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LECTURE ATTENDANCE SYSTEM WITH FACE RECOGNITION AND IMAGE PROCESSING

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ABSTRACT

Image processing is used in many applications, including medical imaging, industrial manufacturing, and security systems. In this paper, we propose a system that takes the attendance of students in classroom automatically using face detection and face recognition. However, it is difficult to estimate the attendance precisely using each result of face recognition independently because the low face detection rate. In this paper, we propose a model for estimating the attendance precisely using all the results of face recognition obtained by continuous observation. Continuous observation improves the performance for the estimation of the attendance. We constructed the lecture attendance system based on face recognition and detection, and applied the system to classroom lecture. This paper is review the related works in the field of attendance management and face recognition.

Keywords: Face Detection, Face Recognition, Eigen Face, Video Streaming, Sensing And Capturing Camera

I INTRODUCTION

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 possible to present the video of the time when he was absent. It is important 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 is not sufficient because it does not represent students' context in face-to-face classroom. It is also difficult to grasp the contexts by the data of a single moment. Student's context such as presence, seat position, status, and comprehension are discussed in this paper.

At the same time face images reflect a lot about these context information. It is possible to estimate automatically whether each student is present or absent and where each student is sitting by using face recognition technology. It is also possible to know whether students are awake or sleeping and whether students are interested or bored in lecture if face images are annotated with the students' name, the time and the place.

We are concerned with the method to use face image processing technology. By continuously observing of face information, our approach can solve low effectiveness of existing face detection technology, and improve the accuracy of face recognition. We propose a method that takes the attendance using face recognition based on continuous observation. In this paper, our purpose is to obtain the attendance, positions and images of students' face, which are useful information in the classroom lecture.

We are developing the Student monitoring system using face recognition technique. Facial scan systems can range from software-only solutions that process images processed through existing closed-circuit television cameras and processing systems with facial recognition technology, a web camera image is used to analyze facial characteristics such as the distance between eyes, mouth or nose. These measurements are stored in a database and used to compare with a subject standing before a camera. In this system the standard images of the students in that class are stored in the database. The stored image has the Students information such as the student's seat number, mobile number, class, branch, year etc. that are the reference template which is used for comparison. The face images are detected from the captured image, archived and recognized. Every teacher gets a username and password to login into the system and then they can take the attendance for that subjects which are allocated to them. When the captured image which is taken from the Webcam is matched with the reference image, it marks the attendance and sends SMS to that student and their parents.

Advantage of this system is that it is a Web based Software and Database of all students is located on Central only a need of one web camera is to be connected to accessing PC. The procedure is repeated during lecture, and estimated the attendance of the students in real time.

II ARCHITECTURE

In this paper, our system consists of two kinds of cameras. One is the sensing camera on the ceiling to obtain the seats where the students are sitting. The other is the capturing camera in front of the seats to

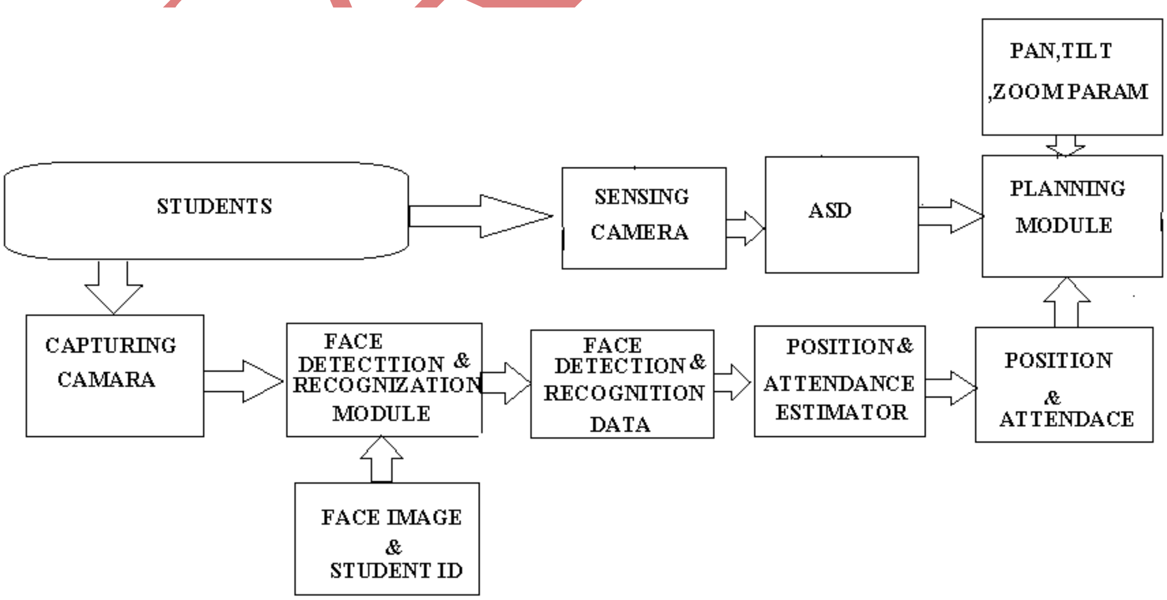

Figure 1: Architecture Of Lecture Attendance System With Face Recognition And Image Processing

capture images of student's face. The procedure of our system consists of the following steps:

2.1 Seats information processing:

This process determines the target seat to direct the camera. We adopt the approach called Active Student Detecting method (ASD). 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.

2.2 Shooting plan:

Our system selects one seat from the estimated sitting area obtained by ASD, directs the camera to the seat and captures images.

2.3 The system processes the face images:

The face images are detected from the captured image, archived and recognized. Face detection data and face recognition data are recorded into the database.

2.4 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.

We use the method of ASD to estimate the existence of a student sitting on the seat. In this approach, an observation camera with fisheye lens is installed on the ceiling of the classroom and looks down at the student area vertically. ASD estimates students' existence by using the background subtraction and inter-frame subtraction of the images captured by the sensing camera. In the background subtraction method, noise factors like bags and coats of the students are also detected, and the students are not detected if the color of clothes of them are similar the seats. ASD makes use of the inter-frame subtraction to detect the moving of the students.

Camera planning module selects one seat from the estimated sitting area in order to determine where to direct the front camera. Actually, in this paper, the module selects a seat by scanning the seats sequentially. This approach is insufficient because it wastes time directing the camera to where the student-and-seat the seats the students correspondence is already decided In other words, if we direct the camera to each seat with the same probability, it is difficult to detect the faces according to the student or the seat, and the system judges the students who are actually present to be absent consequently. In order to solve this problem, it is important to the information of each student's position. The camera is directed to the selected seat using the pan/tilt/zoom that has been registered in the database. The camera captures the image of the student.

III METHODOLOGY

The algorithm has two stages. First web camera takes image, detect the face and then compare with the stored or reference images. And second stage is if image will matched the attendance of student is marked. Face detection and recognition module detects faces from the image captured by the web 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 Seat No. in the database.

3.1 Face Detection:

Face detection has been regarded as the most complex and challenging problem in the field of computer vision, due to the large intra-class variations caused by the changes in facial appearance, lighting, and expression. Such variations result in the face distribution to be highly nonlinear and complex in any space which is linear to the original image space. Moreover, in the applications of real life surveillance and biometric, the camera limitations and pose variations make the distribution of human faces in feature space more dispersed and complicated than that of frontal faces. It further complicates the problem of robust face detection.

Most of the face detection methods focus on detecting frontal faces with good lighting conditions. According to Yang's survey [Yang, 1996], these methods can be categorized into four types: knowledge-based, feature invariant, template matching and appearance-based Any of the methods can involve color segmentation, pattern matching, statistical analysis and complex transforms, where the common goal is classification with least amount of error. Bounds on the classification accuracy change from method to method yet the best techniques are found in areas where the models or rules for classification are dynamic and produced from machine. Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies.

3.2 Face Recognition:

It includes feature extraction, where important information for discrimination is saved, and the matching, where the recognition result is given with the aid of a face database. Among the different biometric techniques facial recognition may not be the most reliable and efficient but it has several advantages over the others: it is natural, easy to use and does not require aid from the test subject. Because the face detection and recognition database is a collection of images and automatic face recognition system should work with these images, which can hold large volumes of computer memory that is way it's necessary to investigate and develop a method / tool for optimal using volume of computer memory (that decrease image database volume) and implement quick face detection within database. There are three main contenders for improving face recognition algorithms: high resolution images, three dimensional (3D) face recognition, and new preprocessing techniques. The FRGC is simultaneously pursuing and will assess the merit of all three techniques. Current face recognition systems are designed to work on relatively small still facial images. The traditional method for measuring the size of a face is the number of pixels between the centers of the eyes. In current images there are 40 to 60 pixels between the centers of the eyes (10,000 to 20,000 pixels on the face). In the FRGC, high resolution images consist of facial images with 250 pixels between the centers of the eyes on average. The FRGC will facilitate the development of new algorithms that take advantage of the additional information inherent in high resolution images. In the last couple years there have been advances in computer graphics and computer vision on modeling lighting and pose changes in facial imagery.

These advances have led to the development of new computer algorithms that can automatically correct for lighting and pose changes in facial imagery. These new algorithms work by preprocessing a facial image to correct for lighting and pose prior to being processed through a face recognition system. The preprocessing portion of the FRGC will measure the impact of new preprocessing algorithms on recognition performance. The FRGC improved the capabilities of automatic face recognition systems through experimentation with clearly stated goals and challenge problems. Researchers and developers can develop new algorithms and systems that meet the FRGC goals. The development of the new algorithms and systems is facilitated by the FRGC challenge problems.

3.3 Eigen face:

Eigen faces are a set of Eigen vectors used in the computer vision problem of human face recognition. The approach of using Eigen faces for recognition was developed by Sirovich and Kirby (1987) and used by Matthew Turk and Alex Pentland in face classification. It is considered the first successful example of facial recognition technology. These eigenvectors are derived from the covariance matrix of the probability distribution of the high-dimensional vector space of possible faces of human beings.

3.4 Eigen face generation:

A set of Eigen faces, that are created will appear as light and dark areas that are arranged in a specific pattern. This pattern is how different features of a face are singled out to be evaluated and scored. There will be a pattern to evaluate symmetry, if there is any style of facial hair, where the hairline is, or evaluate the size of the nose or mouth. Other Eigen faces have patterns that are less simple to identify, and the image of the Eigen face may look very little like a face.

3.5 To create a set of Eigen faces, one must:

Prepare a training set of face images. The pictures constituting the training set should have been taken under the same lighting conditions, and must be normalized to have the eyes and mouths aligned across all images. They must also be all resample to a common pixel resolution (r × c). Each image is treated as one vector, simply by concatenating the rows of pixels in the original image, resulting in a single row with r × c elements. For this implementation, it is assumed that all images of the training set are stored in a single matrix T, where each row of the matrix is an image.

3.5.1 Subtract the mean:

The average image has to be calculated and then subtracted from each original image in T.

3.5.2 Calculate the eigenvectors and Eigen values of the covariance matrix S:

Each eigenvector has the same dimensionality (number of components) as the original images, and thus can itself be seen as an image. The eigenvectors of this covariance matrix are therefore called Eigen faces. They are the directions in which the images differ from the mean image. Usually this will be a computationally expensive step (if at all possible), but the practical applicability of Eigen faces stems from the possibility to compute the eigenvectors of S efficiently, without ever computing S explicitly, as detailed below.

3.5.3 Choose the principal components:

The D x D covariance matrix will result in D eigenvectors, each representing a direction in the $r \times c$ - dimensional image space. The eigenvectors (Eigen faces) with largest associated Eigen value are kept. Facial recognition was the source of motivation behind the creation of Eigen faces. For this use, Eigen faces have advantages over other techniques available, such as the system's speed and efficiency. Using Eigen faces is very fast, and able to functionally operate on lots of faces in very little time. Unfortunately, this type of facial recognition does have a drawback to consider: trouble recognizing faces when they are viewed with different levels of light or angles. For the system to work well, the faces

need to be seen from a frontal view under similar lighting. Face recognition using Eigen faces has been shown to be quite accurate. By experimenting with the system to test it under variations of certain conditions, the following correct recognitions were found: an average of 96% with light variation, 85% with orientation variation, and 64% with size variation.

To complement Eigen faces, another approach has been developed called Eigen features. This combines facial metrics (measuring distance between facial features) with the Eigen face approach. Another method, which is competing with the Eigen face technique, uses 'fisher faces'. This method for facial recognition is less sensitive to variation in lighting and pose of the face than the method using Eigen faces. A more modern alternative to Eigen faces and fisher faces is the active appearance model, which decouples the face's shape from its texture: it does an Eigen face decomposition of the face after warping it to mean shape. This allows it to perform better on different projections of the face, and when the face is tilted.

3.6 Matching:

The newly acquired facial data is compared to the stored data and (ideally) linked to at least one stored facial representation. It facial recognition system is the Local Feature Analysis (LFA) algorithm. This is the mathematical technique the system uses to encode faces. The system maps the face and creates a face print, a unique numerical code for that face. Once the system has stored a face print, it can compare it to the thousands or millions of face prints stored in a database. Each face print is stored as an 84-byte file.

The system can match multiple face prints at a rate of 60 million per minute from memory or 15 million per minute from hard disk. As comparisons are made, the system assigns a value to the comparison using a scale of one to 10. If a score is above a predetermined threshold, a match is declared. The operator then views the two photos that have been declared a match to be certain that the computer is accurate. Facial recognition, like other forms of biometrics, is considered a technology that will have many uses in the near future. In the next section, we will look how it is being used right now.

IV ESTIMATING THE SEAT OF EACH STUDENT

In order to solve the problem of ineffectiveness, we integrated students' seat information into the camera planning. In this way, we can solve the problem such as miss- recognition of faces and seats by constraints of the correspondence relationship between them. The face detected from the captured image may be another neighbor student's face. Therefore, it is necessary to consider the possibility that the face image is the one of a neighbor student even if the camera is directed to the target seat. Considering the points we mentioned above, we propose the following method.

We assume that every seat has a vector of values that represent the relationship between the seat and each student. In the case that the module of face image processing recognizes Student A's face from the image of Seat B, our module votes for Student A's component of the vectors of the seats in the neighborhood of Seat B.

We assume the voting weights in Figure 2. Each cell means a seat, and the gray center cell means the focused seat. This assumption means that, when Student X is recognized at Seat B, 0.24 is voted to Seat B, and 0.11 is voted to the front seat of Seat B, and so on, for Student A's components.

0.06	0.11	0.06
0.11	0.24	0.11
0.06	0.18	0.06

Figure 2: An example of the voting weights

		0.06	0.11	0.06
		0.11	0.24	0.11
		0.06	0.18	0.06

Figure 3. Student X's component of each seat when Student A is recognized at the gray seat

	0.06	0.11	0.06	
	0.11	0.30	0.22	0.06

	0.11	0.29	0.30	0.11
		0.06	0.18	0.06

Figure 4 Student X's component of each seat then Student A is recognized at the gray seat after 1)

For example, Figure 2 shows Student X's components of each seat when Student X is recognized at the gray seat and Figure 4 shows the case that Student X is recognized at the gray seat in the next step. Considering the bipartite graph of the students and the seats, voting can be thought of as the addition to the scores of the edges between the students and the seats, and the cost of the edge is defined as the inverse of the score of the edge. Before the seat information processing, we set two conditions as the premises

1. More than two students are not sitting on the same seat,
2. The students do not move to different seats frequently.

The process of the seats information do not select independently the seat that has the highest score for each student but use the approach that find the matching in the bipartite graph such that the sum of the costs of the edges are minimized where the premises are satisfied.

We assume the assignment of student m to seat n incurs a cost $c_{mn.}$ The problem is formulated as follows:

$$\min \sum_{m=1}^{k} c_{mn} x_{ij}$$

$$\sum_{m=1}^{k} x_{mn} = 1; n = 1,2....k$$

$$\sum_{n=1}^{k} x_{mn} = 1; m = 1,2,...k$$

$$x_{mn} \in \{0,1\}; m, n = 1,2....k$$

The least complexity of the best sequential algorithms for the LSAP is $O(k^3)$, where n is the larger one of the numbers of the students or the seats. Thus, this problem is solved in real time. In this procedure, the system regards the students corresponded to the seats as present.

V EXPERIMENT

5.1 Result of Estimating the seat of each student:

19 students existed in the center area, and we ran the process of camera control and detection for 20 minutes. We labeled the images of the detected faces with the name of the students manually. The system detected faces 186 times, and 15 students were detected.

5.2 Result of Estimating the attendance:

Based on continuous observation We compared the results one cycle only and continuous observation. 12 students existed in the center area, and 2 of them did not have their faces registered. In this experiment of 79 minutes, 8 scanning cycles were completed during this period. In the case of 1 cycle only, we judge the recognized students to be present. In the case of continuous observation, the system estimates the attendance, using the recognition data obtained during 79 minutes.

VI CONCLUSION AND FUTURE DIRECTIONS

In this paper, in order to obtain the attendance, positions and face images in classroom lecture, we proposed the attendance management system based on face recognition in the classroom lecture. The system estimates the attendance and the position of each student by continuous observation and recording. The result of our preliminary experiment shows continuous observation improved the performance for estimation of the attendance.

Current work is focused on the method to obtain the different weights of each focused seat according to its location. We also need to discuss the approach of camera planning based on the result of the position estimation in order to improve face detection effectiveness. In further work, we intend to improve face detection effectiveness by using the interaction among our system, the students and the teacher. On the other hand, our system can be improved by integrating video-streaming service and lecture archiving system, to provide more profound applications in the field of distance education, course management system (CMS) and support for faculty development (FD).

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