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Advanced facial recognition attendance and behavioral feedback system

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ABSTRACT

Manually maintaining an attendance system can be tedious and time-consuming. A smart, automated way to manage attendance can be created using biometrics. Facial recognition is just one example. The problems of proxies and fake attendance can be solved with this system. This system also helps overcome time wasted in calling attendance the traditional way. The previous attendance system that relied on face recognition was flawed. Face occlusion meant that some faces went unnoticed. Therefore, our system helps overcome these issues, make the system more reliable and useful with various techniques like People Counter and Behaviour Analysis. The detection and recognition of faces are the two most important processes in this system. Following that, crosschecking the detected faces against the database of student faces can be done. This smart system will allow students to keep track of their attendance and records. It also helps institution get feedback about a class and helps save time on surveys and questionnaire.

Keywords: *Facial Recognition, SVM, Facial Emotion Recognition, CNN*

1. INTRODUCTION

Face Recognition is one of most effective biometric methods for identifying someone. It can also be used to track student attendance in education.There are many schools and colleges where thousands of students can receive their education. There are approximately ninety-to-100 students in every classroom. Every few days, a new institution opens. It can be difficult to keep track and record the attendance of so many students. It is tedious and time-consuming to take attendance in a class with so many students.We can therefore implement a system to automatically mark students' attendance through recognising their faces. The face recognition process is broken down into several steps. However, the most important steps are recognition of faces and detection of faces. First, each student will be given a photo of their face from the data pile. This image will then be compared with those in the area. The camera device will be set up in the classroom and can take the photo. This image will be used as input to the system. The image will be used to detect faces. A face recognition system will use an image as input to search a database for people who can be identified. Face recognition systems consist of four modules: detection, alignment, feature extract, and matching. Localization and normalisation (face detection) are the processing steps that precede face recognition (facial matching).

Here, we use the face Landmark Algorithm. Facial landmark detection is used to provide important prior information for face alignment problems such as head position estimation, facial emotion expression, and face modelling. A better facial landmark detection can provide stronger prior information and better performance for facial alignment problems. Facial landmark detection algorithms have advanced over the years since PCA was first introduced. The most critical factor in facial landmark detection's success is the face detection algorithm. They are sensitive to facial position, occlusion. Facial landmark algorithms are built on the facial detector that determines which facial bounding box detectors work best and then follows up with facial landmark detection results. This highlights the importance and value of initial detectors. We will discuss this in more detail later. Deep learning-based methods for landmark detection have one goal: to predict the locations of facial landmarks based on data with occlusion. To initiate facial landmark regression, we use Kazemi's TREE algorithm. This algorithm can be used with very small training data derived from the 2-stage object detection algorithm. It is quick and accurate.

Machine learning is used in disease classification and scientists are keen to develop such systems for easier tracking. Machine learning (ML), an Artificial Intelligence discipline, is a way to

solve real-world problems. It does this by "giving learning capabilities" to computers without any programming. Studying how computers absorb information in the same way as the human brain, machine learning was born.

Figure 1: Comparison of Face

The suggested system's goal is to create a face recognition-based attendance system that can detect unknown people using a threshold and save their photos. We chose Haar cascade face detection and the LBPH algorithm face recognition because of its robustness. It can withstand monotonic grayscale changes with ease. The system can even recognize and save photos from any student not already in the database.

The most common way to convey emotion is through facial expression. It is also the first method of detecting emotion between people in communication. Therefore, it plays an important role in emotion calculation. Psychologists have found that facial expression often works in conjunction with literary techniques to transmit emotional information. They have called this formula of emotion expression. This means that 55% of emotional expression can be attributed to facial expression. Deep learning is a common method in pattern recognition. Deep learning's multi-hidden layer structure is designed to create a complex network similar to the human brain in order to learn more abstract data properties. Recent expert studies have proven that deep learning can accurately identify facial features. Facial expression recognition is a combination of computer vision technology, pattern recognition technology and machine learning technology. It is used widely in public security, psychological lies detection, and other areas. For example, in the world of human-computer interaction facial expression can be used to command the computer more naturally and efficiently. Or the computer can provide a more human-oriented human service by identifying facial expression. In the security field, for example, the public security organ is able to detect lies by analysing facial expressions. This can help in the detection and prevention of future cases.

2. METHODOLOGIES

Face Recognition

Step 1: Find all Faces-The first step is the Face Recognition. The face detector was first developed by Michael Jones and Paul Viola in 2000.They used a simple camera that could detect a face. Now we have advance solution for it. By Histogram of Oriented Gradients (HOG) algorithm we are going to detect the faces that was invented in 2005.

We will use black and white to detect faces. This is because we don't need a colour image to detect faces. The following formula can be used to determine the magnitude and direction gradients.

$$g = \sqrt{g_x^2} + \sqrt{g_y^2}$$

$$\theta = arctan\frac{g_y}{g_x}$$

To calculate a HOGdescriptor, first we must calculate the horizontal and the vertical gradients. We then need to calculate our histogram of gradients. By filtering the image, you can achieve this easily.

Figure 2: Kernels

In our image we must look for every single pixel at time. After that we will look for the surrounding pixels for every single pixel. Then we will draw an arrow towards the dark side of the pixel.

If you look for every single pixel after the completion of the process you will get an image whose pixels are replaced by arrows.

Analysing pixels will show that the values of each pixel for dark and bright faces will differ. However, if you know the direction of the pixels, both bright and dark faces will be represented the same way. This makes it much easier to solve the problem.

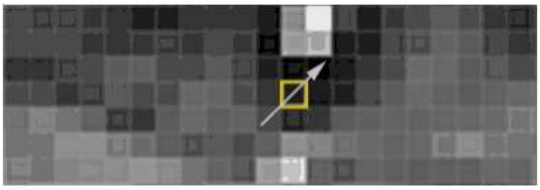

Figure 3: Pixel Comparison

Figure 4: Pixel Mapping

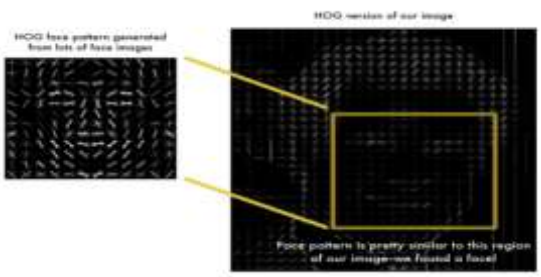

Figure 5: HOG version of Image

Step 2: Posing and Projecting Faces - Sometimes faces have different angles or directions. We need to be able to work with this. Each image will be wrapped so that the eyes are at the same spot as the lips. Face Landmark Estimation algorithm was

developed in 2014 by Vahid Kazemi, Josephine Sullivan. This algorithm will identify 68 landmarks for each face: the top and outer edges of each eye, as well as the inner edge of each eyebrow. These landmarks can then be trained with Machine Learning algorithm.

Figure 6: Encoding the Faces.

Step 3: Encoding Faces- Social media sites with billions ofusers and trillions of photos can't possibly loop through every previously-tagged face. It is possible to compare it with every new uploaded image. This is a tedious process. Recognition of faces should take onlymilliseconds, and not an hour.

To make it faster and more reliable we must take some basic measurements for each face that has been stored in the database. This allows us to measure unknown faces and locate the known faces using the closest measurements.

This researcher has discovered a method in which the computer can measure each face. Deep Learning Convolutional Neuro Network algorithm that will take 128 measurements of each face. The training process involves taking three images of each face at a time

- Train face of known person to be loaded.
- Different face of the known person to be loaded.
- An unknown person face to be loaded.

After millions of photos of thousands of people are used for training, the neural networks will be able to calculate the 128 measurements of every picture. This will ensure that every picture of the same person has the same measurements.

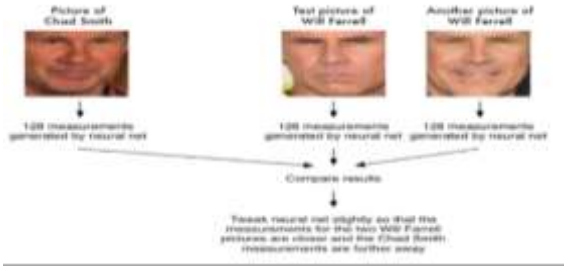

Figure 7: Comparison of Faces

Step 4: Find the name of person from the encoding- We are going to use simple **Machine Learning Classification** algorithm. There is no need of any deep learning algorithm for it. We will use the **Support Vector Machine (SVM),** classifier. The classifier must be tested for measurements on a new test picture. We will then determine the closest match. This classifier runs in milliseconds. The result is person's name.

Figure 8: Finding Faces from Database.

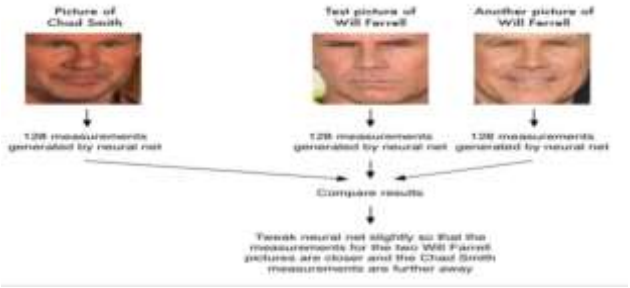

Figure 9: Comparison of Faces

Step 4: Finding the person's name from the encoding
We are going to use simple Machine Learning Classification algorithm. There is no need of any deep learning algorithm for it. We are going to use Support Vector Machine (SVM) classifier. We must test the classifier for the measurements of a new test image and will tell the closest match for it. Running this classifier takes milliseconds. Person name is the result for it.

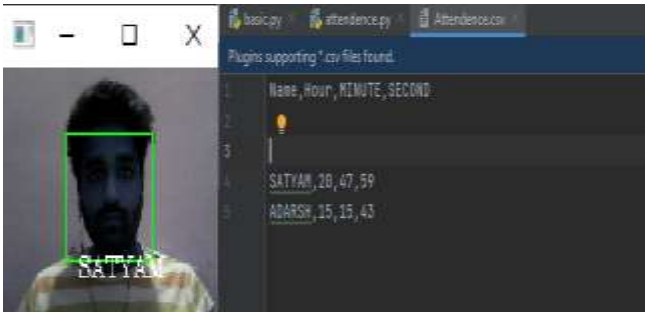

Figure 10: Attendance output

Table 1: Comparison of Faces

Method	No. of Images	Success Rate	Reference No.
Principal Component Analysis (PCA)	400	79.65%	5
Principal Component Analysis + Analysis Relevant Component Analysis	400	92.34%	5
Independent Component Analysis	40	Gauss Function 81.35%	8
Histogram of Oriented Gradients (HOG)	-	96%	8

Support Vector Machines	-	85-92.1%	10
Neural Networks	-	93.7%	11
Eigenfaces Method	70	92-100%	12
Eigenface with PCA method	-	92.30%	13

3. ALGORITHM FOR FACE RECOGNITION

Step 1: Get started.
Step 2: Register the student's information.
Step 3: Install a camera in the classroom.
Step 4: Enter the image captured by your camera.
Step 5: Image enhancement

- Convert to grayscale image
- Create a histogram from grayscale images
- Equalize the image.
- Create a histogram from equalized images.
- Eliminate noise from images
- Image classification based on skin

Step 6: Face Detection.
Image: Crop students' faces.
Select the region you are interested in.
Step 7: Face Recognition

- Compare the cropped images to face database images.
- Mark the attendance-on-attendance server.
- If you have any other faces, go to step 2.

Step 8: Finish.

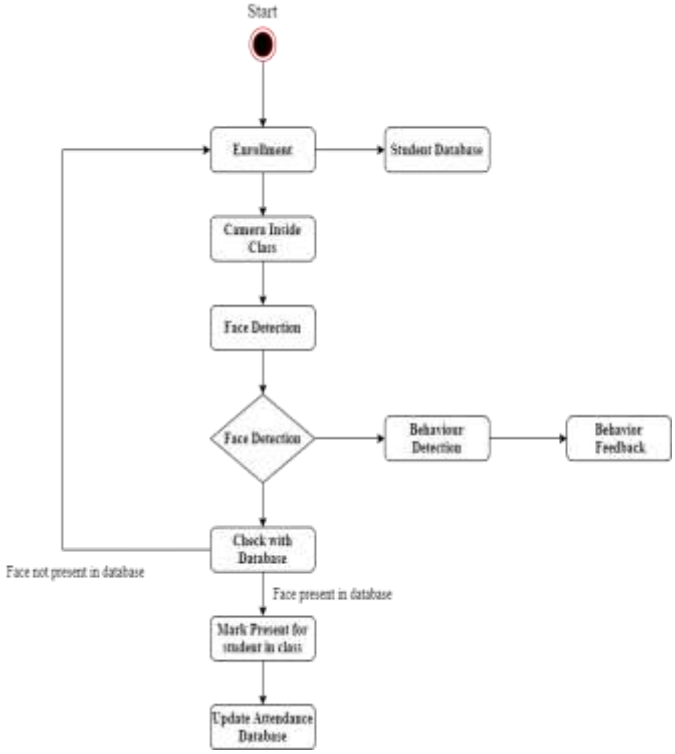

Figure 11: System Architecture for Face Recognition

4. BEHAVIOURAL ANALYSIS

Computer vision is a very important field in facial emotion recognition, also known as FER. It is constantly being improved and evaluated. It was created on the assumption that facial expressions can be used in order to detect emotions in people. Computer vision is advancing rapidly. These tasks are not difficult and can be achieved with very little effort. This is possible with very few lines of Python code.

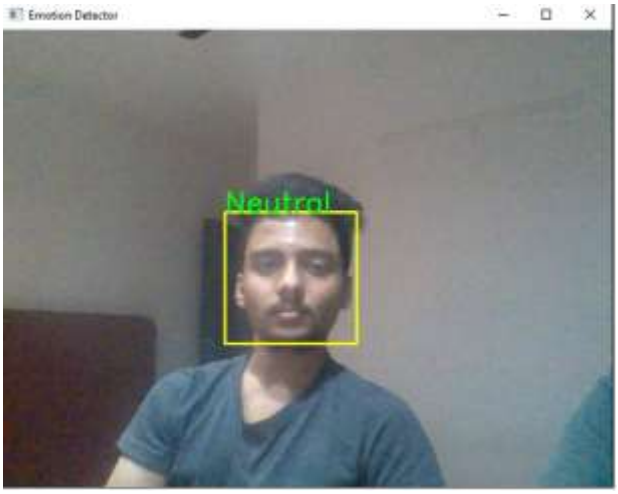

Figure 12: Emotion Detection

As we all know, adding intelligence to a computer is about making it learn data using an algorithm. We need DATA for this.Because our machine learning/deep learning projects are based on data, data is essential. After all, the model we train is only as good as the data it has been trained from. The more accurate the data is, the better the model will perform in real life.

We will need data to complete this FER task. This data will be used to train the model and then we'll test it on real-time video stream and with data left aside. Thisis an example of **Supervised learning**Problem i.e. The learned model is a function data.Equation 1 represents the equation for Supervised Learning.

$$y = f(x)$$

$$model = f(data)$$

Equation 1: Function of Supervised Learning

We will use the most popular data at kaggle for this task. Because it was only collected for this purpose, its name is the same as the task. Other datasets are also available. You can either create your own or use the ones that are already out there.

Figure 13: Dataset for Emotion Detection

We will use a Convolutional Neural Network (CNN) to accomplish this task. Then, we will feed batches of 48x48x1 Gray scaled images. It is necessary to convert data from existing data into this format. It will crash if it does not.

Figure 14: Multiple Behaviour Detection

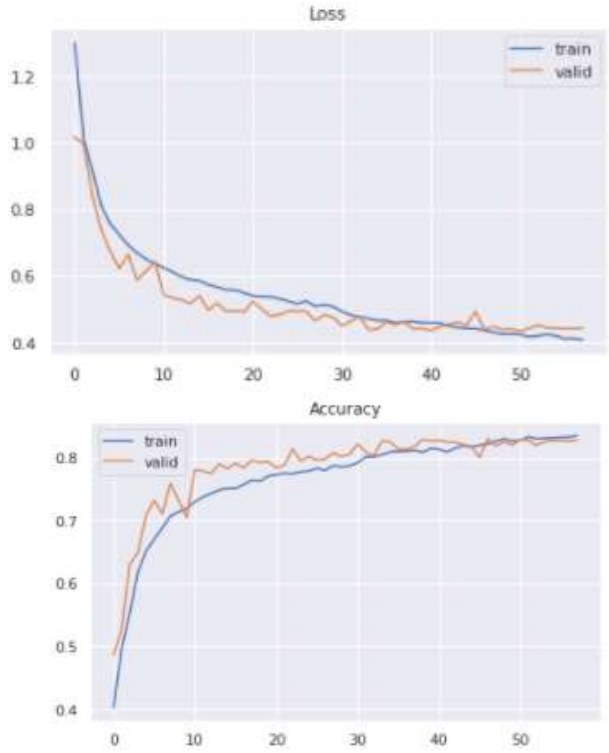

Figure 15: Accuracy Graphs

Figure 16: Confusion Matrix

The history of the epoch shows an increase in accuracy. It reached +83% accuracy after validation and training set. The model started over-fitting the training data towards the end, and it stopped automatically due to our early stopping. Reduce LR On Plateau is a tool that can be used to call for accuracy when it plateaus. We will now see what we called a**Confusion-matrix.**It is a popular evaluator for multi-class classification. It gives a clear picture of the model's performance across all classes. The confusion matrix clearly shows the model's performance in each class. However, it does not show its performance in other classes. These classes may have less data. When I looked at the images, however, I noticed that it was more difficult for humans to tell if someone is happy or sad. Different facial expressions can also be displayed by individuals. A happy face might look happier than one with a neutral expression.

It is important to test and use any model in the real world. This project was a long one. I tried many models and added more emotion classes. Finally, I integrated my model using **OpenCV.** It was tested on video and via a live stream from a webcam. I did this by feeding video**Frame by frame.** This model gives out excellent fps on an average GPU.

5. CONCLUSIONS

Smart and automated attendance systems have been shown to be effective in keeping track of student attendance in class. The likelihood of fraudulent attendance and proxies can be lowered by employing this technique. There are numerous Biometrics Systems that may be used to manage attendance, but face recognition has the best results. As a result, we must develop a dependable and efficient classroom attendance system that can handle numerous face recognitions at once and eliminates the danger of errors such as failing to recognise the face of any student by adding people counters. The smart attendance system can be built with just a camera device, a single PC, and database servers. The proposed method can produce the attendance that has a high accuracy of up to 98% and decrease error rates in detection with the help of people counter.

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