REAL TIME EMBEDDED IMPLEMENTATION OF FACE FEATURE DETECTION SYSTEM ON BEAGLE BOARD-XM

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Abstract

This Paper presents a Standalone low cost face feature detection system. Paper gives detail explanation of system designed using trained classifier using Haar like feature. Feature based detection is more accurate as compared to pixel colored based detection of any size of face and facial features. Our system can be implemented on Beagle Boared-XM. Paper explains advantages of Boared and system development using it.

Key words: Beagle Boared-XM, feature detection, trained classifier, Haar like feature.

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Introduction

A Facial feature detection system is the computer application for automatically detecting facial feature like eye pair in real-time. We have to detect face and eye of the person standing in front of camera. For example, real time image of person is considered as in put to our system. Algorithm may recognize face from particular input. And as face is detected it should detect eye pair from the same face frame. Large number of algorithms can be used for face and eye detection.[7]

Our aim is to design stand alone system which is less expansive, small in size and can give quality performance. we are using BeagleBoard –XM with OpenCV library , upcoming development tool for image processing. OpenCV provides numbers of tools ,algorithmic advantages to develop our system.

In this work we used OpenCV 2.4.1, which contains the extended realization of the Viola-Jones object detection algorithm supporting Haar-like features.Haar-like features, originally proposed by Papageorgiou et al, valuate differences in average intensities between two rectangular regions, that makes them able to extract texture without depending on absolute intensities. However, Viola and Jones, during their work on objects detection algorithms, extended the set of the features and developed an efficient method for evaluating it, which is called an"integral image". Later Lienhart et al. introduced an efficient scheme for calculating 45◦ rotated features and included it in OpenCV library. It should be mentioned, that opposite to many of the existing algorithms using one single strong classifier, Viola-Jones algorithm uses a set of weak classifiers, constructed by thresholding of one Haar-like feature. Due to large number of weak classifiers, they can be ranked and organized into cascade. Hardwar supports this algorithm as it is less mathematical complex.

Hardware and Software

Beagle board-Xm[1] :

Beagle Board-xM delivers with the help of its AM37x 1GHz ARM processor brings a project to fast development. Designed with community the inputs are in mind to develop this open hardware design brings the previous generation laptop-like performance and expandability to the

next level, which improves the power level module growth higher. Direct connectivity is supported by the on-board four-port hub with 10/100 Ethernet.

Processor: AM37x 1GHz ARM Cortex-A8 compatible[11]

More than 2,000 Dhrystone MIPS are used in this board. Up to 20 million polygons/second graphics are modified and High Definition video capable C64+TMDSP core is performing for the resolution. The storage capacity has 512 MB LPDDR RAM inbuilt in this board. Expandable external memory.

Connectivity

- 2D/3D graphics accelerator
- 4 USB 2.0 ports
- MMC/SD connector
- DVI-D port
- S-Video port
- USB mini AB connector
- Ethernet
- **Software Compatibility**
- Angstrom Linux[3]
- Android
- Ubuntu

The advantages of embedded Linux over proprietary embedded operating systems include multiple suppliers for software development and support, there is no royalties or licensing fee[2], a stable kernel are ability to read, and also to modify and redistribute the source code. The technical features include a comparatively large memory footprint (kernel and root file system) as a demerit; complexities of user mode and kernel mode memory access; and a complex device driver's framework. We are using Angstrom Linux OS for our system development.

System Development

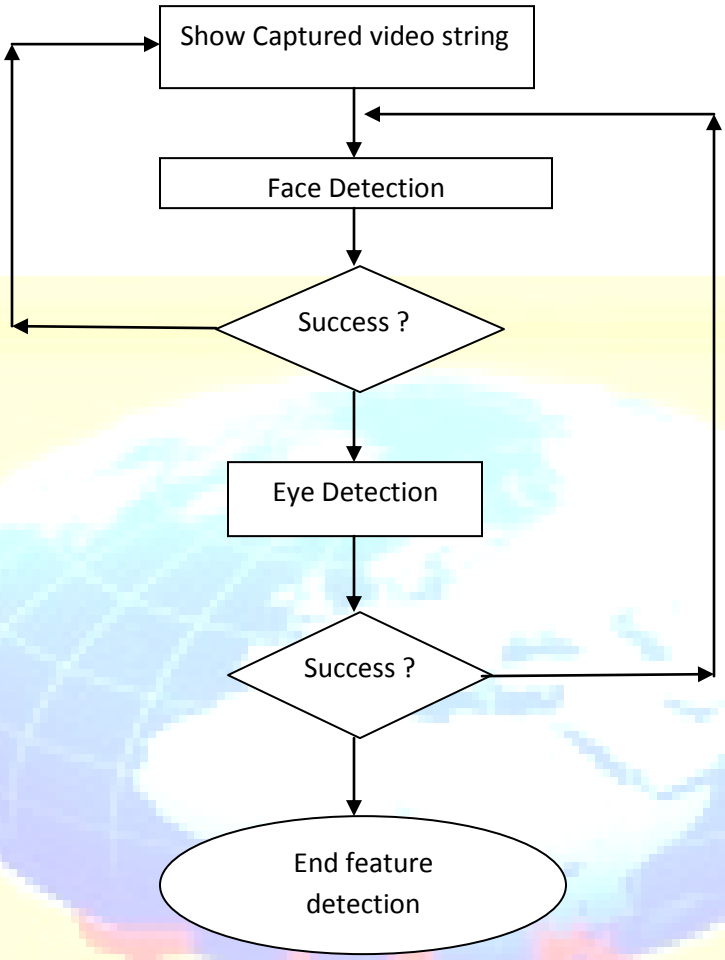

Figure 1: Flow Chart for Detection process

System Block Diagram

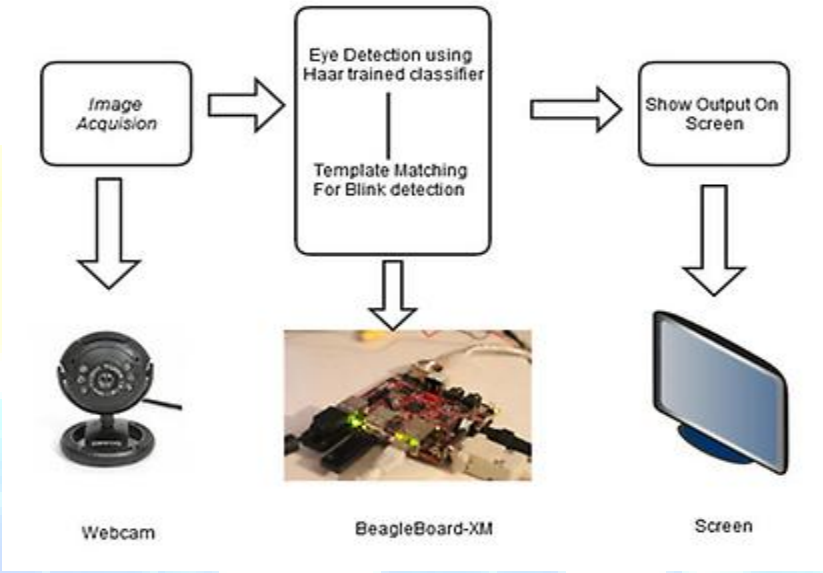

Figure 2: System Block Diagram with Hardware

Explanation

An input video captured by the USB cam for image acquisition process. This captured string is undergoes the further processes designed on board. Like trained Haar classifiers for detection of face and eye pair. This detected area is shown by elliptical shape. User can see Output on screen. Haar Feature-based Cascade Classifier for Object (Face/ Eye Pair) Detection.[10]

The object detector described below has been initially proposed by Paul Viola and improved by Rainer Lienhart.[8],[9]A classifier (namely a cascade of boosted classifiers working with haar-like features) is trained with a few hundred sample views of a particular object (i.e., a face or eye paires), called positive examples, that are scaled to the same size (say, 20x20), and negative examples - arbitrary images of the same size.

After a classifier is trained, it can be applied to a region of interest (of the same size as used during the training) in an input image. The classifier outputs a "1" if the region is likely to show the object (i.e., face/Eyepair), and "0" otherwise. To search for the object in the whole image one

can move the search window across the image and check every location using the classifier. The classifier is designed so that it can be easily "resized" in order to be able to find the objects of interest at different sizes, which is more efficient than resizing the image itself. So, to find an object of an unknown size in the image the scan procedure should be done several times at different scales. The word "cascade" in the classifier name means that the resultant classifier consists of several simpler classifiers (stages) that are applied subsequently to a region of interest until at some stage the candidate is rejected or all the stages are passed. The word "boosted" means that the classifiers at every stage of the cascade are complex themselves and they are built out of basic classifiers using one of four different boosting techniques (weighted voting). Currently Discrete Adaboost, Real Adaboost, Gentle Adaboost and Logitboost are supported. The basic classifiers are decision-tree classifiers with at least 2 leaves. Haar-like features are the input to the basic classifiers, and are calculated as described below.

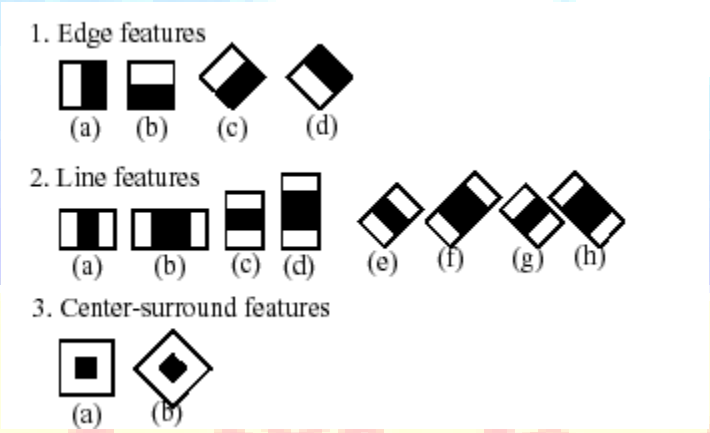

Figure 3: Haar-like features used in Algorithm.

The feature used in a particular classifier is specified by its shape (1a, 2b etc.), position within the region of interest and the scale (this scale is not the same as the scale used at the detection stage, though these two scales are multiplied). For example, in the case of the third line feature (2c) the response is calculated as the difference between the sum of image pixels under the rectangle covering the whole feature (including the two white stripes and the black stripe in the middle) and the sum of the image pixels under the black stripe multiplied by 3 in order to compensate for the differences in the size of areas. The sums of pixel values over a rectangular region are calculated rapidly using integral images.

Implementation

Frontal face detection[10],[2]

In this work, we have tested cascade for the frontal face detection included by default in OpenCV 2.4.1 haarcascade frontalface alt (trained by R. Lienhart).

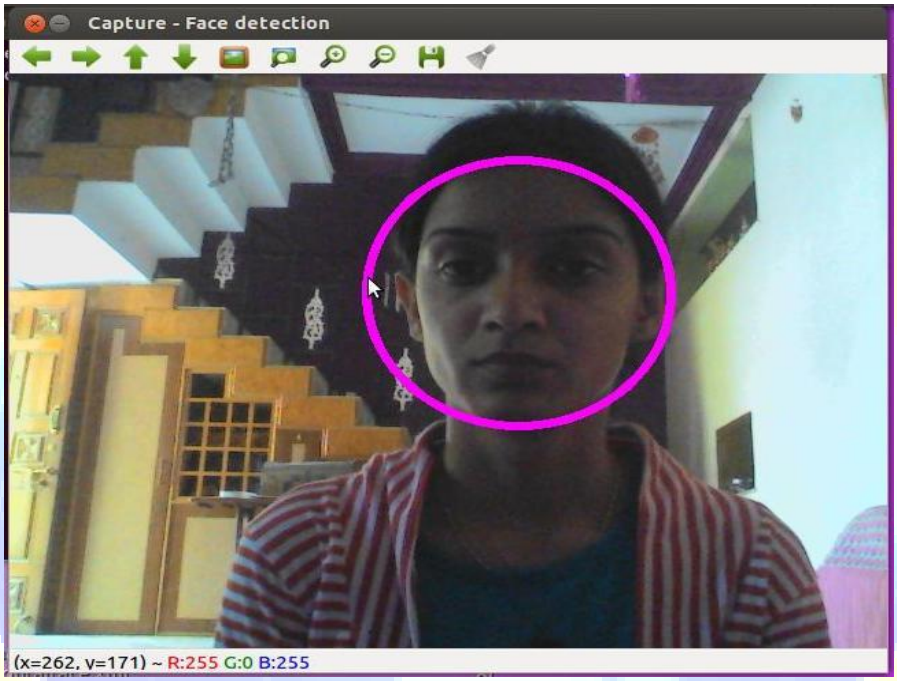

Figure 4: Frontal Face Detection

Eye pair detection[2][10]

For Eye pair detection we trained our own classifier. We use 1000 gray images own created database for positive images. And random gray scale image collection as negative images. These positive images converted in form of fixed size vector (for Eye pair 25 x 5).This preprocessed data under goes training tool provided by OpenCV. It creates trained classifier based on haar like feature. The classifier consists of number of stages (strong classifiers for each feature) and this strong classifier is made from the bunch of weak classifiers. Each input frame of input image has to undergo all theses stages to detect the given image is object or not. Final detected object frame is shown on screen as output. Output of our trained classifier for eye pair detection is shown in figure 5.

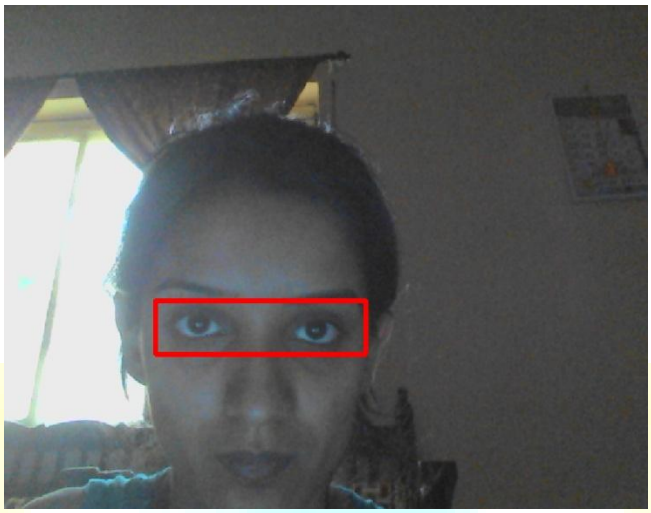

Figure 5: Result Of Eye Pair Detection Classifier

Result

Facial feature detection system provides a solution for automatically detect the faces in still images and the real time video feeds of an image. system can detect an arbitrary number of faces at any scale and location. The system takes photographic images or a video stream as input. The output consists of an array of circles which corresponds to the location, at the scale margin and scale of Faces and Eye pair detected. If it detects no faces then it will be return an empty array. Final result of our designed system will look like figure.

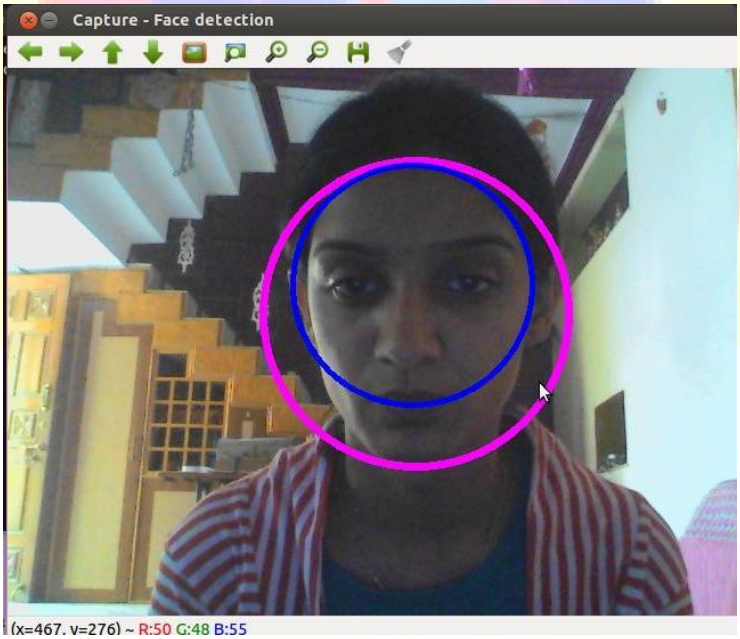

Figure 6: Face Feature Detection

Conclusion and Future Work

This system is designed on development board like Beagle Board –XM with DM3730 digital signal processor along with ARM Cortex-A8 core. It expands application area of hardware based image processing. Execution speed of respective system is one fourth times less than PC due to its RAM support.[4] Still this system Works efficiently as low cost small sized stand lone embedded system. Our further aim is to expand same system for anti spoofing in biometric security system**.**

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