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EYE DETECTION AS FACIAL FEATURE USING SCILAB IMAGE PROCESSING TOOL

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Abstract:

Human face detection and recognition play important roles in many applications such as video surveillance and face image database management. Face detection and extraction is research for future systems to identify the persons in a group and authenticate the reality of human presence as in airport security system, gathering and class room attendance system. In recent years, with the popularity of digital camera and camcorder, the demand for real-time face detection is increasing. Detecting faces directly in a compressed domain, instead of the original image, is an interesting approach that can save time in the decompression process and reduce the complexity of hardware and software design. The paper focus on the eye detection and extraction as facial feature, of human face, and multi human eyes detection using SLILAB Image and Video Processing Toolbox (SIVP).

Keywords: Human Face Detection, SCILAB, Digital Image processing

1. Introduction

In recent years face recognition has received substantial attention from researchers in biometrics pattern recognition [1, 3], and computer vision communities the machine learning and computer graphics communities are also increasingly involved in face recognition. This common interest among researchers working in diverse fields is motivated by ourre mark able ability to recognize people and the fact that human activity is a primary concern both in everyday life and in cyberspace besides, there is a large number of commercial, security and forensic applications requiring the use of face recognition technologies. These applications include automated crowd surveillance, access control, mugs hot identification (e.g., for issuing driver licenses), face reconstruction, design ofhuman computer interface (HCI) [9], multimedia communication [4] (e.g., generation of synthetic faces) and content-based image database management. A number of commercial face recognition systems have been deployed, such as Cognitec, Eye matic, Viisage, and Identix Since features are not spherical, attempting to determine feature location correctness based upon a pixel or 3D error distance would not yield accurate results. To ensure there would never be a missed detection the distance would need to be large enough to incorporate the entire feature as in Fig. 1 (a), which would also create a region of false positives. Alternatively, the distance could be small enough that only the feature would be included as in Fig. 1(b), but true negatives where the feature was correctly identified but not within the allowed error region would also exist. The non-frontal face pose images consisted of 357 subjects taken at -45 to 45 degree angles in pitch and yaw. The numbers of images in the non-frontal pose dataset is almost an order of magnitude larger than in the frontal dataset. The time required to examine all of these results manually every time the algorithm changes would hamper the development rate considerably.

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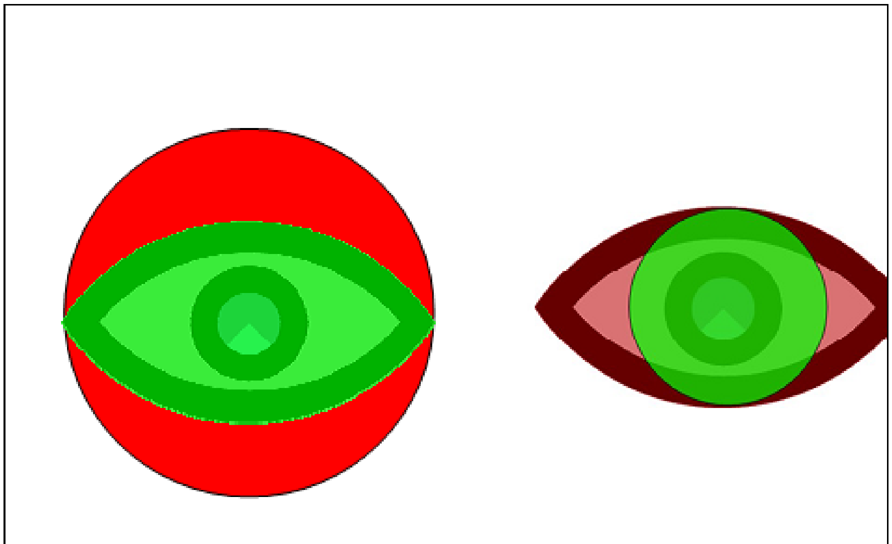


a. When the eye region is large enough to include the entire eye (shown in green), the large red region around the eye is misclassified as an eye	b. When the eye region is small enough to only include the eye (green region), then large portions of the eye are misclassified as not being a part of the eye

Figure 1: Distance based eye regions cannot correctly classify the eye/non eye regions correctly automatically

As a result, we visually examined the frontal dataset results to determine if the automatically detected feature was correct since this is a task a person can easily perform. While this method allows for the best coarse accuracy results, identification of the feature, [4, 5] but not the center of the feature, to determine if the correct feature was identified, it does not allow for a quantitative analysis of the fine accuracy results (identification of the feature and the approximate center of the feature) to determine how close to the center of the feature the algorithm was. In addition, the approach of visually inspecting all of the results on the non-frontal pose dataset is not even feasible because the frontal pose dataset containedapproximately 1,500 images while the non-frontal pose dataset contained over 9,000 images. Therefore, the 2D image of all of the non-frontal pose data was ground truthed to manually identify the center of the eyes, nose, and mouth. We also examined the images to ensure that there was not a shift between capture of the 2D and 3D data since the algorithm and ground truthing process assumes registered 2D and 3D data. This is important because it is possible for the scanner to produce bad unregistered data if the subject is moving during the acquisition process. We removed this type of bad data from the dataset. Once the data is ground truthed, we know the 3D location of the center of the features. In cases where no 3D data exists on the correspondingly selected 2D pixel, we simply search the pixel array for the nearest 3D data point to use instead. Thus, we can determine how close in 3D space the facial feature detected by the algorithm is to the manually located facial feature. By using a small error distance threshold, we can automatically determine a large portion of the images that should always be correct. This will allow a large number of images to be automatically identified for the correctness term. Then we have a small amount of results to examine manually that could be on the desired facial feature. The results manually examined probably do not have a fine accuracy since they are not below the error threshold to be considered automatically correct, but (since they could still be on the facial feature) are not necessarily entirely incorrect either.

2. Face Detection

The face detection module is based on the technique of human face center-of-gravity template matching. Considering the novelty of this technique and the close relationship between the face detection module and other two modules of “Cartoon Face Discrimination” and “Facial Feature Area Location”, it is necessary to make a brief introduction to the technique of face center-of-gravity template in this section. Such a face detection procedure consists of eight steps as shown in Fig .2 and Fig.3, which produces the preliminary locations for detected faces and facial features such as eyebrows, eyes, nose and mouth.

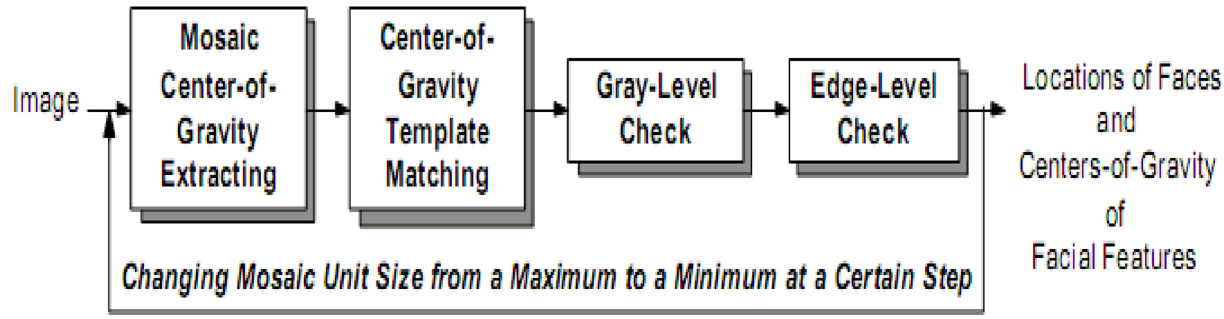


Figure 2: Face detection

It can be observed that the orientations of the main components of an upright human face, as shown in fig. 4(a), such as double eyebrows, double eyes, nose bottom and mouth, are all horizontal and the heights of these components are approximately equal.

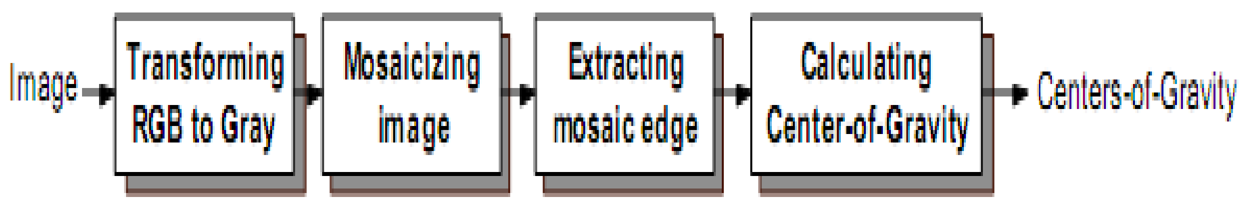


Figure 3: Mosaic center -of-gravity extraction

$$\text{mosaic\_image}(i, j) = \frac{\sum_{k=i1}^{i2-1}\sum_{l=j1}^{j2-1} image(k,l)}{(i2-i1)\times(j2-j1)}$$

where i_1= INT(i/unit_size)×unit_size; i_2=i_1+unit_size; j_1=INT(j/unit_size)×unit_size; j_2=j_1+ unit_size; the function INT(x) returns the integer portion of x. From Fig. 4(b), it can be obviously observed that there are some horizontal bar-like dark regions corresponding to the facial features such as eyebrows, eyes, nose bottom and mouth.

Figure 4: (a) Original image (320×240 pixels, face area: 44×48 pixels) b) Mosaic image (unit size=4×4 pixels)

Facial feature extraction can be defined as a process to locate specific features in a facial image such as points or contours. The features to be extracted can be physical such as eyes, eyebrows, mouth, nose etc. or appearance based like optical flows, Gabor coefficients etc. that represent movements and position of facial features. In this thesis the focus is on the physical features.The eyes are the most commonly extracted facial features. In many approaches, the possible eye regions are located by detecting dark regions in an image. This is based on the observation that in a gray-level image the human iris is of low intensity compared to its surrounding neighbourhood. The eyes are symmetric in nature. This property is used as knowledge to guide further the eye detection process. Furthermore, in almost all cases the eyes come in pairs and each open eye can be described as having a white sclera and a dark iris. The mouth, like the eyes correspond to low intensity regions of the face. However, it is difficult to detect the mouth accurately due to the highly deformable nature of the mouth region. There are other major difficulties such as a beard and the visibility of the teeth in the mouth opening.

The locations of the eyes and the mouth are used to guide the search for other facial features. For example, finding the eyebrows can be based on the location of the eyes. The nostrils are searched for in an area between the eyes and the mouth. The eyebrow candidates are searched for in an area restricted by the position of the eyes. The eyebrows cannot be simply described by means of a geometric curve, because of the variation among various people. Furthermore, the contrast for eyebrows can be very low. Other features, which have not been used so often in feature extraction, include tip of the nose, ears, chin and cheek borders etc. Usually the nose is hard to identify due to the low contrast of the skin. Most of the existing methods for facial feature extraction assume that at least coarse location of the face is detected. If the face is first located, the computational complexity of the facial feature extraction can be significantly reduced. Usually possible feature candidates are roughly located within a possible facial region and then high-level analysis is performed to detect the correct ones. The high-level analysis is typically based on knowledge of the face or is template generated by training. Finally, more advanced methods are utilized to get more accurate positions for features if needed.

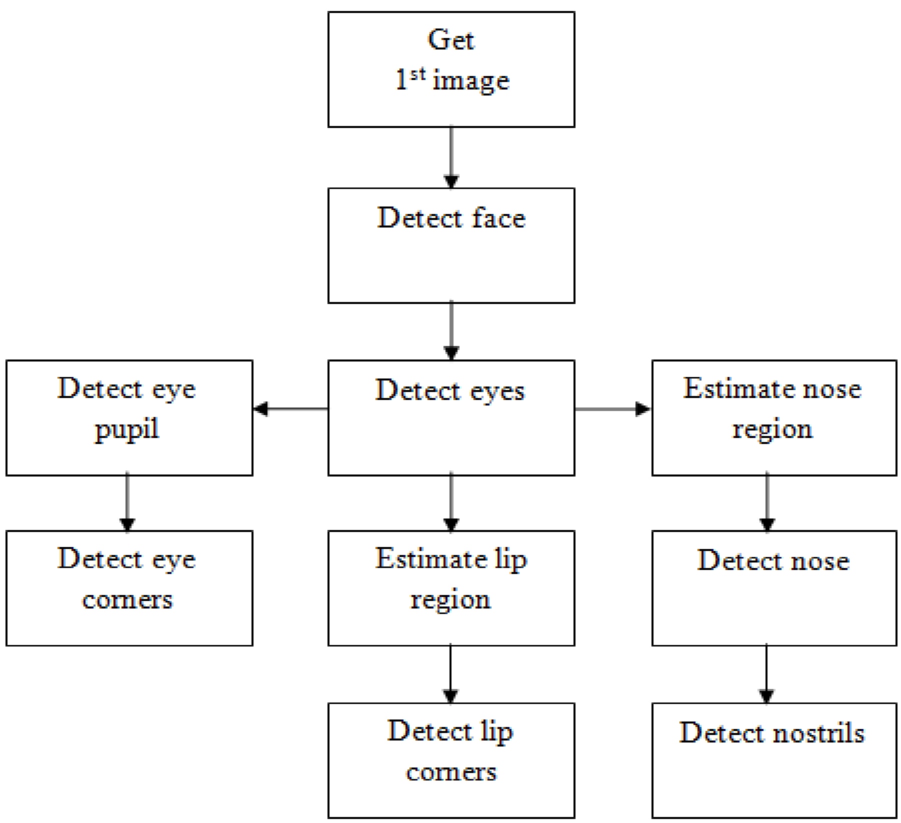


Figure 5: Block diagram for facial feature extraction

There are several factors associated with facial feature extraction such as wearingglasses, different skin color, gender, facial hair, and facial expressions. Also,the human face is a three-dimensional (3-D) object, and the appearance of the face in an image is affected by imaging conditions. In the following, some of the problems are listed:

- ***Size and Orientation of the face:***The size of the face and facial featuresin an image depend on the imaging distance and orientation. This willdifficulties for feature extraction methods. Therefore, minimumwindow sizes for feature extraction methods are usually set. The orientationalso depends on the pose of the camera and some features may be partiallyor fully occluded, for example eyes and nostrils. Sometimes the orientation is normalized if the head orientation is detected before the feature extraction process.
- ***Illumination:***The quality of an image depends heavily on the illuminationcondition. The illumination can make contrast in feature boundaries weakerand cause shadows which can lead to erroneous facial feature extraction.Also, the direction of the illumination source can cause non-homogenousimages. For example, the eye contrast can be poor and therefore a goodedge image cannot be obtained. Histogram normalization techniques are commonly used against inadequate illumination.
- ***Occlusion:***Other things like a beard, moustache, glasses or hair can occlude the facial features. These can hide or warp some facial features such as the eyes and the mouth. In addition, properties like shape, color and the size of these components can vary intensively. Some parts of the body or other objects can also cause occlusion. Most of the existing methods cannot handle occlusion.
- ***Facial expressions:***The shape of a particular facial feature such as the mouth can be deformed by facial expressions. The intensity of facial expressions vary based on a person’s emotional state. Furthermore, there are huge variations between individuals. Facial expressions can also cause transient features like wrinkles and bulges that make facial feature extraction more difficult.

There are so many different methods to extract the facial features like eyes, nose, mouth, nose nostrils, lips and lip corners. The fig.5 shows the flow diagram for step by step detection of facial features.

3. Algorithm

Two-dimensional discrete wavelet transform (2-D DWT) decomposes an input image into four sub-bands, one average component (LL) and three detail components (LH, HL, HH) as shown in fig. 7. The flow of the algorithm is shown in fig.6.

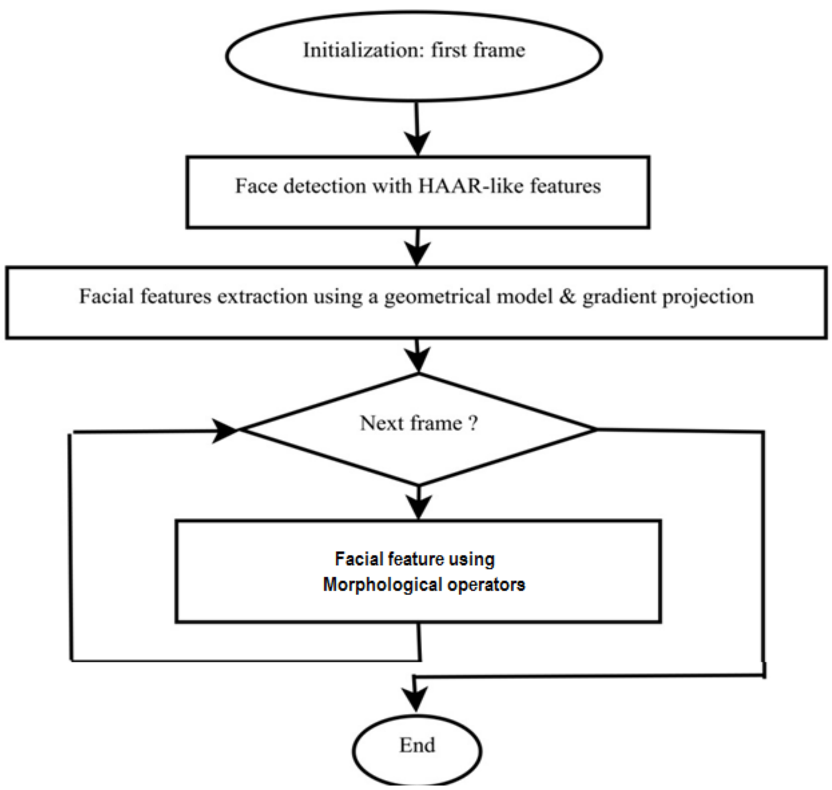


Figure 6: Flow of eye detection

In image processing, the multi-resolution of 2-D DWT has been employed to detect edges of an original image. However, 2-D DWT can detect three kinds of edges at a time while traditional edge detection filters cannot. The traditional edge detection filters detect three kinds of edges by using four kinds of mask operators. Therefore, processing times of the traditional edge detection filters is slower than 2-D DWT.

Image Encoding in HAAR DWT

In discrete wavelet transform six major steps of image compression. These encoding processes are following step-by-step.

Step1: first the original image passed through a combination of filter, such as low-pass and high-pass filter. These filters are applying each row.

Step2: Then output image of the Bothe low-pass and high-pass filter is L1 and H1, these are combining into$\mathrm{T_1} = [\,\mathrm{L1\ H1}\,]$.

Step3: After the filtering the combine output $\mathrm{T_1}$ of these filters are down sampled by the 5.

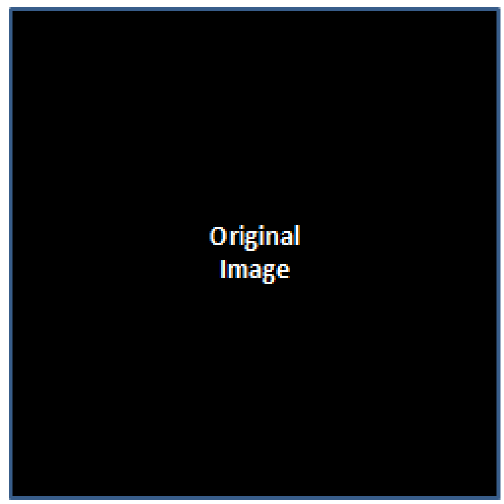
Step4: Now, again T1 has been passed through high pass filter and low filter by applying on each column.

Step5: Let suppose the output of the step4 is L2 and H5. Then H2 and L2 combine into $\mathrm{T_3} = \begin{bmatrix} \mathrm{L2} \\ \mathrm{H2} \end{bmatrix}$

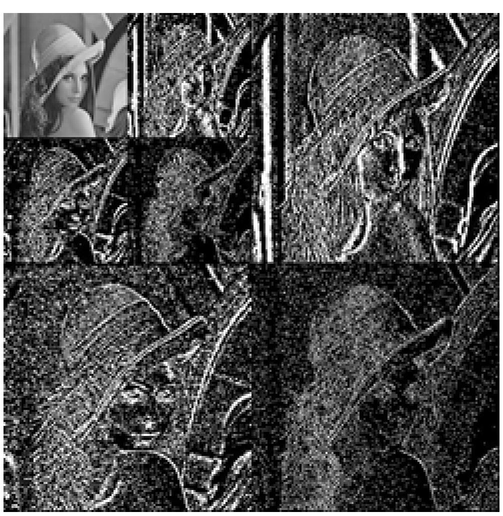
Step6: After the filtering the combine output $\mathrm{T_3}$ of these filters are down sampled by the 5. This is compressed image of the processing.

In Fig. 7 there are shown a resulted image after applying encoding process. In this Fig.7 are four blocks, the first half upper block show the approximation, and second upper half block show the horizontal detail.

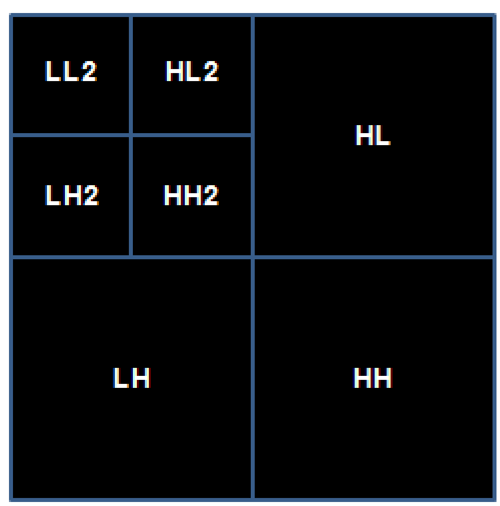
A



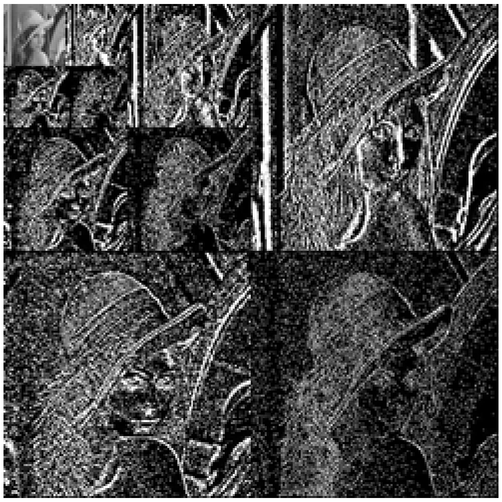
B



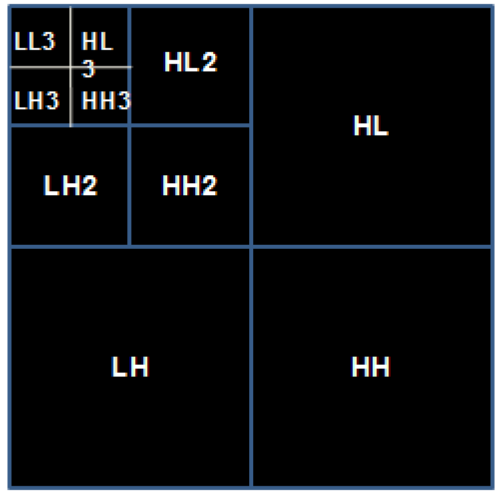
C



D



E



F

Figure 7: HAAR DWT Image Processing

First lower level block shows vertical detail and second lower level block showsdiagonal detail.In this algorithm is shown one level discrete wavelet transform.By applying this process more than one time it can increase the level ofDWT. Second and third level DWT gives the bettercompression ratio of image. But it will come with loss of some information.

Image Decoding in HAAR DWT

The decoding process is not exact reverse of the encoding process. The steps of the decoding process are following.

Step1: First extract low pass filter image and high pass filter image from the compressed image. The low pass filter image is taking by upper half rectangle matrix and high pass filter image is taking by down half rectangle matrix.

Step2: these images are up sampled by 5.

Step3: Then the summation of both images take into one image is called R_1.

Step4: Then again extract low pass filter image and high pass filter image by simply dividing vertically part of the image.First half is low pass filtered image part. And second half is high pass filter image.

Step5: After then above process take summation of both images. It isthe output of reconstructed image.

4. Results

So in the DWT get very high extraction ratio, and also lose minimum amount of information. But if more than one level then get more extraction ratio but the reconstructed image is not identical to original image. The simulation is carried out to detect the face and eye of the color image in SLILAB 5.5.1 Image and Video Processing Toolbox (SIVP).

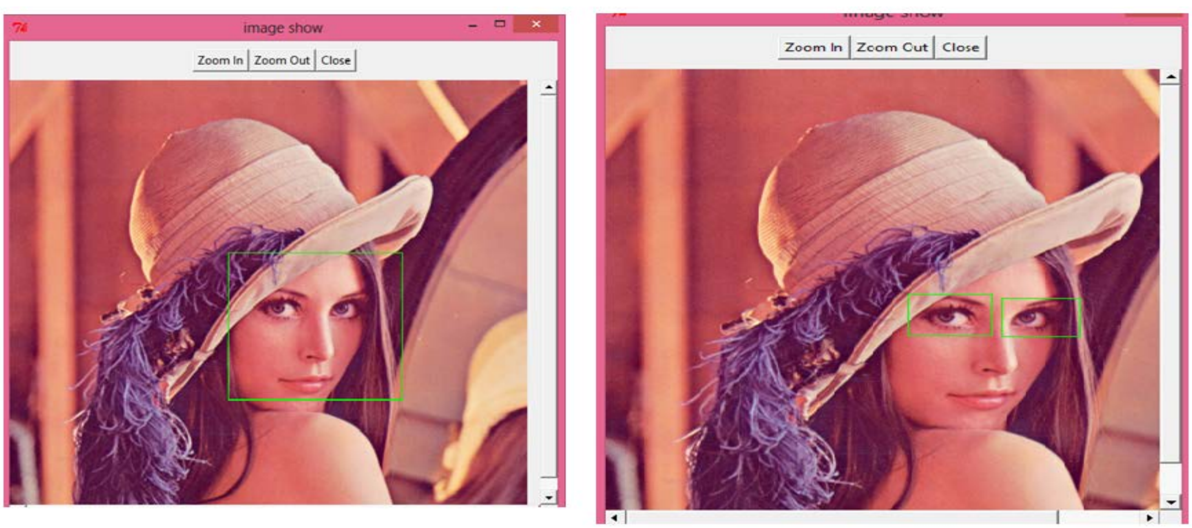


Figure 8: (a) Face and eye detection in lena Image

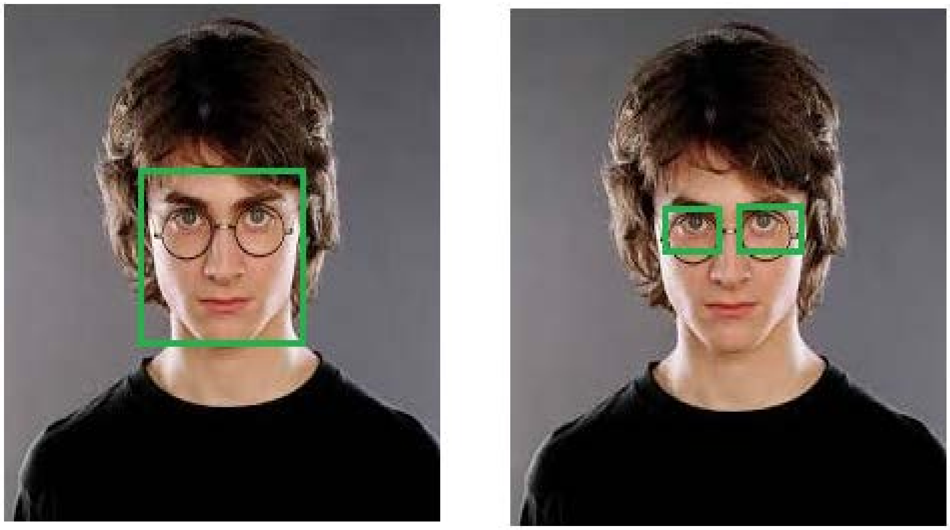


Figure 8: (b) face and eye detection in Harripotter Image

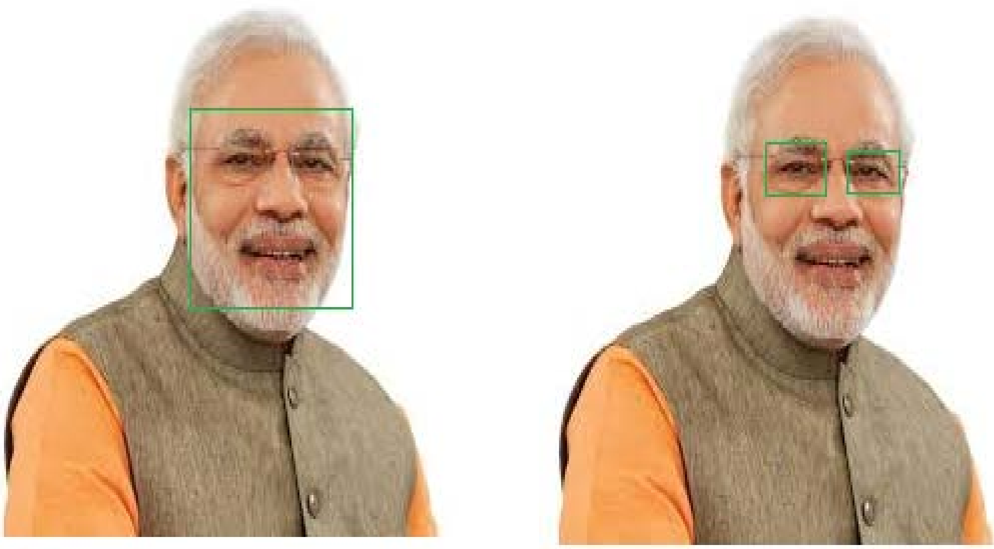


Figure 8: (c) face and eye detection in Harripotter Image

Figure 8: (d) face and eye detection (combined)

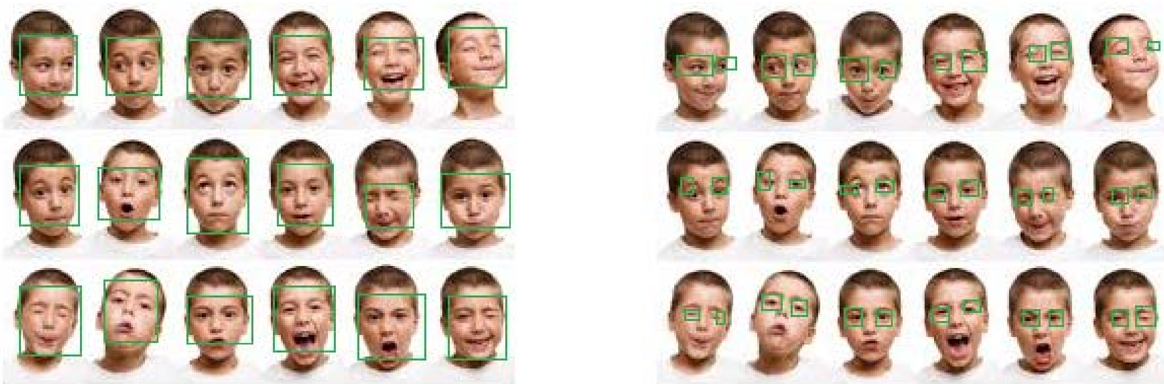


Figure 8: (e) Multi face and multi eye detection

5. Conclusion

In the paper the face detection and eye detection is tested successfully on different images. There are many different automatic face detection and learning.In the tested image we have used Haar-Classifier because we want to detect the face from the front. Moreover, if the programmers need to to use the method with a high frame rate we will need to process the information properly to reduce the computer calculation time. We have tested the results for single face , eye detection and multiface and eye detection. In the future, it can be recommended to use webcam can be integrated into a television and detect any face that walks by.Next generation person recognition systems will need to recognize people in real-time and in much less constrained situations. Human face detection and recognition play important roles in many applications such as video surveillance and face image database management.

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