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HUMAN FACE DETECTION AND TRACKING IN COLOR IMAGE AND VIDEO

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ABSTRACT

Face detection and tracking in a video scene forms the first step in building a practical face recognition system. In this paper a method to detect and track human faces in color image and video is described. The face detection technique based on skin color is used to detect face(s) in the first frame. These detected faces are tracked over subsequent frames by using the modified mean shift algorithm. The method is simple and powerful. The system can detect and track multiple faces.

INTRODUCTION

Automatic face recognition is a process of identifying a test face image with one of the faces stored in an existing database. For recognition the face position and size is needed. Hence a robust system that detects and tracks a face is necessary. Face detection and tracking becomes an important task with the growing demand for content based image functionality. They are also used in face based video coding for video conferencing applications.

Various approaches to face detection are discussed in [1], [2], [3]. For recent surveys on face detection see[1] and [2]. These approaches utilize techniques such as principle component analysis, neural networks, machine learning, information theory, geometric modeling, (deformable) template matching, Hough transform, motion extraction and color analysis [4].

A variety of tracking algorithms [5, 6, 7] have been proposed and implemented to overcome difficulties that arise from noise, occlusion, clutter and changes in the objects being tracked. Important techniques for tracking include region based methods, feature based methods, model based tracking and appearance based approaches.

Many of these approaches employ a statistical description of the region or the pixels to perform the tracking. The tracked object can be described using either parametric or nonparametric frame representation. In a parametric framework, the objects or faces are typically fitted by a gaussian or via mixture of gaussian. A nonlinear estimation problem has to be solved to obtain the number of guassians and their parameters. However the common parametric forms rarely fit the multimodal complex densities in practice and are problematic when the fitted distributions are multi dimensional. In contrast nonparametric density estimation techniques allow representation of complex densities just by using the data. They have been successfully applied to tracking. In this paper, a method to detect and track face(s) in color image and video using skin color is described. Section 2 deals with the face detection algorithm. In section 3 a technique for multiple tracking is discussed. Implementation details and results are discussed in section 4. Section 5 deals with the conclusion and future work.

FACE DETECTION ALGORITHM

In the face detection step the input RGB image is first converted to HSV image. Skin samples are collected from skin portion of the image and the corresponding H and S value are found. Then skin model histogram for H and S is calculated and normalised. The image histogram for H and S is found and normalized. Thresholding is done which results in binary image with skin portion appearing as white. Then connectivity analysis is done to find number of holes in the region, if the number of holes greater than or equal to one and the height to width ratio is within the range called golden ratio then it is a face else it is not. The algorithm is summarized below.

ALGORITHM

Step 1: Convert the input RGB image into HSV image

Step 2: Convert skin sample images from RGB to HSV

Step 3: For each skin pixel get the corresponding H and S value

Step 4: Create the skin model histogram for H and S, and normalize it

Step 5: For each pixel of the input image get the corresponding H and S value

Step 6: Create the im**a**ge histogram for H and S, and normalize it.

Step 7: If (colorhistogram(H, S) > skinthreshold)

then skin(i,j) = 1 i.e. (i,j) is a skin pixel

else skin(i,j) = 0 i.e. (i,j) is a non-skin pixel

Step 8: Find the different regions in the image by implementing connectivity analysis using 8-connected neighborhood.

Step 9: If (number of holes>=1)

then find the height, width and coordinates of the bounding box for that region.

Step 10: For such a region if (height/width) is within the range (golden ratio ± tolerance)

then the region is a face

else it is not a face

Step 11: For each face region correlate with reference face masks and find whether it is a frontal or left or right face.

End of Algorithm

FACE TRACKING ALGORITHM

In the proposed algorithm initial location and size of the 2D search window for each object or faces to be tracked is chosen in the first frame. Then the color probability distribution is calculated in the 2D regions centered at the search window location in an area slightly larger than the meanshift window size. The process is repeated for each object until convergence or for a preset number of iterations, then the zeroth moments which gives the size and the mean location for each object is stored. For the next video frame the search window is centered at these mean locations and the sizes are set to a function of zeroth moment until all the frames are covered by these operations **The Algorithm to track multiple faces**

Step 1: First, set the calculation region of the probability region of the probability distribution to the whole image.

Step 2: Choose the initial location(s) of the 2D mean shift search window(s).

Step 3: For each face or object to be tracked calculate the color probability distribution in the 2D region centered at the search window location in an area slightly larger than the mean shift window size.

Step 4: Mean shift to convergence or for a set number of iterations. Store the zeroth moment(s) (area or size) and mean location(s).

Step 5: For the next video frame, for each face or object to be tracked center the search window at the mean location stored in Step 4 and set the window size to a function of the zeroth moment found there. Go to step 3.

IMPLEMENTATION AND RESULTS

The detection algorithm is applied on a wide variety of images taken under different lighting conditions and with different backgrounds.

The various stages of the algorithm are explained above. The skin threshold used for H value is 0.01 and the threshold used for S value is 0.001. This was found to be optimum in a set of about 25 images containing 36 faces used for this projects.

The results of the experiment are summarized in the table in the figure 4.1 below.

Number of faces detected	27
Number of false alarms	23
Number of faces not detected	9
Total number of faces	36
Percentage of faces detected	75

Figure 4.1 Experimental Results

If a face is detected correctly it is called true positive. The number of false alarms are called false positive. The number of faces not detected are called false negative. In an image if there are no human faces and if there are false detections then it is true negative. The number of true negative for five images not containing human faces is three. True positive rate is calculated and found to be 0.75. The detection rate is calculated by the ratio of number of correct detections to the total number of faces. It is found to be equal to 0.75. False positive is calculated and found to be 0.88. The value is very high showing that there are false detections in the output also the number of true negative cases are low in the set of images considered for experimentation. If the number of true negative cases is less it shows more accuracy, since true negatives must be more avoided than false positives. True positive rate is also very good showing that the system can detect the faces with considerable amount of accuracy. The true positive rate is also indicative of the sensitivity of the system. This shows that the system shows an high amount of sensitivity in detecting the faces. This measure can be improved by using pictures with clearer view of the human faces.

Considering the fact that the algorithm was tested on a wide range of images with different faces, backgrounds etc. the performance of the algorithm is indeed encouraging. The algorithm is not hundred percent accurate there are some false detections in some images this is mainly due to the skin colored objects which satisfies the criteria used by us for face detections.

The tracking algorithm was implemented and tested. Around 30 video clippings containing human faces were collected for testing purpose from different sources such as internet and digital web camera. The algorithm was found to work equally well for the case of multiple faces as well. Thus the algorithm is useful tracking non rigid objects such as faces. It also overcomes the problems of partial occlusions such as glasses in faces. The overall performance of the algorithm is quiet satisfactory

CONCLUSION

An algorithm has been developed to detect and track human faces in a color image or video. Skin color is found to be a powerful feature for isolating potential face candidates. It is also useful for detecting multiple human faces in an image or video. It is orientation independent. For tracking a modified form of meanshift method is used. It has the ability to track multiple objects and is very robust.

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