

Embedded Digital Image Recognition System Based on ARM-DSP

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Abstract— Face Recognition is a very active research area specializing on how to recognize faces from real time video as well as images. A digital image recognition and identification of system based on raspberry pi and Haar classifier algorithm contain in this project The system consists of portable system with raspbian Linux, OpenCV to perform the image processing part. Initially using camera interface continuous real time video are captured and these images are processed with help of OpenCV and compared with existing database. Due to the insecure environment ratio of vehicle theft increasing day by day. Because of this is manufacturers of luxury automobiles has the responsibilities for taking steps to ensure the authorization for the owners and also in built the anti theft system to prevent the vehicle from theft. The proposed security system for vehicles used to prevent them from loss or theft using ATM card size Raspberry pi board. It performs the real time user authentication using face recognition, Raspberry pi. If the real time image is matched with the images stored in the database then only motor of car will start otherwise motor will not start.

Key words: Raspberry pi, Haar Classifier, Face Recognition, OpenCV, Motor

I. INTRODUCTION

Face recognition is a big challenge as there is a chance of high uncertainty due to the external lighting conditions, so we are taking the advantage of gray scale, which are less effected to the external environment changes [1]. Mainly a prior step of this face recognition involves face detection which is also a big challenge. For this we are taking the help of pre-designed cascades whose detection of objects is satisfactory [5]. Due to the insecure environment the ratio of vehicle theft has increased rapidly .To avoid this, we present a real time image recognition system including the application of driver authentication. Face based application such as face recognition system have been more popular in computer vision during past several years. So, for the easy development of these entire image processing algorithms on Raspberry pi, we are taking the help of OpenCV (Open Source Computer Vision Library) which is a library of programming. It focuses mainly on real-time image processing. As OpenCV can support all the Image and Signal processing algorithms and which can be ported onto the raspbian Linux platform very easily. The major applications of face recognition are Security, Communication, HumanComputerInterface, Surveillance.

II. LITERATURE SURVEY

Kunfeng Wang et.al. [1] proposed to use DSP board and image processing technique to construct an automated vehicle counting system. Author used TI 320DM642DSP because of its low cost and improve system structure. Real time video will be easier and more applicable if used with embedded platform for vehicle counting system

automatically. DM642 DSP is based on the second generation high performance advance VelocityTI VLIW architecture developed by TI it is the key part of DSP board[1]. Even in the heavy traffic scenes the proposed system is able to survive being used a lot and provide accurate information.

B.Koteswar et.al. [2] presented real time face recognition system based on ARM7, they used LPCARM2148 board to develop the system which required windows operating system. The system detected face by using HAAR feature and recognized by using LBP features. Windows operating system is much reliable and easier to use and has got its own help section. The main reason of selecting ARM7 by author is that it supports windows operating system easily. Real time embedded face recognition for smart home is the project in which the author proposed real time face recognition system for embedding in consumer application. In this proposal the author used LBP algorithm for face recognition and PCA as a core algorithms of the system identification.

Kandla Arora et.al.[3] provide an overview of real time application of face recognition concept by generating a Matlab code using image acquisition tool box. The author divides the recognition algorithm into two main approaches. One is Geometric approach and other is photometric approach. The Geometric features generated by segments, perimeters and areas of some figures formed by the points, Photometric approach is statistical approach which distills an image into values and compare the values with template to eliminate variance. The result of this paper is more successful by using Matlab.

Shuai Hu et. al. [4] focused to enhancing the decoding performance of H.264/AVC through memory optimization for DSP the improved H.264/AVC system increased the speed of system by 37%. H.264 defines the syntax of an encoded video bit stream together with the method of decoding bit stream. This Paper proposes Three modes, Mode 1: All the spaces of On-Chip memory are configured to SRAM that is used to store codes, data, and global variables. This mode is called ALL SRAM of L2. As for video algorithms, this mode is feasible because the direction of data streams is clear and scheduling EDMA can complete the data exchange. Yet, it will consume a lot of time once DSP accesses external memory , Mode 2: The storage space of 83Kbytes size SRAM is divided into two parts: The first one is of 64Kbytes size for cache, while the surplus is for saving codes and data, which are in common use. In this mode, the L2 cache is four-way set associative, Mode 3: The storage space of 83Kbytes size SRAM is divided into two parts: 32Kbytes size SRAM is set for cache and the surplus is used for saving codes and data[4]. In this way, the access to SDRAM is possible to complete in a high speed taking advantage of the section is the rest of the SRAM, which is considered as cache for the other codes and data management [4]. After comparing the performance of three modes the author decides that second mode is

optimum one by using this mode can improve performance of H.264 by 37% compared to the no memory optimization.

Mikołaj Roszkowski et.al.[5] distinguishes Firstly, the architecture supports all intra prediction modes defined in High Profile of the H.264/AVC standard for all chroma formats, Secondly, the architecture can generate predictions for several quantization parameters, Thirdly, the hardware cost is reduced as the same resources are used to compute prediction samples for all the modes, Fourthly, the high sample-generation rate enables the encoder to achieve high throughputs, Fifthly, 4×4 block reordering and interleaving with other modes minimize the impact of the long-delay reconstruction loop on the encoder throughput.

Jin-Su Jung et.al.[6] presented a fast H.264 intra frame encoder that processes a single macro block of 1920×1080 size video in 334 cycles on average which is 20% faster than the previous best design About 20% of the execution cycles for H.264 intra prediction are saved by the proposed pipeline schedule, early termination, and the mode selection based on IPG. Experimental results show that the proposed schedule with early termination is effective for various video sizes and quality. In spite of the significant reduction in computation time, PSNR drop is 0.0619 dB and the bit rate increase is less than 0.842% [6] Although this paper is mainly for a specific hardware, the proposed methodology can be applied to a wide range of platforms[6].

III. IMAGE RECOGNITION

The face detection algorithm proposed by Viola and Jones is used as the basis of our design. The face detection algorithm looks for specific Haar features of a human face. When one of these features is found, the algorithm allows the face candidate to pass to the next stage of detection. A face candidate is a rectangular section of the original image called a sub-window. Generally these sub-windows have a fixed size (typically 24×24 pixels). This sub-window is often scaled in order to obtain a variety of different size faces. The algorithm scans the entire image with this window and denotes each respective section a face candidate [6].

A. Integral Image

The integral image is defined as the summation of the pixel values of the original image. The *Integral Image* or Summed Area Table, was first introduced to us in 1984, but wasn't properly introduced to the world of Computer Vision till 2001 by Viola and Jones with the Viola-Jones Object Detection Framework

B. Haar Features

Haar features are composed of either two or three rectangles. Face candidates are scanned and searched for Haar features of the current stage. The weight and size of each feature and the features themselves are generated using a machine learning algorithm from AdaBoost [15]. The weights are constants generated by the learning algorithm. Areas of white and black regions are multiplied by their respective weights and then summed in order to get the Haar feature value. Each Haar feature has a value that is calculated by taking the area of each rectangle, multiplying each by their respective weights, and then summing the results. The area of each rectangle is easily found using the

integral image. The coordinate of the any corner of a rectangle can be used to get the sum of all the pixels above and to the left of that location using the integral image. By using each corner of a rectangle, the area can be computed quickly as denoted by "Fig. 3". Since L1 is subtracted off twice it must be added back on to get the correct area of the rectangle. The area of the rectangle R, denoted as the rectangle integral, can be computed as follows using the locations of the integral image: $L4-L3-L2+L1$.

C. Haar Feature Classifier

A Haar feature classifier uses the rectangle integral to calculate the value of a feature. The Haar feature classifier multiplies the weight of each rectangle by its area and the results are added together. Several Haar feature classifiers compose a stage. A stage comparator sums all the Haar feature classifier results in a stage and compares this summation with a stage threshold. The threshold is also a constant obtained from the AdaBoost algorithm. Each stage does not have a set number of Haar features. Depending on the parameters of the training data individual stages can have a varying number of Haar features. For example, Viola and Jones' data set used 2 features in the first stage and 10 in the second. All together they used a total of 38 stages and 6060 features [15]. Our data set is based on the OpenCV data set which used 22 stages and 2135 features in total.

IV. METHODOLOGY

A. Flowchart of System Design

- 1) Start
- 2) Initialize Camera
- 3) Capture Images
- 4) Extract Features
- 5) Face Detection
- 6) Cropped Image
- 7) Update Database
- 8) Recognize Image
- 9) If image matched with Database?
- 10) Motor will start

The methodology consists of capture image, detected face in the image feature extraction, image comparison, declaration of matching image. The acquisition of face image can be done by acquiring the USB camera interface with raspberry pi high speed processor with GPU processing. The prototype is built with Haar like features function from opencv. Haar classifier detection is used to create a search window that slide through image and check whether a certain region of an image looks like face or not. Haar like feature and large set of very weak classifier use a single feature to define a certain image as face or non face. Each feature is describe by the template and its coordinate relative to the search window which is origin of size of feature the search window quickly scan the first classifier on the cascade, if the classifier returns false then the computation on that window also ends and results no detected facet(false). Moreover, if the classifier returns true, then the window will passed down to next classifier in cascade to do exact same thing. When all classifier returns true for that window then the result will return true also for that certain window face is detected. The acquisition can also be done through real time remote monitoring either with Ethernet connectivity or by HDML. The function of the face detection module is to clarify

whether the face is available during real time monitoring or detection or not. When the face appears in the center and presented at a uniform size. OpenCV already provide an algorithm to locate faces in still image nad videos. Haar classifier algorithm scans the image and creates as bounding box as returns for each detected face. The feature extraction in face detection is done by localizing of the characteristics of face components (i.e.eyes,mouth,nose etc) in an image. In other terms, the feature extraction is a step in face detection and recognition where the xy size locate certain point on face such as corner and centre of eyes, age of nose ,mouth etc. Of detected image match with the image stored in the database will run otherwise motor will not start. The phase consists of capture image; Detect faces in the image, feature extraction, image comparison, declaration of matching image. The acquisition of face images can be done by acquiring the USB Camera interfaced with Raspberry pi High speed processor with GPU Processing. The function of the face detection module is to clarify whether the face is available during real time monitoring for detection or not. When the system detects the face, it will produce an sub-image and this sub-image is scaled such that the face appears in the center and presented at a uniform size. OpenCV already provide an algorithm to locate faces in still image and videos. Haar classifier algorithm scans the image and creates a bounding box as returns for each detected face. In other terms, the feature extraction is a step in face detection and recognition where the system locates certain points on the faces such as corner and center of the eyes, tip of the nose, mouth etc.

V. SYSTEM DESIGN

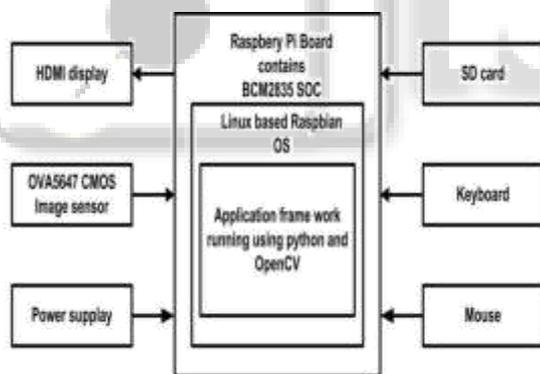


Fig. 5: connection with raspberry

The smile detection mechanism as described above was implemented on a Raspberry Pi BCM2835 SOC computer. The Raspberry Pi was the hardware of choice because of its low power requirements (3.5W), its small size, and it's very low cost (under US\$35). The smile detection prototype block diagram shown in figure 5.. We used 8GB sd card for Raspberry Pi and installed the Raspbian operating system through Win32Diskimager through windows computer. Mouse and keyboard used and placed into the two USB ports of Raspberry Pi [12]. The camera board is a small PCB that connects to the CSI-2 camera port on the Raspberry Pi using a short ribbon cable [13]. It provides connectivity for a camera capturing still images or video recordings. We installed drivers of camera board from the internet using Ethernet cable of Raspberry Pi. Next we connect the HDMI display to Raspberry Pi by the HDMI port.

VI. RESULT



Fig. 7: Result of image recognition

The result of image recognition is shown in Figure 7, Those are the frames extracted from the real time image Sometimes, face detection algorithm may get more than one result even there is only one face in the frame. In this case, a post image processing is been used for extracting the exact face coordinates with OpenCV and SimpleCV Haar Classifier libraries. In this paper we also implement the face recognition with application of driver authentication in Python language by using Viola and Jones face detection.

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