ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 10, October 2015

A Conceptual Model of Automated Attendance System using Image Processing

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Abstract: Conventionally, student record keeping is done manually by teachers through roll calling or by passing an attendance sheet in the class. These methods are time consuming, prone to errors and proxy attendance. Moreover digital assimilation of records is tedious since teachers need to fill in the details in the database by themselves to generate reports. Consistency in manual and digital records also needs to be maintained. In the recent years, automated systems that have evolved use standard biometrics like fingerprint and iris recognition. These systems are intrusive in nature and require expensive gadgetry. Also deploying them on a large scale is detrimental to the project budget. Thus our project design makes use of facial detection and recognition algorithms like Viola Jones and PCA to identify the students in the image captured by a basic camera. This image is uploaded in the software by the professors using a simple USB cable where various combinations of algorithms detect the faces and compare it to the student image database for recognition phase. Daily attendance automatically gets updated in the database thereafter. This system solves the problem of redundancy in manual records and makes attendance keeping a convenient task.

Keywords: Automated Attendance System, Face Detection, Face Recognition, PCA (Principal Component Analysis), Viola Jones, Camera, OpenCV, PHP.

I. INTRODUCTION

Attendance tracking systems are an integral part of educational institutes and corporate sectors. These systems have undergone a phenomenal change, from basic manual attendance to RFID based attendance system. The existing attendance systems are tedious and riddled with inconsistencies. In manual systems, the accuracy of the attendance is reduced since the administrative person needs to maintain the attendance papers / sheets which can be tampered with easily. In case of RFID systems, the RFID card should always be carried and if it is damaged, it can lead to invalid attendance. In the recent times NFC systems have also been trending, that use mobile devices, but have a close range. All of the existing systems are susceptible to proxy attendance. In the proposed thesis, we aim to remove the proxy attendance issues and make the monitoring process efficient and time saving. We are adopting a biometric approach, since forgery is difficult in this domain. Apart from that, deploying this work in a large scale is easy as opposed to other biometric techniques. Methods like iris and fingerprint scanning are highly accurate but aren't cost effective in nature.

II. LITERATURE SURVEY

Mashhood Sajid et al[1] proposed a conceptual model that addresses concerns that if the student comes in the class, shows up and marks his attendance once after image is captured the student can leave the class and be marked as present. They produced a solution of taking the attendance randomly three times in a lecture so that it could be made sure that the student attends the particular lecture and is present in the class actually rather than being marked as present. Their proposed model captured the image from a fixed camera in the classroom. Humans have a diverse set of facial expressions which can reduce the accuracy of facial recognition software. Janarthany Nagendrarajah[2] proposed a model to overcome this dilemma, where Principal Component Analysis (PCA) is used to extract a set of Eigen-images known as Eigen faces and weights of this representation are used for recognition. This system stores only one image of the individual during enrolment phase since it is inconvenient to store more than one image of an individual from a commercial point of view (e.g. Immigration office). During this phase, the individuals are required to maintain a neutral expression and the hair is tied away from their face. The model is tested using a database of images of diverse nations like images of Chinese faces and English faces. This security system was accurate in recognizing enrolled individuals when they had spectacles on. However, this project is yet to recognize real occluded images.

Steven Fernandes et al [3] analysed and reviewed the current face recognition algorithms in order to deduce a new and robust algorithm. They used ORL and SHEFFIELD database for analysing the performance of combination of appearance-based methods like Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). PCA works better when the images are capture with no disturbance. The paper inferred that PCA is better than LDA at recognizing individuals even with background disturbance, since it took shorter time span for recognition. Thus, PCA and its variants are the best facial recognition algorithms.

DOI 10.17148/IJARCCE.2015.41060

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It is usually difficult to compute the attendance with precision by utilizing each result of individual facial recognition because the face detection rate will be reduced. Yohei Kawaguchi et al[4] proposed an application where the attendance is monitored by continuous observation. Continuous observation is the method of using video streaming so that the students sitting position, presence, status and other information is collected. Active Student Detecting (ASD) approach is used 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.

III.PROPOSED SYSTEM

The conceptual model of the system involves creation of a database driven web based application that can be easily deployed on all types of platforms and form factors. As a reason responsive web designing is adopted.

The web application will be divided into the following modules

1. Client side interface
2. Server side server to handle the client request
3. Container to store the business logic
4. Database to store images

In a nutshell the basic aim of the project is to create an image processing application that will accept multiple images of the classroom from various angles and elevated podium using a normal cell phone camera. It should promptly detect and recognise faces from the uploaded images, to create an excel sheet that will mark each student's presence or absence. This excel sheet is accessible by the respective teacher and should be content editable in case some students are missed out or incorrectly identified.

The block diagram for this system is given as follows and is self-explanatory.

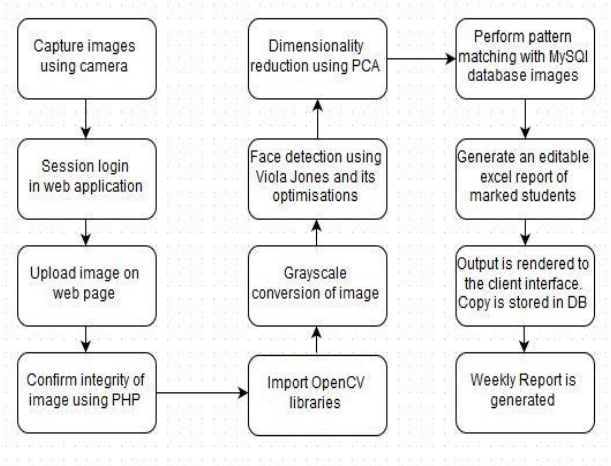

Fig 1: Proposed System

Working of the system

1. The teacher takes multiple images from different angles and/or elevated podium [1] and opens the proposed web application.
2. After successful login, session details and timestamp of the images are recorded and the images are uploaded on the web page.
3. Integrity check of the images is done to check for supported file types using PHP.
4. The client request is processed on the server side using PHP as its core scripting language and subsequently OpenCv libraries are imported on server side.[5]
5. The images are converted to grayscale as a preliminary procedure.
6. Viola Jones is used as a primary face detection algorithm. It is optimised to increase the accuracy by the extraction of Haar features[6]. Also upper body detection and half feature extraction can be used to optimise the results.[7][8]
7. The detected faces are marked and the recognition phase begins by performing dimensionality reduction using the PCA algorithm.[1]
8. The extracted features are matched with the MySQL database features.[9]
9. The output of the recognition phase generated by OpenCV is rendered in the form of a content editable excel sheet. This sheet contains attendance of the students for the particular session.
10. If a particular student has not been marked due to some inconsistencies the sheet can be edited to add the respective student and alert is given to the admin to vary the algorithm optimisation.

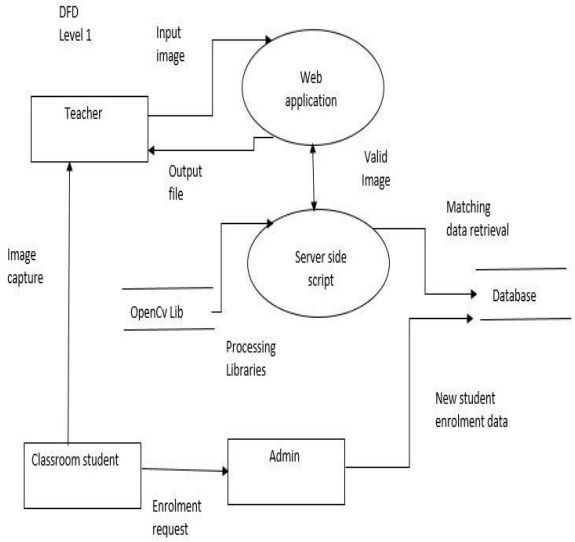

Fig 2: DFD level 1 diagram of Proposed System

The technologies and algorithms to be used in achieving this goal are explained in the next section.

IV.METHODOLOGIES

A. Bootstrap

The client side interface is deployed using Bootstrap in this project is due to its HTML and CSS based design templates which can be customized according to the developers needs'. Bootstrap emphasizes on responsive web designing components so that the viewer is able to view the content comfortably according to his/her screen

ISSN (Online) 2278-1021
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size, either a desktop or a mobile phone. Instead of creating a CSS sheet from scratch, bootstrap enables ready-made blocks of codes to be used which are available in LESS stylesheets. Also if a programmer is not comfortable then he/she can use the plain old CSS for customization. In addition to regular HTML elements such as topography, tables, images; Bootstrap enables designers to utilize advanced components such as drop-downs, navigation bar, alerts, progress bar, etc. Bootstrap has a core concept of pairing designers with developers, making it a faster process for developing Web applications. This front-end framework is open source and freely available on GitHub.

B. OpenCV

OpenCV is an open source, freely available library of programming functions for image processing, which is written in C/C++. It is supported by Windows, Linux, Mac OS, iOS and Android.

Reasons for working with OpenCV are:
Codes in OpenCv, directly provide machine language code to the computer to be executed. Thus more processing is being done in minimal computer cycles. AS a result codes written in OpenCV run much faster than similar softwares.

The libraries are memory efficient since the amount of resources needed is minimal as the libraries require only about 70MB of RAM space.

The programs are portable and can run on all platforms and IDE. This reduces the barrier from the program's prototyping stage, to the final embedding stage on a device for various applications. The library has over 2000 optimized algorithms, and is inclusive of a multitude of computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify different objects, classify human actions in videos and track their movements, extract 3D models of objects, find similar images from an image database, remove red eyes from images taken using flash, recognize scenery and establish markers to overlay it with augmented reality.

OpenCV programs can be written using common IDEs like as Netbeans, Xcode or Eclipse.

C. MySQL

MySQL is a RDBMS system that supports client-server architecture. The client (application programs) can either run on the same device of the server or they can be on separate devices. It supports standard database language which is Structured Query Language which is quick to follow and understand. Through the configuration setting of SQL-mode makes it compatible with other databases which use the same language like IBM's DB/2 or Oracle. It is considered to be a very fast database program and can use the stored procedures for faster insertion or deletion of records.

MySQL is platform-independent as it can be executed under a number of OSs. Some of them are Apple Macintosh OS X, Linux, Microsoft Windows. For client programming languages like C, C++, Java, Perl, PHP, Python are employed. The database provides security mechanisms by using solid data security layers that protect sensitive data from intruders. Each layer has a certain rights associated with it and can be set to allow some or all privileges to individuals by encrypted passwords . In this project MySQL is used as a repository for image database, training dataset and student as well as teacher's login and session details.

D. Server side scripting

PHP is basically a server side scripting language which is popularly known as HyperText Pre-processor. The chief PHP source repository is abundant with modules and interfaces. As a result this platform is mainly used for developing secured, powerful, dynamic, flexible & feature-rich dynamic web pages and intuitive web applications.

In the proposed project PHP is used on the client side as well to verify the integrity of the image by checking if it is of the supported file format or not.

On the server side PHP is used to import the OpenCV libraries by making RPC calls to it, obtain image data from the MySQL database for pattern matching or to extract session details and generate the output excel file which is again rendered on the client interface. Secure HTTP requests are used to communicate between client and server and PHP serves as a backend mechanism.

Since PHP is free, platform independent and is easily integral with MySQL, this was the natural choice for the project.

The Server used is Apache HTTP server for handling all client requests and integrating the server side code as well as managing the MySQL database.

E. PCA

PCA is a linear Dimensionality reduction Technique which searches patterns for reduction of dataset with minimal loss of information and data. It cannot directly operate on the images so it needs to convert them into matrices for computation.

Consider a feature Space (which is the original Face Image dataset) of M-images, where each image is a vector of N*N dimensions. Now PCA will extract a sub-space from our feature space or "face space". This newly extracted sub-space is "best" able to describe our whole dataset (feature space) in a concise and convenient way. It usually finds the direction (Principal Components) that maximize that variance of our dataset (i.e try to find a sub-space with different data). In simple words, PCA removes the dominant features (i.e. directions, components) from every image (e.g. Nose, Cheekbones, eyes, etc.).

These are the Eigenfaces or Principal Components. Now, in order to reduce the data (i.e. dimensionality reduction) we select only those Eigenfaces which has the most dominant feature (ie most data, direction). The Eigenfaces which is more like a proper image. Some of the least dominant Eigenfaces have no facial feature and contains only noise. So we don't select these and remove them from sub-space. These dominant Eigenfaces or PC can

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ISSN (Print) 2319 5940

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represent the feature space. Now any existing image or a new image can be represented using these Eigenface. Thus, Images are the summation of these Eigenfaces or weighted sum of them. This technique is employed in the proposed project to implement face recognition process.

F. Viola Jones Algorithm

The proposed project's face detection process operates on the Viola Jones, algorithm, which was a break through algorithm for real time face detection. Over all these years it still remains a major technology in image processing. In the project, this algorithm is used albeit with some optimisations.[10] The basic algorithm remains the same and is explained with the following flowchart

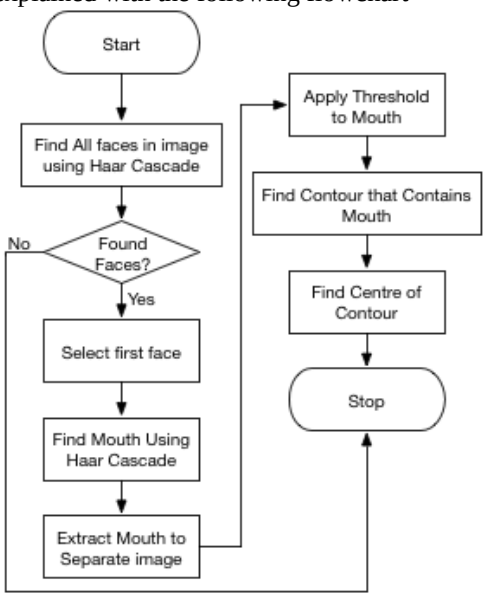

Fig 3: Viola Jones Flow Chart[11]

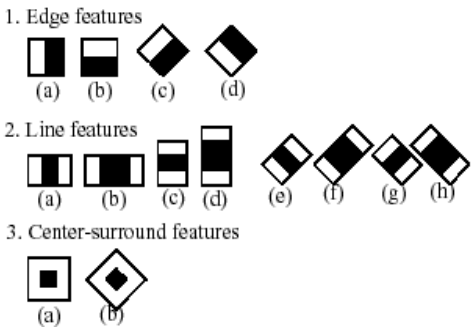

Fig 4: Haar features [12]

The optimisations for Viola Jones that are proposed are

1) Half feature extraction to increase speed of Viola Jones

The average half face can be easily constructed from the full frontal face image in two steps; first step includes centring the face with nose tip as centre point and divide it into two halves and then in second step the two halves are averaged together reversing column of one half. Once the average half face creation is completed then the features in the image are detected through Viola Jones method through concatenation process. [8]

2) Larger scanning and scaling factors must be found to minimize computation while preserving at least one hit per face in a webcam setting.

In the Viola-Jones method accuracy can be improved by averaging the locations and scales of overlapping hits into a single, more accurate detection. Obviously the more scales scanned and the smaller the scanning factor, the more accurate and consistent the final averaged detection will be.[13]

V. CONCLUSION

The Attendance monitoring using image processing is a novel solution to curb the various inconsistencies in manual record keeping. This project has employed various technologies and their optimisations to achieve this goal.

Our project has made this goal cost effective by using open source technologies and daily used mobile phones to create an institutional level project which is easy to use and removes the nuisance of maintaining attendance.

ACKNOWLEDGMENT

It gives us great pleasure in presenting this project report titled "Attendance monitoring using image processing" and we wish to express our immense gratitude to the people who provided invaluable knowledge and support in the completion of this project. Their guidance and motivation has helped in making this project a great success. We express our gratitude to our project guide **Prof. Sumita Chandak**, who provided us with all the guidance and encouragement throughout the project development. We would also like to express our sincere gratitude to the respective Project coordinators. We are eager and glad to express our gratitude to the Head of the Information Technology Dept. **Prof. Neelima Pathak**, for her approval of this project. We are also thankful to her for providing us the needed assistance, detailed suggestions and also encouragement to do the project. We would like to deeply express our sincere gratitude to our respected principal Prof. Dr. Shrikant Kallurkar and the management of Atharva College of Engineering for providing such an ideal atmosphere to build up this project with well-equipped library with all the utmost necessary reference materials and up to date IT Laboratories. We are extremely thankful to all staff and the management of the college for providing us all the facilities and resources required.

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