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Optimized Attendance System Using Face Recognition

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Abstract: The purpose of this paper is to look into a new and improved method for marking the attendance of students gathering the attendance in the traditional way is accomplished by the expenditure of a sizeable amount of time and effort on the part of the teacher or administrator in charge. Apart from a roll call or passing around an attendance sheet, other methods of attendance gathering, like iris scanning, fingerprint recognition and other biometric based systems have been developed. However, these systems are costly to deploy and maintain on a large scale. To counter these disadvantages, a system based on another parameter like facial recognition can be used, involving phases such as face detection, face cropping, image resizing, image normalization, image de-noising along with feature extraction. Finally features from processed image will be given as a training data to the learning model and further classified as the means to mark attendance. To this end, the algorithms such as the Viola Jones object detection algorithm can be utilized in obtaining the intended results. In addition, this system will also solve the problem of maintaining manual records of the rising number of students in universities.

Keywords: Classifier, Face cropping, Face detection, Feature extraction, Image de-noising, Image normalization, Image resizing, Machine learning, Viola jones.

I. Introduction

The attendance of a student is an effective measurement of his/her performance in a class. To that end, it is necessary to have an accurate system for attendance marking. To counter the disadvantages of systems such as roll calls and attendance sheets, systems like RFID, Iris and fingerprint scanning are being used. However, these are expensive to use and can be susceptible to damage from users. Frequent maintenance may also be necessary. In addition, they require queuing students and slow proceedings down. To save costs and not have a requirement of any human intervention, the step is to use human faces. A person's face is their primary field for identification. Due to rapid development in the fields of image processing and pattern recognition, this system will be continually improved. This system provides an automated platform for marking the student's attendance. It carried out face recognition through an image for recording the attendance in lectures and maintains records regarding that attendance. Once the dataset is created, minimal efforts are required from the teacher or student when it comes to maintaining or checking the attendance.

II. Related Work

The process of marking attendance is of paramount importance in any institute. Currently we can observe colleges and schools employing certain methods to recognize a student's presence in the classroom and by extension, his/her absence. These include doing a roll call and passing an attendance sheet around. However, a roll call takes a significant amount of time and may cause inaccuracies if the class is inattentive. Similarly using the attendance sheet may lead to proxy attendance being marked. Damage to the sheet may also occur resulting in that day's attendance being nullified. Some of the methods developed for this are RFID [1], Iris [2] and Fingerprint [3]. However, even though these newer methods improve on the accuracy of attendance marking they are neither cheap nor time saving to implement. The very fundamental requirement of the system is a face detection technique, of which there are many. Some of them are the SMQT features and SNOW classifier, SVM based face detection and the Viola Jones face detection algorithm [4]. Out of these, the Viola Jones algorithm [5] was chosen for its high image processing rate. There is also an abundance of feature extraction algorithms. The LBP [6] (Local Binary Pattern) is used for classification in Computer Vision and is particularly effective in case of excessive illumination and low resolution. Gabor [6] Filters can also be applied for a similar purpose, although they are primarily used for iris and

fingerprint recognition. Discrete Cosine Transform (DCT) [7] describes data points in terms of cosine functions, and they are described are different frequencies. Cosine functions are preferred over sine for compression purposes. The advances in Computer Vision [8] are what have made systems like this possible. Computer Vision is the field that allows a computer to gain understanding from digital media like images and videos. It attempts to mimic what a real human ocular system can accomplish. It produces symbolic or numerical information from a series of images or videos. Computer Vision is a highly powerful tool in the field of image processing, object tracking, pose recognition etc. Along with Computer Vision, machine learning [9] is also essential for this system. Models like Support Vector Machine [9], Neural Networks [12] and K Nearest Neighbour Classification [13] [14] are needed to classifying the data gathered from the features extracted earlier. These algorithms offer varying accuracy while the trade off associated with it is the drop in performance. KNN or K Nearest Neighbours is a supervised learning model which uses the data from the "k" nearest neighbours of a certain data point to classify it by simple comparison. It is used in this system for the purpose of recognizing the faces of students based on the extracted features.

III. Proposed System

The proposed system will use facial recognition to mark the attendance of students. The attendance management system will mark a student present or absent based on a collection of photographs taken at predetermined time instances. The system allows the teacher to mark student's attendance automatically without any extra cost and effort. Furthermore, the proposed system requirements are minimal such as; camera, laptop or personal computer and local network. This method is secure, reliable and easy to use. The input to this system will be the photograph(s) of the entire class. It will then undergo face detection, followed by preprocessing of the image, extraction of features. These features are then used to match the faces against a previously created dataset of faces to mark the attendance.

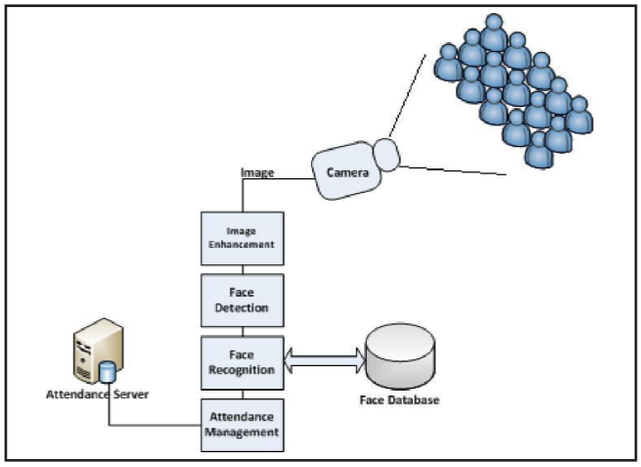

Fig. 1: Architecture of the System

A. Image Preprocessing

The essential and basic steps of image preprocessing are elaborated in further detail below. The first step, we can say is the conversion of an image that has color, which may use any of the color scales to define said color, to an image that is gray scale. Subsequently, the image will undergo cropping, in this case facial detection to get rid of the background elements in that image and divert focus completely onto the face of the subject(s). The image will also be resized to meet the requirements specified for the success of the further processing of the image. It is the additional requirement of the system that the image have uniformity in the gray scale. To this effect, the image will be normalized. It is also made to pass through a low pass filter. To convert the colored image into gray scale image the OpenCV utility cvtColor(source image, gray_scale_constant) can be used.

B. Face Detection

The Viola Jones Facial Detection framework is a real time, robust and efficient way to detect faces.

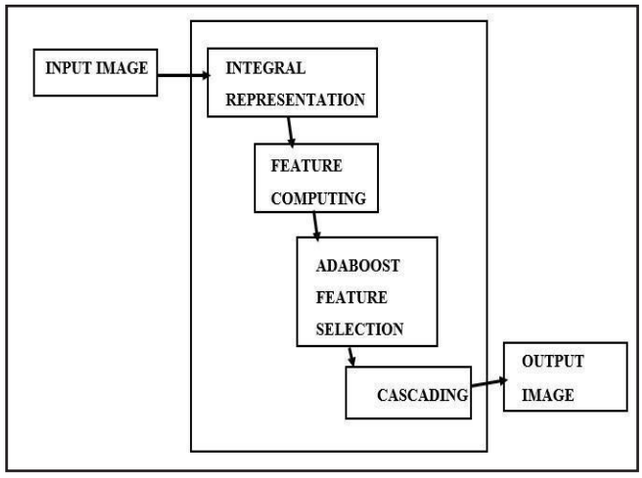

Fig. 2: Face Detection Process

The algorithm has four stages:

1. *Haar Feature Selection:* Haar features help in detecting the presence of a particular feature in the given image. The Haar Cascade model is trained with around 6000 rudimentary rectangular features. These rectangular features are incorporated in the detection phase to draw analogies with facial features by utilizing the relative contrast between protruding and deflated facial regions such as nose and cheeks respectively.
2. *Creating an Integral Image:* The integral images select any pixel and calculate the pixel values using all the pixels on the left and top of the selected pixel. If we consider all possible parameters of the Haar features like position, scale and type we end up calculating about 160,000+

features. The integral image at a location say (x, y) contains the sum of the pixels above and to the left of (x, y) inclusive.

3. *Adaboost Training:* Adaboost training is an iterative process that involves evaluating facial features from multiple weak classifiers until a single powerful and effective classifier is not obtained. Examples misclassified by a previous weak classifier are given more emphasis at future rounds. Final classifier is combination of the weak ones, weighted according to error they had.
4. *Cascading Classifiers:* The single feature in the image is called weak classifiers and when they are sum up they form a group of features called strong classifiers. Summing of all these features is done by cascading. The Viola and Jones face detection algorithm eliminates face candidates quickly using a cascade of stages. The cascade eliminates candidates by making stricter requirements in each stage with later stages being much more difficult for a candidate to pass. Candidates exit the cascade if they pass all stages or fail any stage. A face is detected if a candidate passes all stages.

Fig. 3: Face Detection

C. Image Resizing

The resulted image from various face detection schemes is resized. This is needed because the image will contain faces that will have varying sizes. For the optimized processing of the image in the near future, it is necessary that the image be of uniform size.

D. Face Cropping

Cropping is an essential sub process in image preprocessing. Cropping is a necessity to achieve a satisfactorily high facial recognition rate in the subject images and the dataset. A well cropped image can be achieved using a myriad of face detection techniques. Once the faces are detected the coordinates associated with the border that captures the face are rendered to the OpenCV function imwrite(path, coordinates).

Fig. 4: Cropped Faces

E. Training Model

A training model must be created from a dataset of student faces. The student faces are captured via a laptop camera over a decided time frame in a short burst. A set of 10-30 pictures of each student must be taken. These pictures must also be cropped and converted to gray scale. This is to reduce their size and help focus on the face with the exclusion of all else. To capture the pictures from all angles, the subject must be asked to look around while the photos are being captured. Once the photos are taken, they must be stored in the respective directory for that student marked by his/her roll number. All these directories must then be put into a single directory. The training model will then be created by extracting the features of all the images of all the students by visiting each and every student's directory. HOG based features are used for this purpose, which will be explored thusly.

F. Feature Extraction

Features are distinct attributes or aspects of image. Features are important for accuracy. A feature extraction algorithm extracts features from the image. It creates those new features based on transformations or combinations of the original image. This feature extraction process can be defined as the procedure of extracting relevant information from a face image. These extracted features are utilized to create the required machine learning model that is subsequently used to classify the image and mark the attendance. The feature extraction process must be efficient in terms of computing time and memory usage. The performance of a classifier depends on the amount of sample images, number of features and classifier complexity.

HOG Features: Histogram of Oriented Gradients (HOG) which is a feature descriptor widely used in computer vision is used for object detection. It is based on counting the occurrences of gradient orientation in localized portions of an image. This method has similarity with edge orientation histogram, scale invariant feature transform descriptor, shape contexts. However, overlapping local contrast normalization is used and computed on a dense grid of uniformly spaced cells in order to improve accuracy.

Principal Component Analysis: Principle Component Analysis (PCA) is a common feature extraction method in data science. PCA finds the eigenvectors of a covariance matrix with the highest eigenvalues and then uses those to project the data into a new subspace of equal or less dimensions.

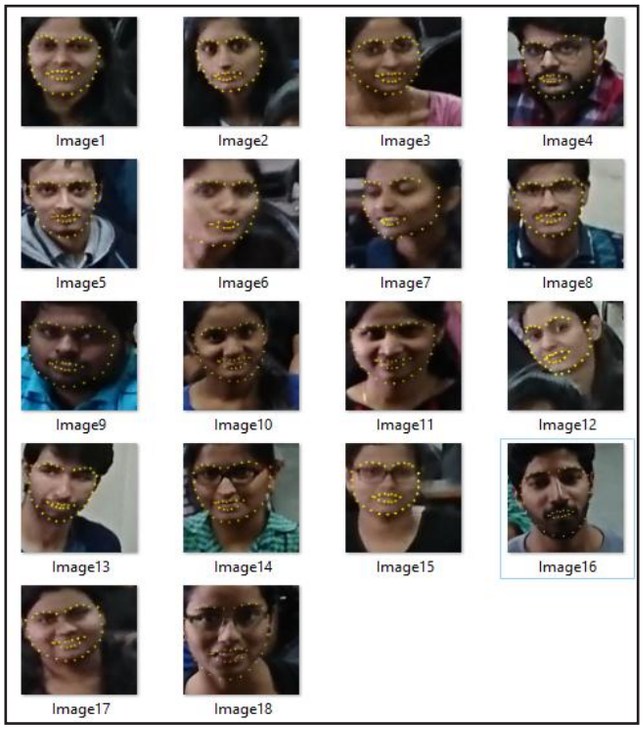

Fig. 5: Feature Extraction

G. Classification

The feature values will be calculated for the new, unseen test image. These values will be provided as input to the trained model. The output will be calculated based on these feature values which will classify the student as present or absent and according to that result attendance will be marked.

For classification, the classifiers like SVM (Support Vector Machine) or Naïve Bayes classifier can be used.

Support Vector Machines: SVMs are classifiers that maximize the boundary between the two classes that are being separated. So, an optimal hyper plane, i.e. classifier will minimize the classification errors that may occur.

Naive Bayes Classifier: This is performed by computing the probability of a face being present in that particular part of the image. This can be achieved by counting the number of previous occurrences of faces in the training set.

K-Nearest Neighbor: K-Nearest Neighbor (KNN) is data classification method that can be used as face recognition method. Each pixel in face represents unique information. This paper recognized face based on each pixel classification. Face was determined by most class resulted in each pixel classification. In recognition, pixel matrix of face image should be reshaped into vector before classification. The training model created earlier is used for classification in KNN to classify whether a student is present or absent. A spreadsheet is used for marking the actual attendance, where all students are marked absent as default, and marked present according to their roll number only after they have been classified as present.

IV. Conclusion

This system calculates the attendance of all students by using a series of photographs clicked at predefined time intervals and utilizing face detection and recognition for attendance marking. The system requires minimal skill, time and effort to operate. It also has very basic requirements like a camera, computer and a network. This technique is secure and reliable. The overall system can be implemented in Python.

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