpenCV is also possible with Local Binary Pattern methods. This can be used for rapid object detection of more specific targets, including non-human objects with Local Binary Pattern -like features. The process mainly includes the database of positive and negative samples, where the negative samples correspond to arbitrary non-object images in sense the image with particular object. The time constraint in training a cascade classifier can be circumvented using cloud-computing methods. The classifier is used to reject more false positives of the sub-windows. The number of false positives is radically reduced after several steps of processing.

IV. BLOCK DIAGRAM

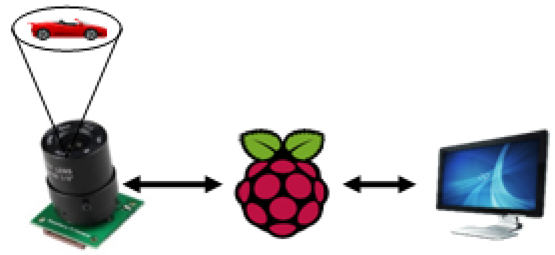

Figure.1. Block Diagram of the System

Taking into account the relatively high performance requirements of image processing in general and the equipment as a relatively inexpensive and powerful embedded platform the Raspberry Pi was an obvious choice. Another contributing factor to this choice was the availability of the Pi camera module, which can capture high-definition video as well as stills and requires the user to simply update Raspberry's firmware to the latest version. Although using the officially supported camera module, which can be accessed through the MMAL and V4L APIs and is supported by numerous third-party libraries, any USB web camera can be used. The remote access is fairly convenient to use and simple to set up with a wireless internet USB dongle, image processing applications, even displaying live camera feed, require a lot of CPU processing power and therefore it is best if some of it can be spared by simply connecting the Pi to a monitor and wireless mouse and/or keyboard. Once configuration is properly done, installing and updating is done in Open CV. While coding can be done in numerous ways in IDE and is used, a good way to save time is to write code on a personal computer and compile it on the Raspberry, because while Raspberry is pretty powerful for such a small computer, it is much more convenient to write code on a smoothly operating machine.

V. REQUIREMENTS

Figure.2. Raspberry Pi 3 Model B

The Raspberry Pi is a small single-board computers developed by the Raspberry Pi Foundation as keyboard, mice and cases are not included with the Raspberry Pi. The Raspberry Pi has several versions that varies in features with memory availability and support to other peripherals to simply update Raspberry's firmware to the latest version. Although using the officially supported camera module, which can be accessed through the MMAL and V4L APIs and is supported by numerous third-party libraries, any USB web camera can be used. Most Raspberry Pi chips could be overclocked to 800 MHz, and some to 1000 MHz. In the Raspbian Linux the overclocking options on boot can be done by a software command running "sudo raspi-config" without voiding the warranty. In those cases the Pi automatically shuts the overclocking down if the chip reaches 85 °C (185 °F), but it is possible to override automatic over-voltage and overclocking settings. Latest versions of the firmware contain the option to select one of the five over clock ("turbo") that pre-sets when used, attempt to maximize the performance of the system on chip without impairing the lifetime of the board. Maximising the performance of the chip is done by monitoring the core temperature of the chip, the CPU load, and also by dynamically adjusting the clock speeds and the core voltage. When the work on the CPU is low or when running with high temperature the performance is throttled, but when CPU has much more to perform and the core temperature is also acceptable, performance is bit increased with clock speeds of up to 1 GHz depending on the board and on which type of turbo settings is used.

VI. CONCLUSION

In this paper, developed object detection and classification system, and also applied it for counting and risk warning. The strength of this system is that it can be trained for any type of object to be detected for different situations. We also designed a low-dimensional soft-output SVM object classifier. The combination of the classifier with the support thread can improve vehicle and pedestrian detection accuracy and the speed of operating. An extension to this work would be to adapt the system to a low cost card and adapt it to the card architecture with Pi camera module in order to get better performances in real time environment that can be one of the features in ADAS for collision detection.

VII. RESULTS

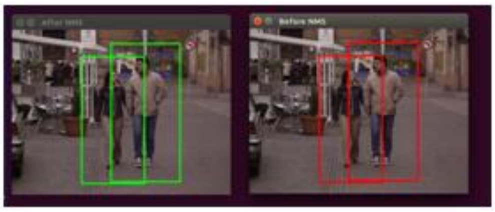

Figure.3. Pedestrian Detection

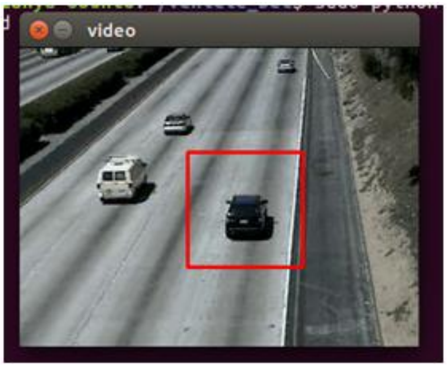

Figure.4. Vehicle Detection

VIII. REFERENCE

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