Face Recognition based Attendance System using Machine Learning

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***Abstract* - Attendance is an important part of daily classroom ascertainment for the teacher for his or her smooth running of class. At the beginning and ending of the class, usually teacher check the attendance, but the manual attendance system may leads to appear that a teacher may miss someone or some students may answer multiple times. Now a days, Machine Learning has been highly explored for computer vision applications. So, we use the concept of machine learning in Face – recognition for automatic attendance systems. In this project, we perform the face recognition and face detection algorithms, to provide the computer systems the ability of finding and recognizing human faces fast and precisely in images or videos so that the systems can used in giving attendance.**

***keywords* - Machine Learning, face recognition, assessment, face detection algorithm, LBPH,HAAR**

I. INTRODUCTION

Generally, in the classroom the attendance was taken by the teachers manually at the beginning and ending of the class. The problem with this approach is that it requires some time to take and also the manual process will have chances to make mistakes in most of the cases. To overcome that problem, RFID (Radio Frequency Identification) was introduced in the past years. But those are also having the fail proof of attendance system. So, we are introducing the concept of Face Recognition Based Attendance system, the main objective the proposed system is to allot attendance to the students using face recognition-based algorithms to achieve fail proof attendance system.

Face detection is used for many applications for the identification of human faces in digital images or video. It is defined as specific case of object-class detection; where it is used to find the locations and sizes of all objects in an image that belong to a given class. The technology is can be able to predict frontal or near-frontal faces in a photo, regardless of orientation, lighting conditions or skin color.

Face Recognition is a form of biometric software that maps an individual's facial features mathematically and stores the data as a faceprint. The software consists of Deep Learning algorithms to compare a live capture or digital image to the stored face print in order to verify an individual's identity.

Face Recognition using Python

Faces are made of thousands of fine lines and features that must be matched. The face recognition using Python is used to break the task of identifying the face into thousands of smaller, bite-sized tasks, each of which is easy to face Recognition Python is the latest technology in Machine Learning techniques. OpenCV utilizes Machine Learning algorithms to search for faces within a picture.

Facial Recognition using Python Libraries

An easy way to detect faces using Python is by using the OpenCV package which is written in C/C++, OpenCV now provides bindings for Python. It uses machine learning algorithms to search for faces within a picture. Faces are very complicated, made of thousands of small patterns and features that must be matched. The face recognition algorithms break the task of identifying the face into thousands of smaller, bite-sized tasks, each of which is easy to solve, known as classifiers.

A face may have 5000 or more classifiers, all of which must match for a face to be detected. Since there are at least 5,000 or more tests per block, you might have millions of calculations to do, which makes it a difficult process. To solve this, OpenCV uses cascades. The OpenCV cascade segments the problem of detecting faces into multiple stages. It performs a detailed test for each block. The algorithm can be performed on around 30 to 50 of these stages or cascades, and it will only detect a face if all stages pass. The cascades are a bunch of XML files that contain OpenCV data used to detect objects.

II. LITERATURE REVIEW

Traditionally attendance was taken manually which is very time consuming and often leads to human error. Additionally, there are many uncertainties towards the sources of the attendance records which in fact, most of the attendance records are not retrieved from the actual situation. The old method that uses paper sheets for taking student's attendance can no longer be used. Based on the research, there are many solutions that are available to solve this issue. According to research journal "Attendance System Using NFC Technology with Embedded Camera on Mobile Device" (Bhise, Khichi, Korde,Lokare, 2015). The attendance system is improved by using Near Field. Communication (NFC) technology and mobile application. According to the research paper, each student is given a NFC tag that has a unique ID during their enrolment into the college. Attendance of

each class will then be taken by touching or moving these tags on the lecturer mobile phone. The embedded camera on the phone will then capture the student's face to send all the data to the college server to do validation and verification.
The advantages of this method are where the NFC is simple to use, and the speed of connection establishment is very high. It indeed speeds up the attendance taking process a lot. However, this system couldn't automatically spot the violation when the NFC tag is not personally tagged by the original owner. Apart from that, the convenience of the system which uses the mobile phone as the NFC reader was actually an inconvenience to the lecturer. Imagine if the lecturer had forgotten to bring their mobile phones to work, what would be the backup procedure for the attendance to be recorded? Moreover, most of the lecturer will not likely to prefer their personal smart phones to be used in this way due to privacy matter. Hence, unique information about the student like biometrics or face recognition, which is guanine for a student, should be used in replacement of the NFC tag. This will ensure attendance to be taken originally by the actual student.
The second research journals "Face Recognition Based Attendence Marking System" (Senthamil Selvi, Chitrakala, Antony Jenitha, 2014) is based on the identification of facerecognition to solve the previous attendance system's issues. This system utilizes camera to capture the employee images to do face recognition. The captured image is compared one by one with the face database to search for the worker's face where attendance will be marked when a result is found in the face database. The main advantagethis system is where attendance is marked on the server which is highly secure where no one can mark the attendance of other. Moreover, in this proposed system, the face detection algorithm is improved by using the skin classification technique to increase the accuracy of the detection process. Although more efforts are invested in the accuracy of the face detection algorithm,
This system requires a standalone computer which will need a constant power supply that makes it not portable. This type of system is only suitable for marking staff's attendance as they only need to report their presence once a day, unlike students which require reporting their attendance at every class on a particular day, it will be inconvenient if the attendance marking system is not portable.
Thus, to solve this issue, the whole attendance management system can be developed on an embedded design so that it can be work similarly with just batteries that makes it portable.
The third research journal "Fingerprint Based Attendance System Using Microcontroller and LabView" (Kumar Yadav, Singh, Pujari, Mishra, 2015) proposed a solution of using fingerprint to mark the attendance. This system is using 2 microcontrollers to deal with the fingerprint recognition process. Firstly, the fingerprint pattern will be obtained through a fingerprint sensor, then the information will be transmitted to microcontroller 1. Next microcontroller 1 will pass the information to microcontroller 2 to do the checking with the database that resides in it. After finding a student's match, the details are sent to the PC through serial communication to be displayed. This design is good as it accelerates development while maintaining design flexibility and simplifies testing. But again, this system is attached to a PC which make it not portable.
Other than that, the database information cannot be accessible easily. Meaning that, for the parents whom are interested in knowing their child's attendance cannot easily or conveniently access the information. Therefore, to provide accessibility of the student's information to the legitimate concerned party, the information can be uploaded to a web server for easy access. While the authentication for the appropriate access can be enforced through a login screen.
According to the forth research journal "RFID based Student Attendence System" (Hussain, Dugar, Deka, Hannan, 2014), the proposed solution is almost similar to the first research journal where RFID technology is used to improve the older attendance system. In this system, a tag and a reader is again used as a method of tracking the attendance of the students. The difference between the first journals with this is where attendance's information can be accessed through a web portal. It provides more convenient for information retrieval. 8 BCS (HONS) Computer Engineering Faculty of Information and Communication Technology (Perak Campus), UTAR Again, this system is imperfect in the sense that, firstly, it is not portable, as the RFID reader can only work when it is connected to a PC. Secondly, the RFID tag is not a guanine information that can uniquely identify a student, thus, resulting in the inaccuracy of the collected attendance information. RS232 is used to connect that device to the computer and save the recorded attendance from the database. This RFID based attendance system may give rise to the problem of fraudulent access. Unauthorized person may have a chance to make use of authorized ID card and enter into the organization.
Fingerprint based Attendance System has a portable fingerprint device which can be passed between the students then they have to place their finger on the sensor during the lecture time without the instructor's involvement. The problem with this approach is that passing of the device during the lecture time may distract the focus and concentration of the students.
Iris is another branch of bio-metric that can be used for Attendance Systems. In this system authors have proposed Daugmans algorithm-based Iris recognition system. This system uses iris recognition management system that does capturing the image of iris recognition and then extraction, storing and matching. But the difficulty occurs to lay the transmission lines in the places where the topography is not good. In this the authors have proposed a system based on real time face recognition which is reliable, secure and fast which needs improvement indifferent lighting conditions.
Face detection is a basic technology of human-computer interaction. It can get the data from the faces in pictures or videos. Face recognition technology analyses the face images to extract the facial features, and then identify specific targets. The development of machine learning technology tries to further improve the accuracy of face recognition
The face recognition problem is formulated as a problem in difference space, which models dissimilarities between two facial images. In different space they formulate face recognition as a two class problem. The cases are: (i) Dissimilarities between faces of the same person, and (ii) Dissimilarities between faces of different people. By modifying the interpretation of the decision surface generated a similarity metric between faces, that is learned from examples of differences between faces. The SVM-based algorithm is compared with a principal component analysis (PCA) based algorithm on a difficult set of images from the FERET database. Performance was measured for both verification and identification scenarios. The identification performance for SVM is 77-78% versus 54% for PCA. For verification, the equal error rate is 7% for SVM and 13% for PCA.

III. METHODOLOGY

PROPOSED WORK

The proposed system face recognition-based attendance system can be divided into five main modules.The modules and their functions are defined as follows.

Image Capture

The camera is fixed at a distance from the entrance to capture the frontal image of the students.And remaining process goes for face detection.

Face Detection

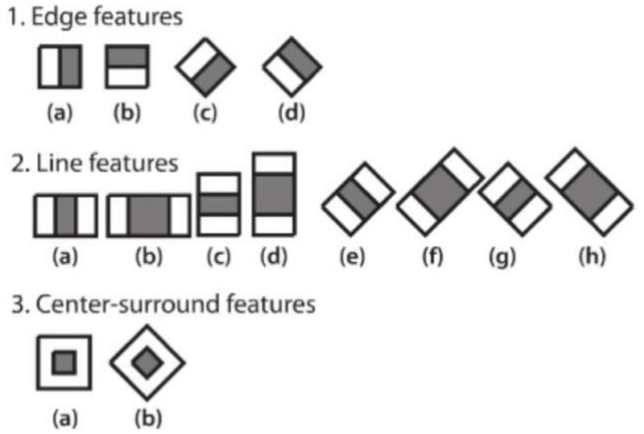
A proper and efficient face detection algorithm always increases the performance of face recognition systems. Various algorithms are proposed for face detection such as face knowledge based methods, feature invariant methods, machine learning based methods. In this project, I implemented a system for locating faces in digital images. These are in JPEG format only. Before we continue, we must differentiate between face recognition and face detection. They are not the same, but one depends on the other. In this case face recognition needs face detection for making an identification to "recognize" a face. I will only cover face detection. Face detection uses classifiers, which are algorithms that detects what is either a face(1) or not a face(0) in an image.

Classifiers have been trained to detect faces using thousands to millions of images in order to get more accuracy. OpenCV uses two types of classifiers, LBP (Local Binary Pattern) and Haar Cascades

Understanding Haar Cascades

A Haar Cascade is based on "Haar Wavelets" which defines as:

A sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. It is based on the Haar Wavelet technique to analyze pixels in the image into squares by function. This uses machine learning techniques to get a high degree of accuracy from what is called "training data". This uses "integral image" concepts to compute the "features" detected. Haar Cascades use the **Adaboost** learning algorithm which selects a small number of important features from a large set to give an efficient result of classifiers.

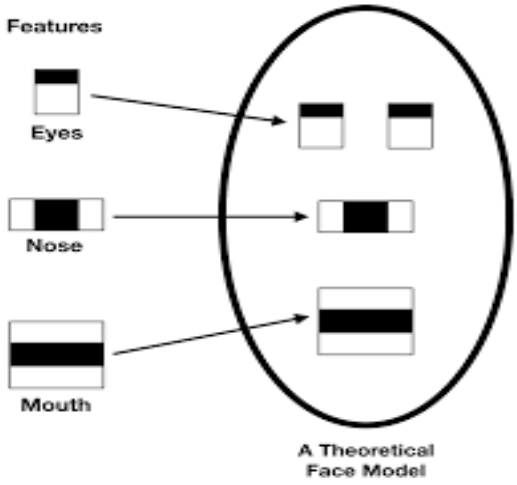


Face Detection determines the locations and sizes of human faces in arbitrary (digital) images.

In **Face Recognition**, the use of Face Detection comes first to determine and isolate a face before it can be recognized.

Feature Extraction

Haar Cascades use machine learning techniques in which a function is trained from a lot of positive and negative images. This process in the algorithm is feature extraction.



Pre-Processing

The detected face is extracted, subjected to pre-processing. This pre-processing stage involves With the histogram equalization of the extracted face image and is resized to 100x100.Histogram Equalization is the most common technique in Histogram Normalization. This improves the contrast of the image as it stretches the ranges of the intensities in an image by making it more perfect.

Database Development

In this Biometric based system collection of every individual is required. This database development phase consists of image capture of every individual student and extracting the Bio-metric feature for every individual, in our proposed system it is face, and after it is enhanced using pre-processing techniques and to be stored in the database

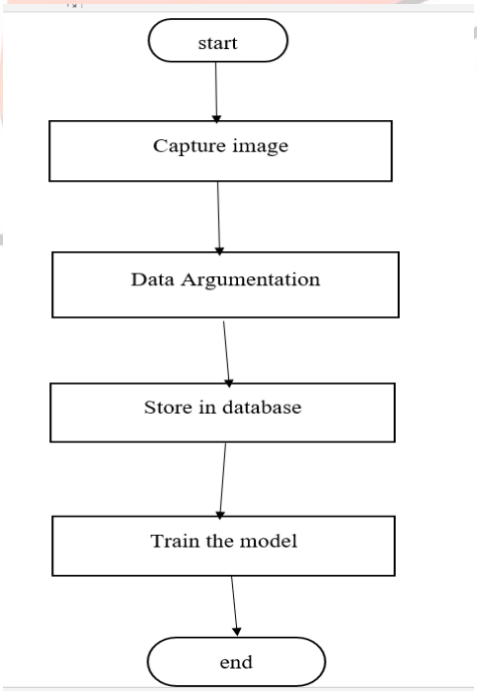
Post -Processing

In the proposed system , after recognizing the all faces of the students, the names of individuals are updated into an excel sheet is created by exporting mechanism present in the database. The database also has the ability to generate monthly and weekly reports of students attendance. These generated records can be viewed by the faculty and students .this ensures that student whose Faces are not recognized correctly by the system have the chance to send a request to admin. And Thus giving the ability to the correct the system and make it more stable and accurate.

Proposed Algorithm

1. Capture the student's image through camera.
2. Detect each and every individual face by apply face detection algorithm.
3. Extract the ROI(Region Of Interest) in rectangular bounding box.
4. Converting to gray scale, apply histogram equalization and resize to 100x 100 i.e. apply pre-processing.
5. If image captured then
Store in database
Else
Apply LBPH (for feature extraction)
Apply SVM(for classification)
End if
6.Post-processing

Flow chart



Data augmentation encompasses a wide range of techniques used to generate "new" training samples from the original ones by applying random jitters and perturbations (but at the same time ensuring that the class labels of the data are not changed).

- Scaling
- Translation
- Rotation (at 90 degrees)

- Rotation (at finer angles)
- Flipping
- Adding Salt and Pepper noise
- Lighting condition

Scaling: Having differently scaled object of interest in the images is the most important aspect of image diversity. When your network is in hands of real users, the object in the image can be tiny or large. Also, sometimes, object can cover the entire image and yet will not be present totally in image (i.e cropped at edges of object).

Translation: We would like our network to recognize the object present in any part of the image. Also, the object can be present partially in the corner or edges of the image. For this reason, we shift the object to various parts of the image. This may also result in addition of a background noise

Rotation (at 90 degrees): The network has to recognize the object present in any orientation. Assuming the image is square, rotating the image at 90 degrees will not add any background noise in the image.

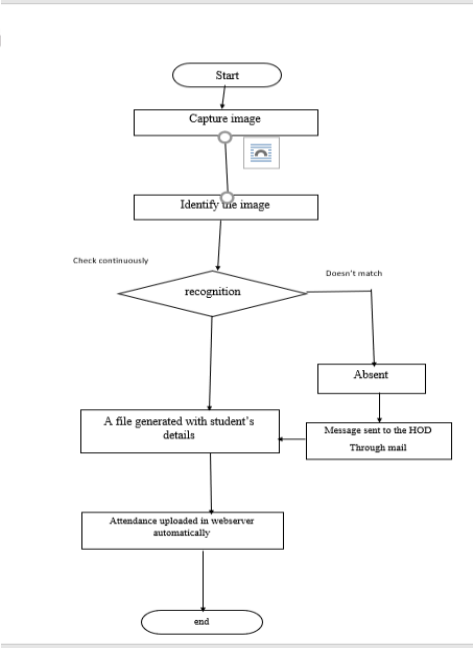
Rotation (at finer angles): Depending upon the requirement, there maybe a necessity to orient the object at minute angles. However problem with this approach is, it will add background noise. If the background in image is of a fixed color (say white or black), the newly added background can blend with the image. However, if the newly added background color doesn't blend, the network may consider it as to be a feature and learn unnecessary features.

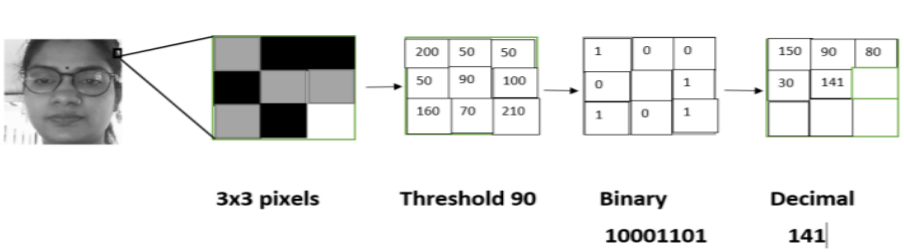
Flipping: This scenario is more important for network to remove biasness of assuming certain features of the object is available in only a particular side. Consider the case shown in image example. You don't want network to learn that tilt of banana happens only in right side as observed in the base image. Also notice that flipping produces different set of images from rotation at multiple of 90 degrees.My additional question is has anyone done some study on what is the maximum number of classes it gives good performance.

Adding Salt and Pepper noise: Salt and Pepper noise refers to addition of white and black dots in the image. Though this may seem unnecessary, it is important to remember that a general user who is taking image to feed into your network may not be a professional photographer. His camera can produce blurry images with lots of white and black dots.

Lighting condition: This is a very important type of diversity needed in the image dataset not only for the network to learn properly the object of interest but also to simulate the practical scenario of images being taken by the user. The lighting condition of the images are varied by adding Gaussian noise in the image.

Perspective transform: In perspective transform, we try to project image from a different point of view. For this, the position of object should be known in advance. Merely calculating perspective transform without knowing the position of the object can lead to degradation of the dataset. Hence, this type of augmentation has to be performed selectively. The greatest advantage with this augmentation is that it can emphasize on parts of object in image which the network needs to learn.





Local Binary Patterns Histogram(LBPH)

Step- by -step algorithm:

1. Parameters: the LBPH uses 4 parameters: • Radius: the radius is used to build the circular local binary pattern and represents the radius around the central pixel. It is usually set to 1. • Neighbours: the number of sample points to build the circular local binary pattern. Keep in mind: the more sample points you include, the higher the computational cost.
It is usually set to 8. • Grid X: the number of cells in the horizontal direction. The additional cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.
Grid Y: the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector

Training the Algorithm: First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same
ID.

Applying the LBP operation: The first computational step of the LBPH is to create a intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameter's **radius** and **neighbours**.

Extracting the Histograms: Now, using the image generated in the last step, we can use the **Grid X** and **Grid Y** parameters to divide the image into multiple grids.

Performing the face recognition: In this step, the algorithm is already trained. Each histogram created is used to represent each image from the training dataset. So, given an input image, we perform the steps again for this new image and create a histogram which represents the image. So, to find the image that matches the input image we just need to compare two histograms and return the image with the closest histogram. We can use various approaches to compare the histograms (calculate the distance between two histograms), for example: **euclidean distance**, **chi-square**, **absolute value**, etc. In this example, we can use the Euclidean distance (which is quite known) based on the following formula:

$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2}$$

So the algorithm output is the ID from the image with the closest histogram. The algorithm should also return the calculated distance, which can be used as a '**confidence**' measurement. We can then use a threshold and the 'confidence' to automatically estimate if the algorithm has correctly recognized the image. We can assume that the algorithm has successfully recognized if the confidence is lower than the threshold defined

CONCLUSION

This system helps to avoid the fail proof of attendance system and this system works as the substitute for the all existing systems i.e. Radio Frequency Identification and all other bio-metric systems. It saves the time and energy in the aspect of taking attendance. Automated Attendance Systems based on face recognition techniques thus proved to be time saving and secured. This system can also be used to identify an unknown person whether he is related to the organization or not.

FUTURE SCOPE

Further extensions can be made, to achieve the real time detection of specific student in the surveillance premises. Instead of taking images, we can also work with recorded videos. But some time period is maintained to record the images, because if continuous recording is done then load on database increases. The future work is to improve the recognition rate of algorithms when there are unintentional changes in a person like tonsuring head, using scarf and beard. The system developed only recognizes face up to 30 degrees angle variations which has to be improved further. Gait recognition can be fused with face recognition systems in order to achieve better performance of the system.

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