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MULTIPLE FACE DETECTION AND TRACKING FROM VIDEO USING HAAR CLASSIFICATION ALGORITHM

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ABSTRACT

Face detection and tracking systems have received increasing interest in the last decade. Face detection and tracking are subfield of biometric information processing and object tracking, respectively. Recent advances in theory and practical implementations made the online detection and tracking system work in real time Face detection and tracking system designed and implemented in this paper exploits a combination of techniques in two topics; Face detection and tracking. Face detection is performed online achieved images from video. Processes exploited in the system are color balance, skin segmentation, and facial image extraction on face candidates. In this paper, intend to implement multiple face detection and tracking the head poses position from high definition video using Haar cascade classifier. Finally, the result from detection part is engaged with a Kalman filter for tracking candidate face in reasonable speed of change the system is tested in practice and have shown to have acceptable performance for tracking faces with in the proposed limits. The proposed will give satisfactory results for multiple faces in live achieved images with in each video frame.

KEYWORDS: Face detection, object tracking, facial feature extraction, Haar cascade classifier, Kalman filter.

1. INTRODUTION

An image may be defined as a two-dimensional function, where x and y are spatial (plane) coordinatinates, and the amplitude of F at any pair of coordinates (x,y) is called the intensity or gray level of the image at that point. In this paper work focuses on the study of face detection and tracking.

From video streams. Face detection and tracking systems are sub-fields of image processing and they are receiving increasing interest by researchers and industry. In this manner, face detection and tracking can be attractive in several uses, in particular for surveillance, high security entrance, care systems, and automatic teller machines (ATM). Face detection algorithms detect faces and extract facial images based on the location of eyes, nose, and lips whereas the tracking algorithms use estimation/correction methods. This makes the combined algorithm more complicated than individual detection or tracking algorithm. The face detection and tracking methods used in this thesis work are fundamentally based on Haar classification method and Kalman filter algorithm, respectively.

In this paper, the MATLAB Simulink platform is used for creating a system with an online digital camera. Consequently, all the implemented algorithms are integrated with this system to process video frames sequentially one after another. All data processing, detection and tracking algorithms are handled within the simulation framework.

The contents of this paper work are specified as follows:

- Face detection and tracking system should detect, extract faces, and track frontal faces from live video sequences.
- System should work under indoor and outdoor lighting condition.

1.1 Video Processing

Video processing technology has revolutionized the world of multimedia with products such as Digital Versatile Disk (DVD), the Digital Satellite System (DSS), high definition television (HDTV), digital still and video cameras. The different areas of video processing includes.

(i) Video Compression

(ii) Video Indexing

(iii) Video Segmentation

(iv) Video tracking etc.

2. Face Detection

Face, nose, mouth and eyes have been detected using the MATLAB built-in class and function. Based on Viola-Jones face detection algorithm, the computer vision system toolbox contains vision.CascadeObjectDetector System object which detects objects based on above mentioned algorithm.

Face detection is a computer technology being used in a variety of applications that identifies human faces in digital images. Face detection also refers to the psychological process by which humans locate and attend to faces in a visual scene.

3. Face Tracking

The faces which are detected in the face detection system should be used to track the faces. Face tracking system is composed of preprocessing facial image, system state model, prediction, measurement, and correction. The Kalman filter has two basic structures which are described by system rate model and measurement model .One can employ the adaptive Kalman filtering to track the objects in video streams. The system state model in Kalman filtering is constructed by the motion model and it is used in prediction step.

Object tracking is the problem of estimating the positions and other relevant information of moving objects in image sequences.

- Two-frame tracking can be accomplished using correlation-based matching methods, optical flow techniques, or change-based moving object detection methods.
- Rapid appearance changes caused by image noise, illumination changes, norigid motion, and varying poses

4. Skin Segmention

In skin segmentation, RGB, HSV color spaces are examined for skin like color RGB is sensitive to light changes but HSV is not because of its separated intensity and color changes. However, in our implementation the best results are obtained using the RGB color space. The result of skin segmentation will be a grayscale image. Skin regions are observed brighter than the non-skin regions. The final image is applied for pointed locations of faces and results are sent to the next step. The result of skin segmentation is used by a Haar-like feature extraction method. This method extracts five types of Haar-like features from the skin segmented images. Skin segmentation are mostly used for lips, eyes, nose.

5. Haar Cascade Classifiers

The core basis for Haar classifier object detection is the Haar-like features. These features, rather than using the intensity values of a pixel, use the change in contrast values between adjacent rectangular groups of pixels. The contrast variances between the pixel groups are used to determine relative light and dark areas. Two or three adjacent groups with a relative contrast variance form a Haar-like feature. Haar features can easily be scaled by increasing or decreasing the size of the pixel group being examined. This allows features to be used to detect objects of various sizes.

6. Methodology

6.1 Basic Concepts

This paper on face detection and tracking are planned and state-of-the-art algorithms were summarized in the previous chapter. Among the many possible approaches, the combinations of Haar classification method for face detection and Kalman filter method for tracking have been chosen. Below fig 6.1.1 is represented by Face Detection and Tracking System

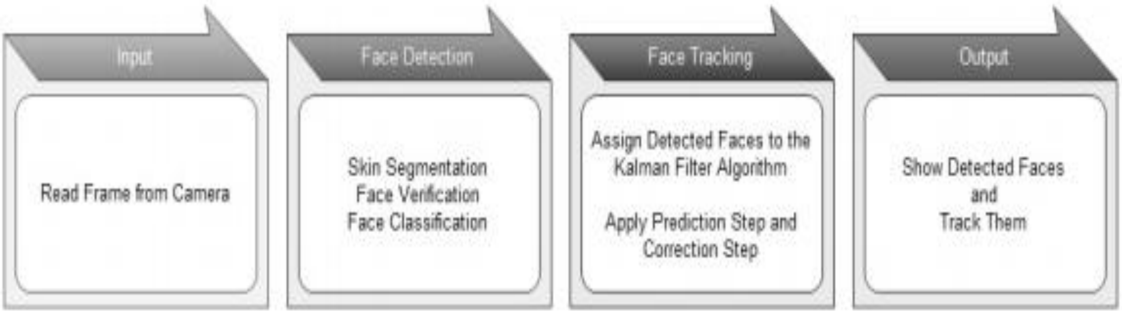


Figure 6.1.1: The Implemented Face Detection and Tracking System

Face Detection

Face detection procedure extracts facial images and locates facial images over the current video frame.

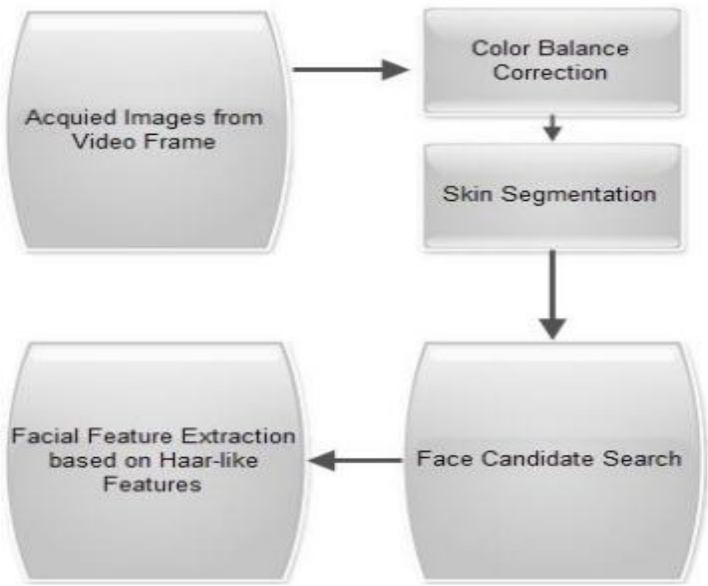


Figure 6.2.1: Block Diagram of the Face Detection Procedure.

After reading a video frame, the first step of the face detection procedure is color balance correction. Color balance is needed for the global adjustment of color intensities. The main goal of the adjustment is to render specific colors correctly. This is why color balance should be applied before face segmentation. For the purpose of color balance correction, the mean values (mv) of Red (Rmv), Green (Gmv), and Blue (Bmv) colors from N×M image are calculated together with the mean value of gray color:

$$R_{mv} = \sum_{i=1}^{N}\sum_{j=1}^{M} R(i,j)/(N \times M)$$

$$G_{mv} = \sum_{i=1}^{N}\sum_{j=1}^{M} G(i,j)/(N \times M)$$

$$B_{mv} = \sum_{i=1}^{N}\sum_{j=1}^{M} B(i,j)/(N \times M)$$

$$Gray_{mv} = (R_{mv} + G_{mv} + B_{mv}) / 3 \qquad (1.1)$$

7. Haar Like Feature

Haar-like feature extraction method. This method extracts five types of Haar-like features from the skin segmented images. These features use the alteration in contrast values between adjacent rectangular groups of pixel values. The five types of Haar-like feature templates used in this thesis are shown in Figure 7.1.These five types of feature templates are used for the purpose of extracting lips, eyes, and nose.

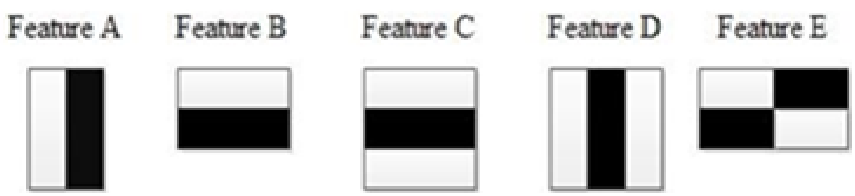


Figure 7.1: Features of Haar-like method.

The simple rectangular Haar-like features of an image are calculated using an intermediate representation of the image, known as the integral image.The integral image is an array containing the sums of the pixels' intensity values located directly to the left and above the pixel at location (x, y). The integral image (AI[x,y]) of an image A[x,y] is computed using equation 1.4, that is graphically illustrated in Figure 7.2

$$AI[x,y] = \sum_{x' \le x, y' \le y} A(x',y')$$

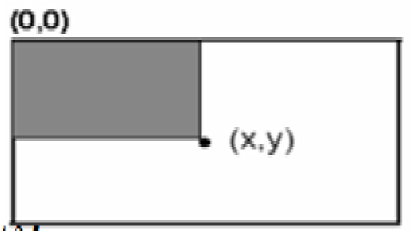


figure 4.2.5 :Computation of AI[x,y] Values (1.4)

The integral image, also known as summed area table can be computed easily in a single pass over the image using the fact that:

$$AI(x,y)=A(x,y)+AI(x-1,y)+AI(x,y-1)-AI(x-1,y-1) \quad (1.5)$$

Once the integral image has been computed, area of any rectangular region (P, Q, R, S) over the image can be computed in constant time as follows: Let P(x0,y1), Q(x1,y1), R(x1,y0), and S(x0,y0) (see Figure 7.2), then

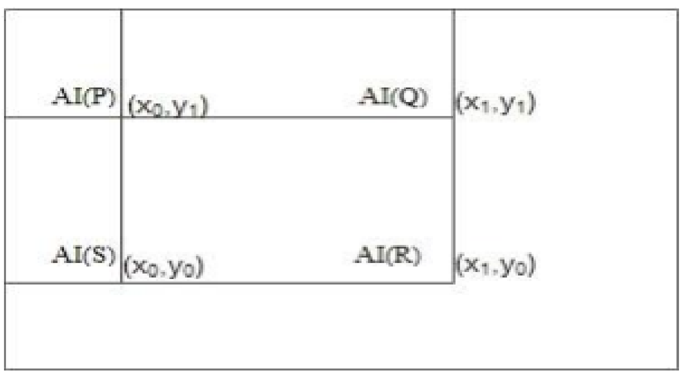


Figure 7.2: Computation of the Area Table.

$$\sum_{\substack{x_0<x<x_1 \\ y_0<y<y_1}} A(x,y) = AI(R) + AI(P) - AI(Q) - AI(S) \quad (1.6)$$

A Haar feature classifier uses the summed area table to calculate the value of each Haar-like feature. A stage comparator sums all the Haar feature results in each stage and compares it with a stage threshold. The threshold is also a constant obtained from the weak classifier.

8. Implementation of Face Detection and Tracking System

The system on face detection and tracking was studied and state-of-the-art was appraised and summarized in the methodology section. To make automatic face detection and tracking system for an online video, we require extracting and tracking faces in an image from a video sequence. For making such type of system, we have included three distinct phases. First, faces are detected and classified in each frame of a video sequence by using weak classifier. Candidate faces are posted to Kalman filter module for prediction and tracking. Then, the candidate faces are updated frame to frame. Finally, the result is shown in rectangular boxes as output.

A flowchart depicting the main stage of the system is shown in Figure 8 and more explanation will be given below.

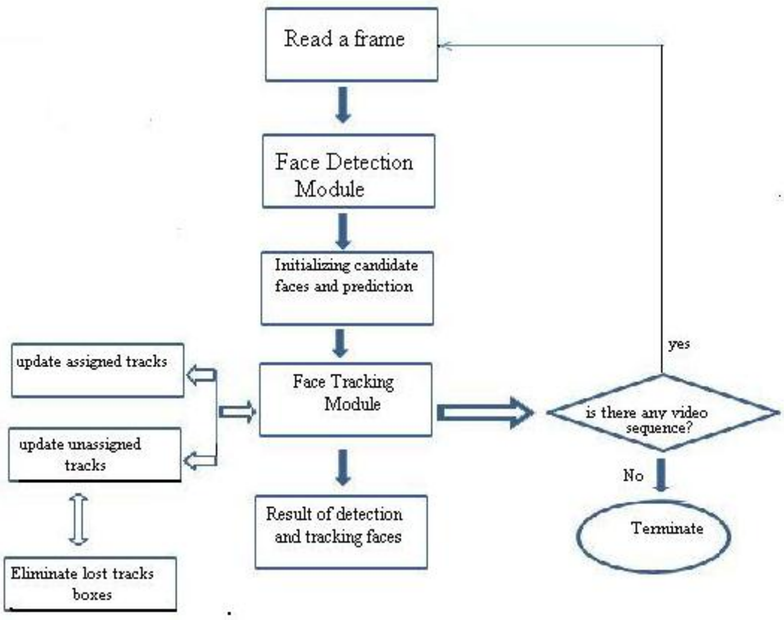


Figure 8: Flowchart of the Main Stages of the System.

As the main part of this work, we discuss reading a frame from video sequence. “Read frame” is the action needed to ensure that the system commence its issue with a correct clarification of the current frame of video sequence. “Acquiring image” task is performed in this part. An image is acquired from each frame of video and it is converted to digital data for performing image processing subtractions.A video sequence is defined in 640×480 pixels and color space is defined as RGB. The capturing frame is sent to face detection part.

8.1 Face Detection

In order to detect the faces, extraction is performed in the RGB color space. In this regard, RGB color space is more suitable for color extraction. To solve face detection problem, as explained in the previous chapter, we use the Haar-like features by engaging the weak classifier method. The Haar-like features consist of eyes, nose, and lips. These features are able to construct a more powerful classification. Furthermore, color balance and skin segmentation are applied for commencing of the face detection process. Lighting conditions are always changing, or different lighting is occurred in indoor/ outdoor environments.

8.2 Face Tracking

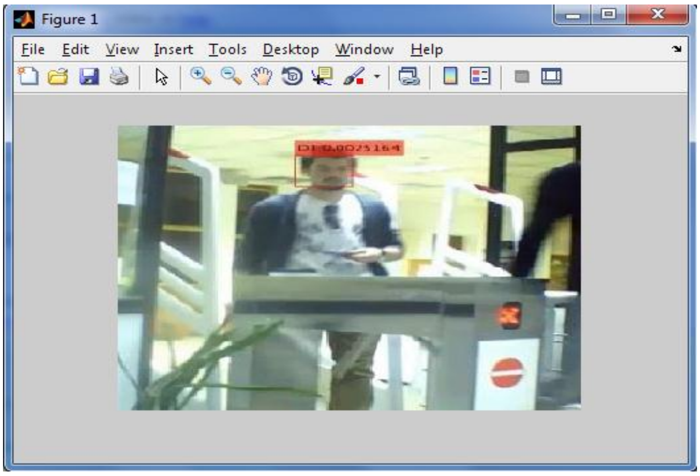
After detecting faces, with the locations stored in the bounding box data set, Kalman filter is applied for each of the candidate faces. In this regard, the location of each candidate faces is initialized as input in the Kalman filter chain. Also, estimation error is initialized for the tracking moving faces in the noisy environments.

9. RESULT AND DISCUSSION

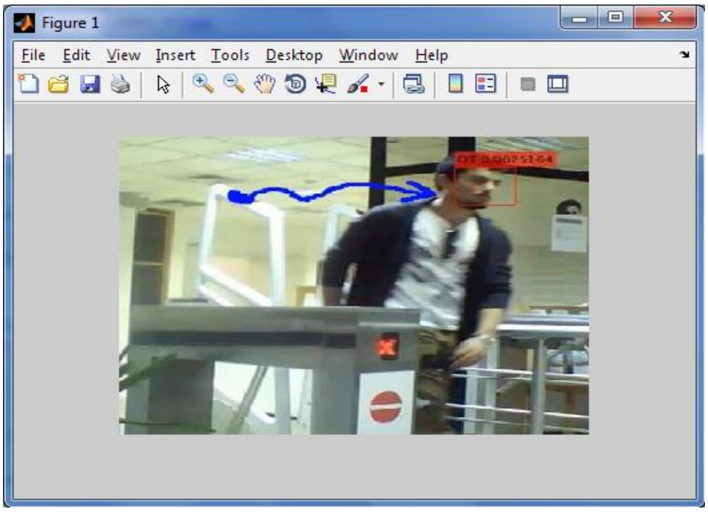
9.1 Face Detection

First of all, implementation of system is performed on face detection in acquiring image form each frame, and skin like region segmentation is a first implementation of face detection. In that case, many methods have been tried to select which segmentation algorithm works best on acquired images. Based on RGB, HSV, and HSV and YCbCr are tested on acquired images from frames and the best result are taken from RGB color space.

After segmentation is completed, candidate search is achieved as described in the previous chapter. Candidate faces are followed by facial feature extraction and face verification of candidate.

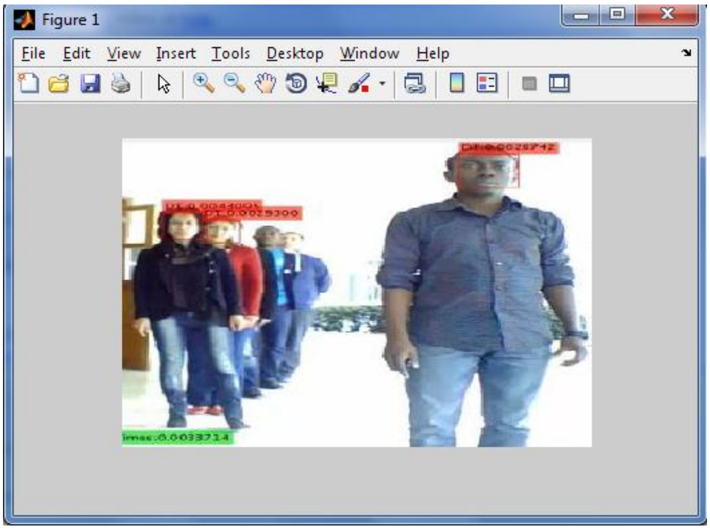


(a) The 213th frame

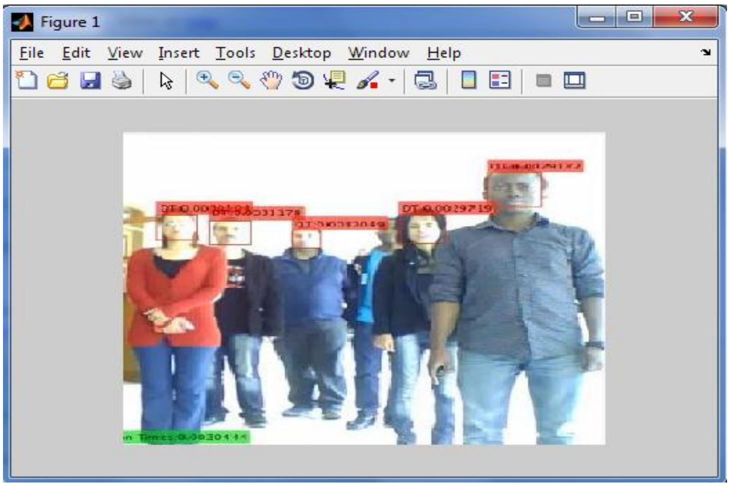


(b) The 219th frame

The Experimental Result in Outdoor



(c) The199thframe



(d) The 232th frame

Figure 9: Blocking and Tracking of Candidate Faces.

Online tracking faces are shown with respect to output of face detection and tracking system by covering boxes for each candidate face. Also, detection of a new face candidate and tracking of candidate faces are updated for each frame of video sequence, because some candidates are probably eliminated or inserted.

9.2 DISCUSSION

In this paper focuses on implementing face detection and tracking system. System is composed of acquired images form online video stream; face detection part, and tracking part.

Haar classifier method is performed for face detection part by Haar-Like facial features with combination of skin color balance. Methods are combined due to decreasing computational time and increasing accuracy of detection part. Before skin color segmentation, color balance correction is executed to overcome color problem while achieving image from frames. Also, the method was useful for black race of humans in bright environments.

On the other hand, RGB skin color segmentation used in the algorithm works well at any environment tested (Indoor/Outdoor condition) in our experimental studies. Segmentation is performed on recorded images after color balance. Face candidates are selected from segments and facial feature extraction is executed to verify face candidate and extract face images. Haar-like method is performed to show facial components clearly. After extraction of faces, face detection part is complete and face images is ready to be classified. Classification is performed by Haar classifier learning algorithm. The algorithm is good for training and classification problem.

10. CONCLUSION

Face detection and tracking system is part of image processing applications. Implementations of system are video surveillance and similar security activities. The goal is reached by face detection and tracking methods. Facial feature face detection methods are used to find position and extract faces in achieved images form frames of video. Implanted methods are color balance and facial features. Also, Kalman filter is used for face tracking. A Weak classifier is employed to classify and solve face detection problem since face tracking is required. Classification results are satisfactory. Also, classification is satisfactory when extracted faces are small oriented, smiled, closed eye, wore sunglass, and wore hat. The proposed algorithm is capable of detecting multiple faces, and leads to acceptable performance in terms of obtained results.

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