Intelligent Face Recognition Attendance System

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Abstract— Face recognition from image or video is a popular topic in biometrics research. The human face is one of the natural traits that can uniquely identify an individual. Therefore, it is used to trace identity as the possibilities for a face to deviate or being duplicated is low. In this paper we propose an automated attendance management system. The main purpose of this project is to build a face recognition-based attendance monitoring system for educational institution to enhance and upgrade the current attendance system into more efficient and effective as compared to before. The current old system has a lot of ambiguity that caused inaccurate and inefficient of attendance taking. Many problems arise when the authority is unable to enforce the regulation that exist in the old system. In this project, face databases will be created to pump data into the recognizer algorithm. Then, during the attendance taking session, faces will be compared against the database to seek for identity. When an individual is identified, its attendance will be taken down automatically saving necessary information into a excel sheet. At the end of the day, the excel sheet containing attendance information regarding all individuals are mailed to the respective faculty.

Keywords: Face Recognition, SVM Classifier, OpenCV, PyQt5, NumPy, CSV, dlib

I. INTRODUCTION

The main objective of this project is to develop face recognition based automated student attendance system for educational institution to upgrade the current attendance system. In order to achieve better performance, the test images and training images of this proposed approach are limited to frontal and upright facial images that consist of a single face only. The test images and training images have to be captured by using the same device to ensure no quality difference. In addition, the students have to register in the database to be recognized. The enrolment can be done on the spot through the user-friendly interface which shows the current date and time with the status of the student whether he/she clocked in or clocked out of the class.

A. Problem Statement and Motivation

Attendance is prime important for both the teacher and student of an educational organization. So, it is very important to keep record of the attendance. The problem arises when we think about the traditional process of taking attendance in class room. According to the previous attendance management system, the accuracy of the data collected is the biggest issue. This is because the attendance might not be recorded personally by the original person, in another word, the attendance of a particular person can be taken by a third party without the realization of the institution which violates the accuracy of the data. For example, student A is lazy to attend a particular class, so student B helped him/her to sign for the attendance which in fact student A didn't attend the class, but the system overlooked this matter due to no enforcement practiced. Supposing the institution establish an enforcement, it might need to waste a lot of human resource and time which in turn will not be practical at all. Thus, all the recorded attendance in the previous system is not reliable for analysis usage. The second problem of the previous system is where it is too time consuming. The third issue is with the accessibility of those information by the legitimate concerned party.

B. Research Objectives

In order to solve the drawbacks of the previous system stated in the above section, the existing system will need to evolve. The proposed system will reduce the paperwork where attendance will no longer involve any manual recording. The new system will also reduce the total time needed to do attendance recording. The new system will acquire individual attendance by means of facial recognition to secure data accuracy of the attendance. Following are the objectives of this project.

- To ensure the speed of the attendance recording process is faster than the previous system which can go as fast as approximately three seconds for each student.
- Have enough memory space to store the database.
- It is able to recognize the face of an individual accurately based on the face database.
- Able to show an indication to the user whether the face-recognition process is successful or not.

C. Project Scope and Direction

The main intention of this project is to solve the issues encountered in the old attendance system while reproducing a brand new innovative smart system that can provide convenience to the institution. In this project, an application will be developed which is capable of recognising the identity of each individuals and eventually record down the data into a database system. Apart from that, an excel sheet is created which shows the students attendance and is directly mailed to the respected faculty.

D. Historical Development Prior To the Project

Back in the years, attendance management system in school/colleges was done by manual reporting where the student's attendance was recorded by placing a mark or signature beside their name in a name list to indicate their presence in a particular class. While the staff in the institution will report their attendance through the punch card machine which also have to be done manually. Later on, some of those attendance systems had evolved into using smart cards to replace signature markings where each students/staff will be required to report their attendance using a smart card embedded with a unique identification chip.

II. LITERATURE SURVEY

A. Attendance System Using NFC Technology with Embedded Camera on Mobile Device.

According to research journal "Attendance System Using NFC (Near Field Communication) Technology with Embedded Camera on Mobile Device" [1]. The attendance system is improved by using 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.

B. Face Recognition Based Attendance Marking System.

The second research journals "Face Recognition Based Attendance Marking System" [2] is based on the identification of face recognition to solve the previous attendance system's issues. This system uses camera to capture the images of the employee to do face detection and 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 advantage of this 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, the system is yet not portable. 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 to report 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 a portable module so that it can be work just by executing the python program.

C. Fingerprint Based Attendance System Using Microcontroller and LabView.

The third research journal "Fingerprint Based Attendance System Using Microcontroller and LabView" [3] proposed a solution of using fingerprint to mark the attendance. This system is using two 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.

D. RFID Based Student Attendance System.

According to the fourth research journal "RFID based Student Attendance System" [4], 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 are 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. 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. In conclusion, a better attendance monitoring system should be developed based on its portability, accessibility and the accuracy of the collected attendance information.

III. SYSTEM DESIGN

The design part of the attendance monitoring system is divided into two sections which consist of the hardware and the software part. Before the software design part can be developed, the hardware part is first completed to provide a platform for the software to work. Before the software part we need to install some libraries for effective working of the application. We install OpenCV, cmake, dlib, PyQt5, pyqt5-tools and NumPy through Python.

A. Hardware Requirement

- Camera module with good mega pixel
- Intel core I3 or higher processor
- Minimum 4GB main memory
- Minimum 50 GB hard disk space
- Windows 10 operating system

– 1024x768 or higher resolution display
– Power supply cable

B. Software Development

There are two major system flows in the software development section as shown below:

– Creation of the face database
– The process of attendance taking

The face database is an important step to be done before any further process can be initiated. This is because the face database acts as a comparison factor during the recognition process. In this process, a csv file is created to aid the process of image labelling because there will be more than one portrait stored for each student, thus, in order to group their portraits under the name of the same person, labels are used to distinguish them. After that, those images will be inserted into a recognizer to do its training. Since the training process is very time consuming as the face database grew larger, the training is only done right after there is a batch of new addition of student's portraits to ensure the training is done as minimum as possible.

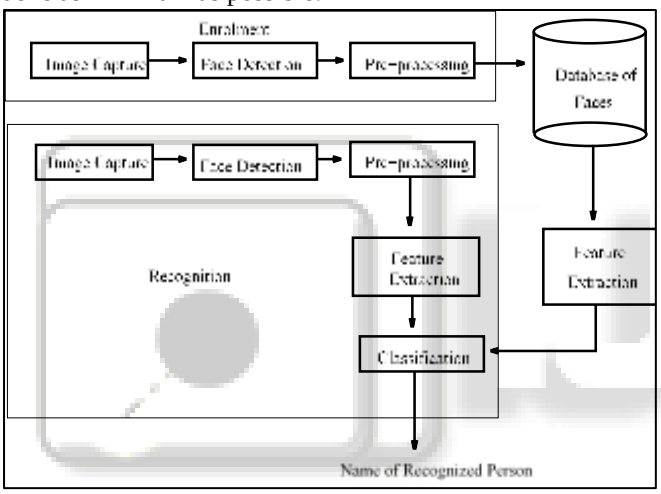

Fig. 1: The process of attendance taking

Stored images in the image database are compared against face of the particular person while taking the attendance, then the error rate is calculated between the stored image from the image database and the captured image. If those images match against each other then that person will be recognised and the attendance is noted in the excel sheet.

IV. METHODOLOGY

Face recognition is really a series of several related problems [5]:

– First, look at a picture and find all the faces in it.
– Second, focus on each face and be able to understand that even if a face is turned in a weird direction or in bad lighting, it is still the same person.
– Third, be able to pick out unique features of the face that you can use to tell it apart from other people like how big the eyes are, how long the face is, etc.
– Finally, compare the unique features of that face to all the people you already know to determine the person's name.

A. Finding All the Faces.

The first step in our pipeline is face detection. Obviously, we need to locate the faces in a photograph before we can try to tell them apart.

Fig. 2: Face detection

Face detection is a great feature for cameras. When the camera can automatically pick out faces, it can make sure that all the faces are in focus before it takes the picture. But we'll use it for a different purpose, finding the areas of the image we want to pass on to the next step in our pipeline.

Face detection went mainstream in the early 2000's when Paul Viola and Michael Jones invented a way to detect faces that was fast enough to run on cheap cameras. However, much more reliable solutions exist now. We're going to use a method invented in 2005 called Histogram of Oriented Gradients or just HOG for short.

To find faces in an image, we'll start by making our image black and white because we don't need colour data to find faces. Then we'll look at every single pixel in our image one at a time. For every single pixel, we want to look at the pixels that directly surrounding it.

Fig. 3: Single pixel of an image

Our goal is to figure out how dark the current pixel is compared to the pixels directly surrounding it. Then we want to draw an arrow showing in which direction the image is getting darker.

If we repeat that process for every single pixel in the image, we end up with every pixel being replaced by an arrow. These arrows are called gradients and they show the flow from light to dark across the entire image. This might seem like a random thing to do, but there's a really good reason for replacing the pixels with gradients. If we analyse pixels directly, really dark images and really light images of the same person will have totally different pixel values. But by only considering the direction that brightness changes, both really dark images and really bright images will end up with the same exact representation. That makes the problem a lot easier to solve. But saving the gradient for every single pixel gives us way too much detail. We end up missing the forest for the trees. It would be better if we could just see the basic flow of lightness/darkness at a higher level so we could see the basic pattern of the image. To do this, we'll break up the image into small squares of 16x16 pixels each. In each square, we'll count up how many gradients point in each major direction. Then we'll replace that square in the image with the arrow directions that were the strongest. The end result is we turn the original image into a very simple

representation that captures the basic structure of a face in a simple way.

To find faces in the HOG image, all we have to do is find the part of our image that looks the most similar to a known HOG pattern that was extracted from a bunch of other training faces.

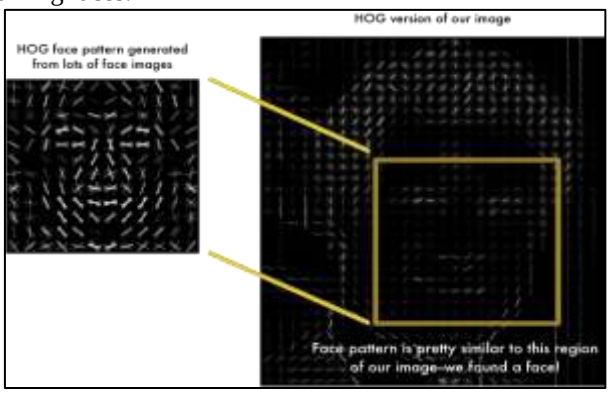

Fig. 4: HOG Pattern

Using this technique, we can now easily find faces in any image.

B. Posing and Projecting Faces.

We isolated the faces in our image. But now we have to deal with the problem that faces turned different directions look totally different to a computer. We will try to warp each picture so that the eyes and lips are always in the sample place in the image. To do this, we are going to use an algorithm called Face Landmark Estimation.

The basic idea is we will come up with 68 specific points called landmarks that exist on every face the top of the chin, the outside edge of each eye, the inner edge of each eyebrow, etc. Then we will train a machine learning algorithm to be able to find these 68 specific points on any face.

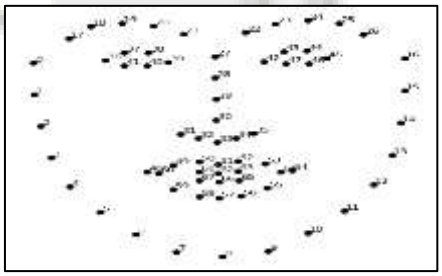

Fig. 5: Face landmarks

Now that we know where the eyes and mouth are, we'll simply rotate, scale and shear the image so that the eyes and mouth are centred as best as possible. We won't do any fancy 3D warps because that would introduce distortions into the image. We are only going to use basic image transformations like rotation and scale that preserve parallel lines called affine transformations.

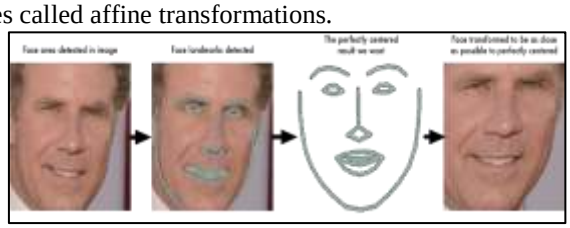

Fig. 6: Affine transformation

Now no matter how the face is turned, we are able to centre the eyes and mouth are in roughly the same position in the image. This will make our next step a lot more accurate.

C. Encoding Faces.

Here what we need is a way to extract a few basic measurements from each face. Then we could measure our unknown face the same way and find the known face with the closest measurements. For example, we might measure the size of each ear, the spacing between the eyes, the length of the nose, etc.

The most reliable way to measure a face is to train a Deep Convolutional Neural Network. But instead of training the network to recognize pictures objects, we are going to train it to generate 128 measurements for each face. The training process works by looking at 3 face images at a time.

- Load a training face image of a known person.
- Load another picture of the same known person.
- Load a picture of a totally different person.

Then the algorithm looks at the measurements it is currently generating for each of those three images. It then tweaks the neural network slightly so that it makes sure the measurements it generates for one and two are slightly closer while making sure the measurements for two and three are slightly further apart.

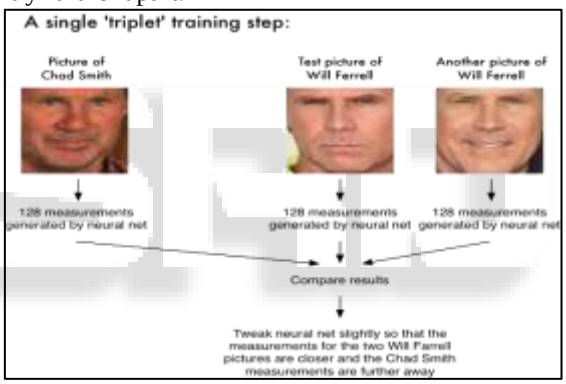

Fig. 7: Deep convolutional neural network

After repeating this step millions of times for millions of images of thousands of different people, the neural network learns to reliably generate 128 measurements for each person. Any ten different pictures of the same person should give roughly the same measurements. Machine learning people call the 128 measurements of each face an embedding. The idea of reducing complicated raw data like a picture into a list of computer-generated numbers comes up a lot in machine learning.

Encoding our face image is the process of training a convolutional neural network to output face embeddings requires a lot of data and computer power. But once the network has been trained, it can generate measurements for any face, even ones it has never seen before. So, this step only needs to be done once. So, all we need to do ourselves is run our face images through their pre-trained network to get the 128 measurements for each face. Here's the measurements for our test image.

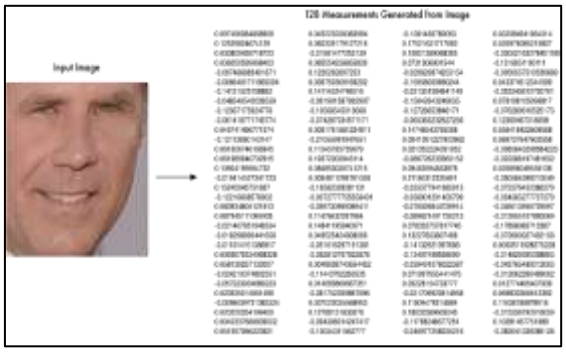

Fig. 8: 128 measurements of an image

So, what parts of the face are these 128 numbers measuring exactly? It turns out that we have no idea. It doesn't really matter to us. All that we care is that the network generates nearly the same numbers when looking at two different pictures of the same person.

D. Finding the Person's Name from the Encoding.

All we have to do is find the person in our database of known people who has the closest measurements to our test image.

We can do that by using any basic machine learning classification algorithm. No fancy deep learning tricks are needed. We'll use a simple linear SVM classifier, but lots of classification algorithms could work.

All we need to do is train a classifier that can take in the measurements from a new test image and tells which known person is the closest match. Running this classifier takes milliseconds. The result of the classifier is the name of the person.

So, let's try out our system. First, we trained a classifier with the embeddings of about 20 pictures. Then we can run the classifier on every frame of the video.

Fig. 9: SVM Classifier training with the embeddings of about 20 pictures

Then we ran the classifier on every frame of the famous YouTube video of Will Ferrell and Chad Smith pretending to be each other on the Jimmy Fallon show.

Fig. 10: Finding the person in the image or video

It works, and it also able to detect even sideways faces. The same method is applied for taking attendance in the educational institutions.

V. CONCLUSION

Before the development of this project, there are many loopholes in the process of taking attendance using the old method which caused many troubles to most of the institutions. Therefore, the facial recognition feature embedded in the attendance monitoring system can not only ensure attendance to be taken accurately and also eliminated the flaws in the previous system. By using technology to conquer the defects cannot merely save resources but also reduces human intervention in the whole process by handling all the complicated task to the machine. The only cost to this solution is to have sufficient space in to store all the faces into the database storage. Fortunately, there is such existence of micro-SD that can compensate with the volume of the data. In this project, the face database is successfully built. Apart from that, the face recognizing system is also working well.

At the end, the system not only resolve troubles that exist in the old model but also provide convenience to the user to access the information collected by mailing the attendance sheet to the respected faculty.

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REFERENCES

[1] "Attendance System Using NFC Technology with Embedded Camera on Mobile Device" (Bhise, Khichi, Korde, Lokare, 2015).
[2] K.SenthamilSelvi,P.Chitrakala,A.AntonyJenitha"Face Recognition Based Attendance Marking System", IJCSMC, Vol. 3, Issue. 2, February 2014.
[3] "Fingerprint Based Attendance System Using Microcontroller and LabView" (Kumar Yadav, Singh, Pujari, Mishra, 2015).
[4] "RFID based Student Attendance System" (Hussain, Dugar, Deka, Hannan, 2014).
[5] https://medium.com/@ageitgey/machine-learning-is-fun-part-4-modern-face-recognition-with-deep-learning-c3cffc121d78

