Face Recognition and Person Localization using SURF for Automated Attendance System

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ABSTRACT
This paper discusses the experimentation of a robust face recognition descriptor and its implementation in camera based lecture attendance system. The Speeded Up Robust Features (SURF) descriptor used for recognition produced a reliable performance with regard to change in illumination, scale and rotation of the test images used. Experiments were done on various test images with varying conditions in each image and obtained repeatable output. Finally, an interactive MATLAB GUI was created to mark the attendance and to locate a student along with his academic details.

Keywords
Attendance system, Speeded Up Robust Features, Face recognition

1. INTRODUCTION
The conventional attendance marking methods includes calling a student`s name in class, which involves wastage of energy and time of the lecturer and also this way of attendance marking have several loop holes to mark proxy attendance by the students. With the advancement in the technology, biometric based attendance and RFID based attendance system was introduced. Though these technologies are accurate in sensing a particular person using their unique feature, they have their own limitations since they do not involve continuous monitoring of the students and can easily be tricked.

These disadvantages gave rise to the use of camera in attendance marking system. But initially the camera based system was sensitive to variations in light, transformations in scale and rotations. With the combination of 2D Haar wavelet and integral images [7] and with the high computational capability of the modern processors, it is now possible to practically implement a reliable camera based attendance system using a tablet or AR Glasses. The implementation of the SURF descriptor in face recognition and its application are discussed below.

2. FEATURE DETECTION AND EXTRACTION
The SURF detector is used to find point correspondence of the specific face in the entire scene of the class room. The interest points are selected from the distinctive points in the image such as corners, blobs and T junctions. The detection is speeded up by the summed area table known as an integral image, which is an algorithm for generating the sum of values in a rectangular sum of grid [3]. Hence the number of iterations gets reduced thereby reducing the computation time. The value of a pixel at any location x and y can be given as,

$$\sum_{\substack{x0\le x\le x1\\ y0\le y\le y1}} I(x,y) = I(C) + I(A) - I(B) - I(D)$$

Where A,B,C,D are the summed area of pixels.

The SURF detector is based on the Hessian matrix. Given a point X = (x, y) in an image I, the Hessian matrix H(X, σ) at X at scale σ is defined as follows:

$$H(X,\sigma) = \begin{bmatrix} Lxx(X,\sigma) & Lxy(X,\sigma) \\ Lxy(X,\sigma) & Lxy(X,\sigma) \end{bmatrix}$$

Where $Lxx(X,\sigma)$is the convolution of the Gaussian second order derivative with the image Iat point X, and similarly for $Lxy(X,\sigma)$and $Lxy(X,\sigma)$.The features are detected using the 'detectSURFFeatures' function in MATLAB and extracted using the 'extractFeature' function with the input image and the detected interest points as arguments. After detecting the feature points from the input face and the entire scene of the class room, the feature points are extracted from both the images. Then the features of the face are compared with that of the features of the entire class room and all the features are plotted. By estimating the geometric transform, the matched face features in the class room image is obtained by eliminating the outlier points of the class room features [1] [2].

The estimated transformation detects and localizes the input face in the class room image. This transformation is obtained by using 'estimateGeometricTransform' [4] with the matched face feature and the class room feature as arguments. Once the transformation is estimated, all matching points in the class room image are projected to the input face image if the face is identified.

Figure (a), interest points in the entire image

Figure (b), interest points in the specified face

Figure(c), matched face in the entire image the projected transform

The actual number of correspondence varies between the training and the test data [5]. But it is found that matching of four or more points in the transformation results in better performance and accuracy.

3. IMPLEMENTATION

3.1. Database Creation

Creating a database of all students' faces along with their details is the initial step in the implementation. This was done in two ways: 1.Manual and 2.Automatic. In the manual method, the faces of the students are perfectly cropped and labeled with their details. Whereas, in the automatic method, the class room image is obtained with all students and the cascade object detector function from the computer vision toolbox is applied to the acquired image. The cascade object detector is set to detect faces and the detected faces are marked by the bounding box [6]. This also gives the total number of students present in class. Figure(d) consists of detected faces of student volunteers, whose images was used to test the detection algorithm.

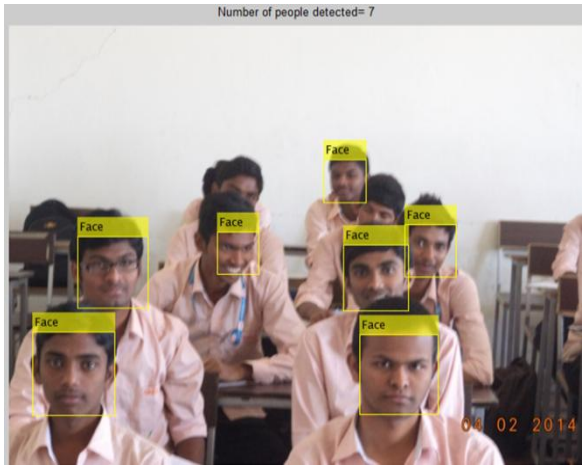


Figure (d), test image with detected faces

By extracting all the regions of the bounding box, the detected faces are cropped from the original image and the images containing only faces are obtained and stored in the database and labeled.

Figure (e), cropped faces from the entire scene

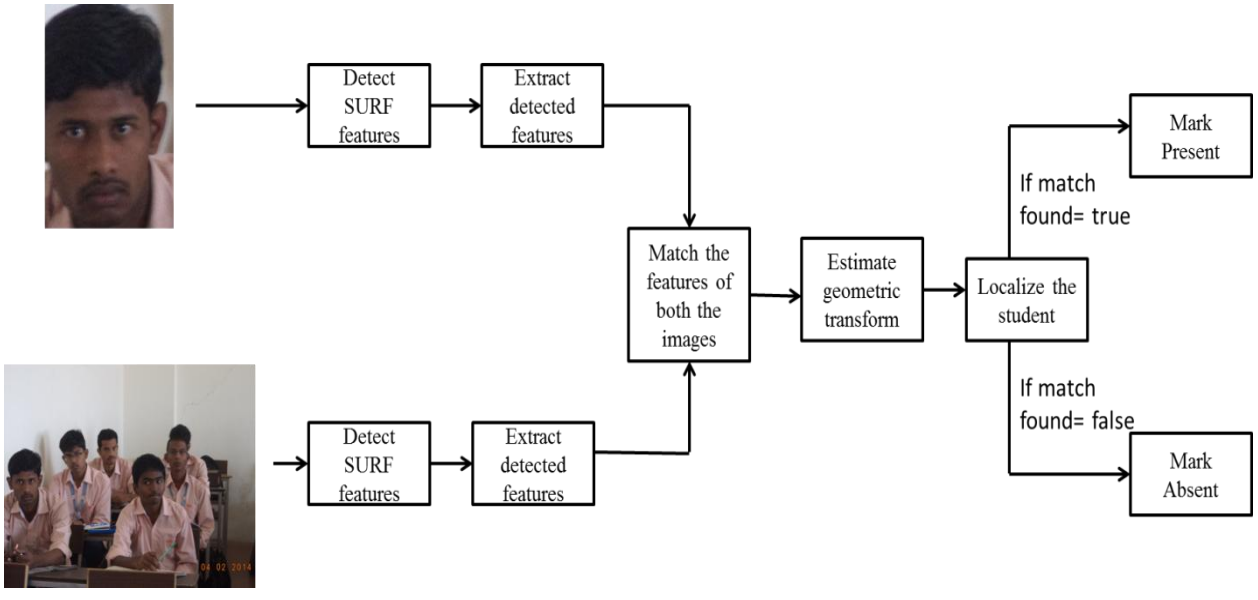


Figure (f), flowchart for face recognition and localization

3.2. Classification and Decision making

Once the database with all the credentials of the students along with their faces is created, then the students details can be retrieved whenever their faces are detected. For each student, a separate set of detector functions are maintained. Hence based on the value returned by each detecting function, an individual student can be identified. And this is used to classify between different faces. The minimum point correspondence between the test and training image was set as four for better results. If the detector function returns a value greater than 4, then the geometric transformation is made on the detected image frame and the corresponding student is marked present. If the detector function does not return satisfactory matching points, then the student is marked absent. The flowchart for decision making is shown in fig(g).

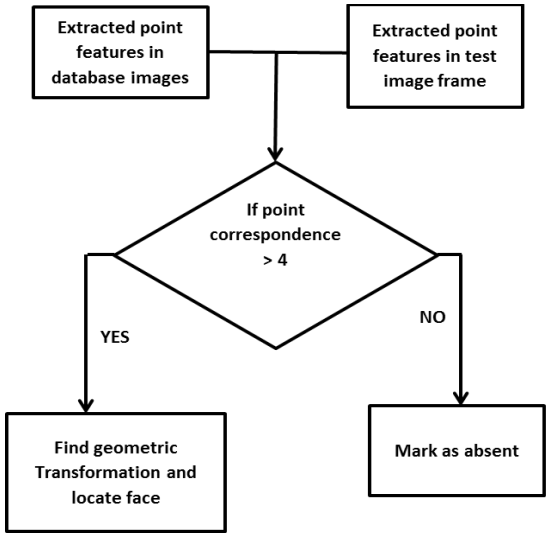


Figure (g), Detecting function flowchart for single face

4. EXPERIMENTATION

4.1. Testing with Varying Illuminance

The detector was tested with varying illuminance and the output was repeatable though decreased number of interest point was obtained. Fig.(h) and fig.(i) are images with varied lighting conditions. Fig.(j) and fig(k) are detected feature points of fig(h) and fig(i) respectively.

Figure(h),(i), varying illuminance test

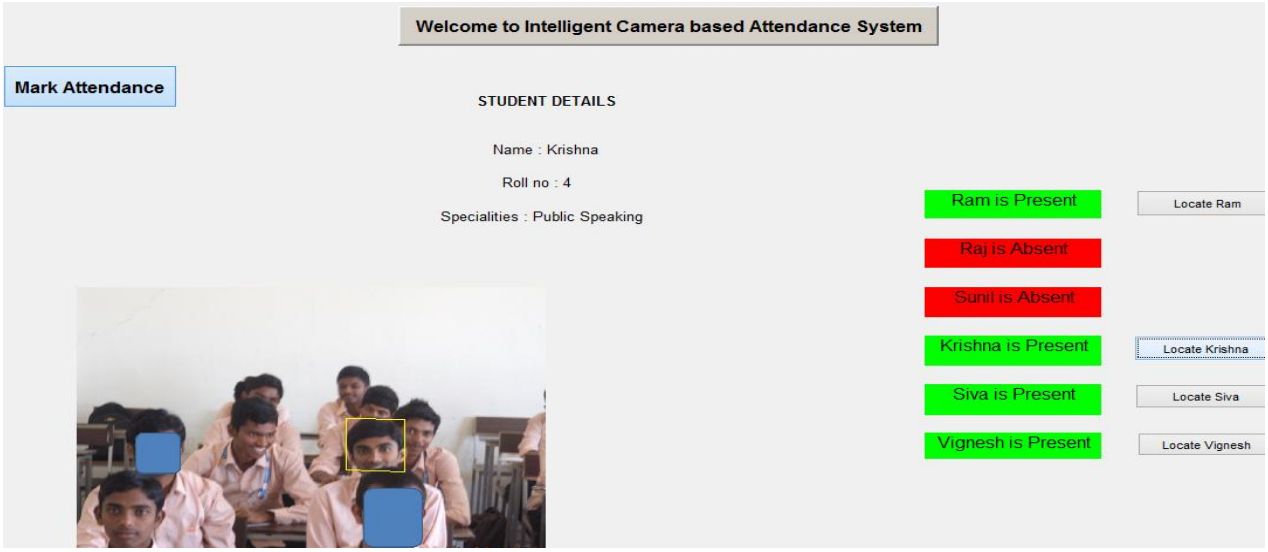
Figure(j),(k), detected feature points

4.2.Testing with Varying Viewpoint

In this test, a particular student`s face was selected and detected at different viewpoint and the corresponding feature points are plotted.

Figure(l), view point 1

Figure(m), view point 2



Figure(n), MATLAB GUI for attendance marking and student localizing(two faces blocked to indicate absence)

5. EXPERIMENTAL RESULTS

The detector used in this work, took 1.57 seconds (average) to detect the faces and mark attendance in the test image of 1024x768 resolution and database images of 640x480 resolutions. When tested with the 1024x768 and 50x50 pixels of test and database images respectively, the detection time was 0.98 seconds (average) with no loss in accuracy rate. When the test image was resized to 640x480, it is found that the accuracy rate reduced due to lack of sufficient distinguishable feature points in the image. Figure (n) shows the MATLAB GUI for automated attendance system.

6. CONCLUSION AND FUTURE WORKS

In this paper, the robustness of the SURF detector was tested under varying conditions of the input image which promises the reliability of its implementation in camera based attendance system. This system proves to be foolproof and accurate in marking attendance of a student and also provide continuous monitoring of the students within the campus. In future, the work will be extended to android platform with optimized algorithm, which will replace the traditional cameras and processors in the classrooms.

7. REFERENCES

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8. AUTHOR'S PROFILE

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