ISSN: 2321-7782 (Online)

Volume 3, Issue 1, January 2015

International Journal of Advance Research in Computer Science and Management Studies

Research Article / Survey Paper / Case Study

Available online at: www.ijarcsms.com

Paperless Digitalization of Educational System with Fuzzy Face Genetics

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Abstract: A paperless educational system is a environment in which the use of paper is eliminated or reduced significantly. This is possible by converting documents and other papers into digital form. Proponents claim that "going paperless" can save money, enhance efficiency, save space, make documentation and information sharing easier, maintain individual information safer, and help the environment. Paperless Digitalization of Educational System is a web application which will manage all the regular work of student and staff digitally and with all ease so that noticeable reduction in workload for student and staff. This system can become a significant bridge between student, staff & parent so campus life will be more transparent & trustworthy. In most part of the world today attendance system is being used manually which is very essential for Roll call and answering taking significant time. Also other systems are available but efforts, cost, and intrusiveness is more. Paperless Digitalization of Educational System with Multiple Face Detection is one solution that minimizes all above problems.

Keywords: Fuzzy Face Genetics, OpenCV, Haar Cascade, Gaussian Mixture Model, PDES

I. INTRODUCTION

The goal of this work is to propose a model in openCV that captures live stream from camera and enables multiple face detection and segmentation. The segmented faces can further be used to identify the student. As such the system leads towards the development of automatic attendance system, where the camera can be fixed and from time to time can take the snap of the class. Further each image is processed to remove the faces. Haar cascade is used for face finding and Gaussian mixture model is used for face segmentation. Human Face conveys wealthy information about identity and emotional state of the person.

Face segmentation is further a two step process. Firstly, the system is trained with several template faces. The template faces are arbitrary faces that are selected from the video frames, which may or may not include the faces of registered users. Some of the common back ground object templates are also stored which includes wall background, chairs and so on. As the system starts capturing the video, using a Normalized Cross Correlation technique the faces in the templates are matched with the scene and current faces are marked. The marked faces are segmented and are stored in a face array. The size of the faces is normalized for earlier and efficient finding. Each face is recursively matched against the registered database of faces and the instance is saved.

II. RELATED WORK

[1] Related system takes the attendance automatically using face recognition. However, it is very difficult to mark the attendance using each result of face recognition independently because the face detection rate is not sufficiently high. We propose using real time face detection algorithms integrated on an existing Learning Management System (LMS), which automatically detects and registers employees working on their respective jobs. The system represents a supplemental tool for instructors, combining algorithms used in machine knowledge with adaptive methods used to follow facial changes for longer period of time.

Another work presents an automated system for human face recognition in a real time environment for a company to mark the attendance of their employees. So Smart Attendance using Real Time Face Recognition [6] is a real world solution which comes with day to day activities of managing employees. The job is very complex as the real time background subtraction in an image is still a challenge. To detect real time person face Haar cascade is use and a simple fast Principal Component Analysis is used to recognize the faces detected with a high accuracy rate.

[5] Another survey describes both face detection using the eigenface space and face recognition with neural networks. Real-time face detection from face images was performed in two steps. In the first step, a normalized skin colour map based on the Gaussian function was useful to remove a face candidate section. The facial attribute information in the candidate section was employed to detect the face section.

In recent years face recognition has received considerable concentration from both research communities and the market, but still remained very tricky in real applications. A set of face recognition algorithms, along with their modifications, have been developed during the earlier period.

III. Proposed System

Though the video streaming service of lecture archive is readily available in many systems, students have few opportunities to view the lecture in this service because lecture content is not summarized. If the attendance of a student of classroom lecture is attached to the video streaming service, it is feasible to present the video when he was deficient. It is significant to take the attendance of the students in the classroom automatically.

ID tag or other identifications such the record of login/out in most e-Learning systems are not sufficient because it does not represent students' context in face-to face classroom. It is also complicated to grasp the contexts by the data of a single moment.

Most modern learning management systems, implement some type of attendance management. Modal automates the process by using RFID or barcode scanners. Classrooms are equipped with a barcode / RFID scanner which scans and enrolls students that enter the classroom. Other LMS systems such as Angel require students to login in to a web page with a special onetime temporary key in order to mark their presence on class. The problem with these approaches is that they interfere with the regular teaching process.

IV. System Architecture

Fuzzy face genetic is attendance based system is basically automatic attendance system which help in management the attendance automatically. In our system there are three main actors those are admin, student and server. First of all student are registered in the database by using registration form and accordingly database is updated. Student everyday places their self in front of the camera and checks the attendance of the products and sends the request to the server. Then controller takes the decisions on request according to their application. Alerts are given to student through email. It is constructed in many modules:

» Image capturing,

» Face Detector and

» Face recognizer.

The entire process is shown in Fig 1:

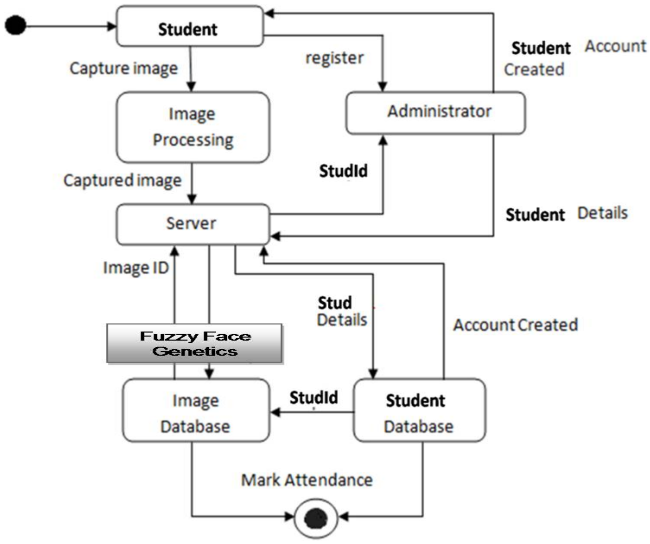

Figure 1: System Architecture Flow

The required infrastructure in classroom is a rotating camera positioned centrally in the front of the classroom (Fig. 2). Using this setup, the camera is capable to capture frontal images from students such as the one in Our system consists of two types of cameras. One is the sensing camera on the ceiling to acquire the seats where the students are sitting. The other is the capturing camera in front of the seats to capture images of student's face. The procedure of our system consists the subsequent steps (see Figure 4):

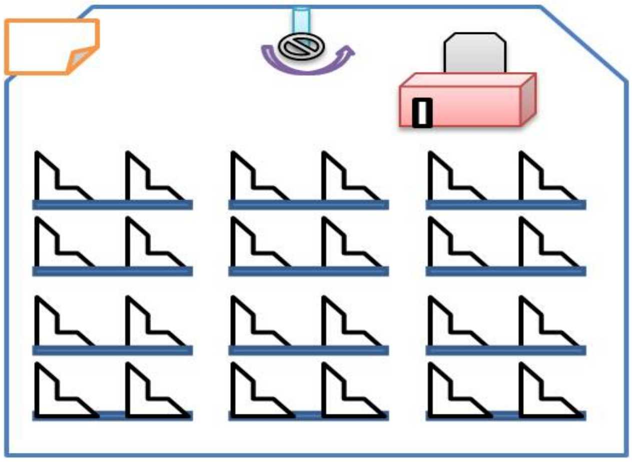

Fig 2: Classroom setup

Fig 3: Classroom with students

1) *Student Seat Finding (SSF):* This process determines the target seat to direct the camera. The idea of this approach is to estimate the existence of a student sitting on the seat by using the background subtraction and inter-frame subtraction of the image from the sensing camera on the ceiling.

2) *Shooting preparation:* Our system selects one seat from the estimated sitting area obtained by SSF, directs the camera to the seat and captures images.

3) *Face Images processing:* The face images are detected from the captured image, archived and recognized. Face detection data and face recognition data are recorded into the database.

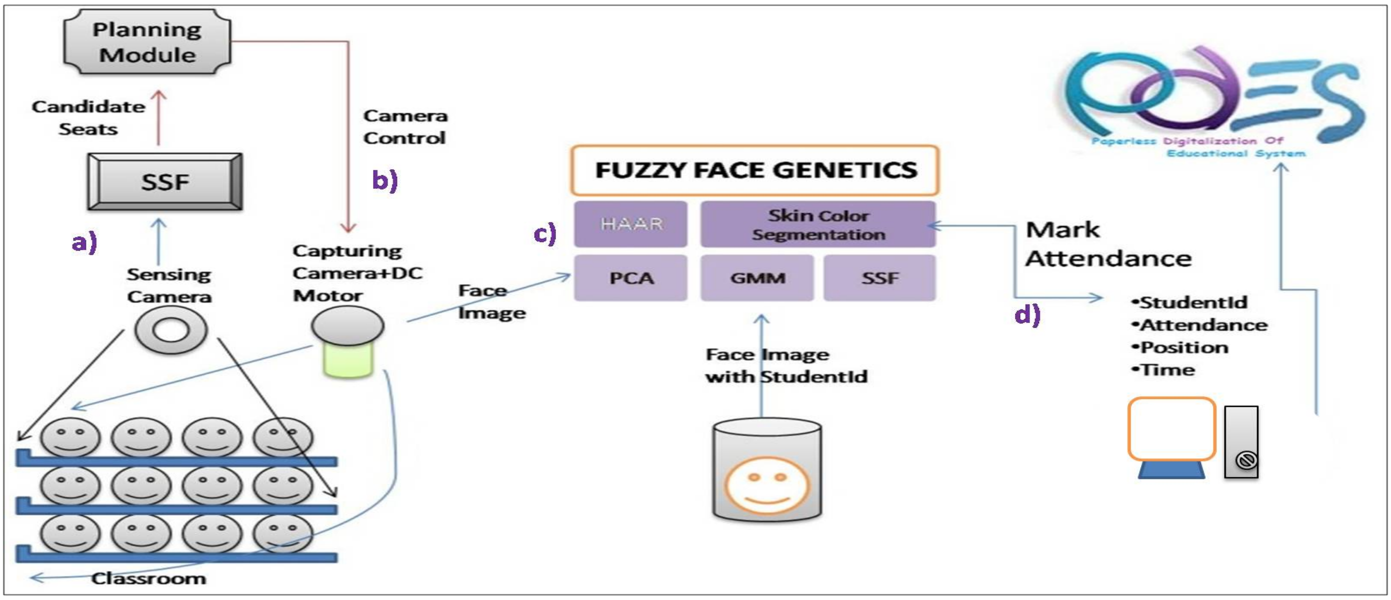

Fig 4: Architecture of the system

4) *Attendance information processing:* this process estimates the attendance by interpreting the face recognition data obtained by continuous observation. The module obtains the most likely correspondence between the students and the seats under the constrained condition. The system regards a student corresponded to each seat as present. The position and attendance of the student are recorded into the database. The procedure is repeated during lecture, and estimated the attendance of the students in real time.

V. FUZZY FACE GENETICS

Fuzzy Face Genetics will allow to employees for login and request for leave online. This leave application is then processed by the admin and the feedback is generated by the command of admin through the server.

1. *Description and Priority*

This is a medium priority system feature. The employee requests are processed by department admin with their respective server and feedback is given by Post backing main server on the respective email id's of employees.

2. *Stimulus/Response Sequences*

System Administrator: Is generally the owner that takes care of maintenance for the database system. The administrator will be in charge of assigning privileges of department server. Suggested more than one individual can have administrator privilege to ensure advisability. Full documentation will be provided to the Administrator to assist with this process. Admin is also responsible for granting the employees requests regarding subscription of any item from the system.

System Controller: Is generally the owner of the Web Store tasked with regularization process of carrying all the task manually with a simple user interface as a substitute in case of unable to mark attendance automatically, controller can add, delete and change descriptions in the database. The main job of controller is to check the entries into database through the auto generated list of marked attendance system.

Student: This is active part of the system that needs to be present in workspace area when the image capturing device is turned ON in order to mark the attendance. In case of leave he just needs to login with the provided id & password and apply for leave by mentioning the date.

FACE DETECTION AND RECOGNITION:

Face detection and recognition module detects faces from the image captured by the camera, and the image of the face is cropped and stored. The module recognizes the images of student's face, which have been registered manually with their names and ID codes in the database. Face detection data and face recognition data are recorded into the database.

a) Face detection

There are several Face detection or segmentation and recognition algorithm already. With OpenCV and AForge.Net providing real time libraries for image processing and video processing, modeling the algorithms practically has been easy. The main contribution of this work is GMM based face extraction. Note that several authors have urged that a face detection be followed by skin segmentation. But through our work we have proved that face pixels offers a unique color space which even though falls in the skin map, still offers a significant texture difference from the rest of the skin part. Hence detection is fast and efficient.

Let $c = [Cb\ Cr]T$ denote the chrominance vector of an input pixel from an input image that may contain multiple faces. Then the probability that the given pixel lies in the face is given by:

$$p(c/face) = \frac{\exp\,[-\frac{1}{2}(c-\mu_s)^{\mathrm{T}}\ \Sigma_s^{-1}(c-\mu_s)]}{2\pi\sqrt{|\Sigma_s|}} \tag{1}$$

Where µs and Σ*s* are the mean covariance matrix respectively of the training data. While recognizing the one face it is first of all separated from the chrominance vector. In the face extraction process with Gaussian model described above, the probability of each color value, given it is a skin color, is a linear combination of its probabilities calculated from the *M* Gaussian components. Hence the probability of a pixel

$c = [Cb\ Cr]T$

given it is a skin pixel, is:

$$\mathrm{p(c/face\,)} = \sum_{f-1}^{M} \mathrm{p}\left(\frac{\mathrm{c}}{\mathrm{j}}\right).\mathrm{p(j)} \tag{2}$$

Where In a Mixture model, *M* depicts the number of Gaussian, *P*(*j*) is the probabilistic weight of the *j* th component. This is also referred to as the prior probability of the data point having been generated from the component *j* of the model.

$$p(c/j) = \frac{\exp\,[-\frac{1}{2}(c-\mu_j)^{\mathrm{T}}\ \Sigma_j^{-1}(c-\mu_j)]}{2\pi\sqrt{|\Sigma_j|}} \tag{3}$$

b) Algorithm for Skin Modeling (for Face detection)

Let *i* denote the iteration, *Mi* the number of components at the *ith* iteration and *Li* the likelihood for the validation set w.r.t the model at iteration *i*. The initial number of components can be taken to be *M*0 = 1. The algorithm [3] for model order selection can be outlined as follows:

1. Apply Expectation-Maximization for model with *Mi* components.

2. Compute *Li* for validation set.

3. Save model

c) Face Recognition

Secondly the recognition is performed over the normalized segmented faces. The normalization process adopts resampling with Gaussian interpolation which keeps is model intact even in the new space.

$$\sum_{j=1}^{M} p(j) = 1 : 0 \le p(j) \le 1 \tag{4}$$

Therefore the parameters to be estimated from the given pixel matrix are *M*, μ*j* , Σ*j* ,and *P*(*j*), *j* = 1 to *M*, i.e. for every *M* components. In this work, the number of components is decided automatically by a constructive algorithm [4] using the criteria of Maximum likelihood estimator. Once *M* is decided, the other parameters, of each component are calculated from the given matrix. One of the most adopted approach is to maximize a likelihood function of the parameters for the given set of data . The negative log-likelihood for the dataset is given by:

$$E = -\ln L = -\sum_{n-1}^{N} \ln p(c_n) = -\sum_{n-1}^{N} \ln \left\{ \sum_{j-1}^{M} \mathrm{p}(\mathrm{c_n}/\mathrm{j}).\, \mathrm{p}(\mathrm{j}) \right\} \tag{5}$$

Which can be regarded as an error function. Note that *L* is equivalent to minimizing the error function *E, N* is the number of data points *cn*. Maximizing the likelihood.

d) Algorithm for Skin modeling (for Face recognition)

4. Find component *j* with the lowest total responsibility

5. Split component *j*

6. Restart from step 1 with *Mi+1*= *Mi*+1 and *i* = *i*+1.

The above sequences of steps are repeated until *Mi* reaches a desired value (10 in this implementation). The peak in the Likelihood functions for the checking the data corresponding to the optimal model order. The parameters of this optimal order model are then used to estimate *p(cFace).* Once the Face texture is modeled using Gaussian, it is used to calculate the probability of whether an input pixel in the matrix is representing a face region ,i.e, *p*(*Face/c*), where *c* is the input color value. The Gaussian model can be used to evaluate the probability of a color value given it is a skin color, i.e., *p(c/skin).* This is again used to compute the required probability *p*(*skin/c*) using the Bayes formulation :

$$\mathrm{p(skin/c)} = \frac{p(c/face)\mathrm{p(face)}}{p(c/face).\,\mathrm{p(sface)} + \mathrm{p(c/non - nonface).\,p(non - face)}} \tag{6}$$

To calculate the above probability for each input pixel, the skin and the non-skin classes are assumed to occur with equal probability. Hence

$$P(skin) = P(non\text{-}skin) = 0.5 \tag{7}$$

This gives,

$$\mathrm{p(skin/c)} = \frac{p(c/face)}{p(c/face) + \mathrm{p(c/non - face)}} \tag{8}$$

To obtain the probability, *p(c/non-skin)*, a non-skin or the background model is build with same Gaussian distribution.

Once the models are correctly obtained, face segmentation is performed using connected components. Connected components are mathematical operators that operate on results of binary structure post GMM. Once skin part is segmented from rest of the image, they need to be eliminated from being considered as probable face candidate regions. As a first step, gray level „open operation is performed. This operation involves gray level erosion followed by gray level dilation using the same structuring element. Erosion removes small and thin isolated noise-like regions that have very low probability of representing a face. Dilation preserves those regions that are not removed during erosion. Hence, the effect of using area open is removal of small but bright regions of the skin probability image. This is followed by gray level „close operation. Closing is dilation followed by erosion using the same structuring element. The dilation during close operation enhances small regions of low intensity that may lie within large regions of high intensity in the skin probability image. Hence, during the thresholding step that follows, holes are not created within large high probability regions with a small gray level depression inside their periphery. These depressions may be caused due to bad lighting conditions or the skin model may fail to give a high probability in those regions. The erosion (of close operation) removes the extra pixels that may be added, during the previous dilation operation, as high probability pixels around existing regions. A smaller structuring element is used for close operation so that a large area of pixels around existing regions is not enhanced [3].

This image is then threshold into a binary image for further shape analysis.

VI. Conclusion

Most of the existing systems are time consuming and require for a semi manual work from the people. Our approach aims to solve the issues by integrating face recognition in the process. Even though this system still lacks the ability to identify each student present on class, there is still much more room for improvement. Since we implement a modular approach we can improve different modules until we reach an acceptable detection and identification rate. Another issue that has to be taken in consideration in the future is a method to ensure users privacy. Whenever an image is stored on our servers, it must be impossible for a person to use that image.

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