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ATTENDANCE MANAGEMENT SYSTEM USING FACE RECOGNITION

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Abstract:

Face recognition systems are essential in practically every industry in our digital age. Recognizing faces is one of the most popular biometrics. It has numerous more benefits in addition to being useful for security, authentication, and identity. Due to its non-invasive and contactless nature, fingerprint and iris recognition systems are still commonly employed despite their lower accuracy. Additionally, facial recognition systems can be utilized in businesses, colleges, schools, and other settings to indicate attendance. The goal of this system is to create a facial recognition-based class attendance system because the current manual approach requires a lot of time and effort to maintain and may lead to proxy attendance. The four stages of this method are face detection, face recognition, attendance updation. Database is created by the images of the students in class. Face detection and recognition is performed using Haar- Cascade classifier and Convolution Neural Network algorithms respectively. Faces are detected and recognized from live streaming video of the classroom. Attendance will be updated on the website after taking the attendance.

Keywords: Face Recognition; Face Detection; Haar-Cascade classifier; Convolution Neural Networks (CNNs) ; attendance system

I. INTRODUCTION

Face recognition-based attendance management systems utilize advanced facial recognition technology to accurately record and manage attendance in various settings, such as educational institutions, workplaces, and events. By analyzing unique facial features captured through cameras, these systems can quickly identify individuals and log their attendance without the need for manual input or physical contact, offering a seamless and efficient solution. This technology not only enhances accuracy but also provides real-time monitoring, ensuring better accountability and security. Additionally, it streamlines administrative tasks by automating attendance tracking processes, saving time and resources for organizations while promoting a more modern and convenient approach to attendance management.

The LBPH algorithm is a combination of Local Binary Pattern (LBP) and Histogram Oriented Gradients (HOG), which is used to change the performance of face recognition results to be more accurate. LBPH is famous for its performance and accuracy, which can recognize a person's face from both the front and the side said by the Andre Budimana in [1].

The algorithms like ViolaJones and Histogram of Oriented Gradients (HOG) features along with Support Vector Machine(SVM) classifier were used to implement the system. Various real time scenarios such as scaling, illumination, occlusions and pose was considered by the authors. Quantitative analysis was done on the basis of Peak Signal to Noise Ratio (PSNR) values and was implemented in MATLAB GUI said by the Hemant kumar Rathod in [2]. In

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[3] Radhika C. Damale said that we proposed a n Multi-Layer Perceptron, back-propagation method is used for training purpose which falls in a supervised learning class. In this, the output is compared with the actual or target output and a cost function is created which implies errors in the predictions. Our goal is to minimize the cost function. The input will be given to hidden units along with weights heading towards output. Then as stated earlier, output is compared with the target value and if we are not getting the desired output the cost function value is back propagated and the weights are adjusted accordingly.

In [4] Samuel Lukas said that we proposed a method for student attendance system in classroom using face recognition technique by combining Discrete Wavelet Transforms (DWT) and Discrete CosineTransform (DCT). These algorithms were used to extract the features of student's face followed by applying Radial Basis Function (RBF) for classifying the facial objects. This system achieved an accuracy rate of 55%.

In [5] Kennedy O. Okokpujie said that we have designed and implemented an attendance system which uses iris biometrics. Initially, the attendees were asked to register their details along with their unique iris template. At the time of attendance, the system automatically took class attendance by capturing the eye image of each attendee, recognizing their iris, and searching for a match in the created database.

A fingerprint recognition system is integrated into an existing university portal system to provide accurate and efficient attendance management. The existing portal system provides a platform for course, result/transcript, school fee campus accommodation and sport activities management as well as other related academic activities. The portal often serves the dual purpose of monitoring students' academic activities for staff (instructors, administrative and management) as well as planning and evaluation for students. The integration of a unique and accurate identification system into the existing portal system offers at least, two advantages: accurate and efficient analysis and reporting of student attendance on a continuous basis; and also facilitating the provision of personalized services, enhancing user experience altogether said by A. Badejo in [6].

There are several drawbacks associated with the above mention references. That is limited accuracy and precision. So, we can implement CNN based attendance management system using Face recognition for increasing accuracy and precision.

This paper is organized as follows. Section I presents the introduction. Section II presents The proposed methodology. Experimental Results is presented in Section III. Section IV provides the Conclusion

II PROPOSED METHODOLOGY

This section describes the proposed web-based application for Attendance Management System using face recognition by CNNs. The proposed system for Attendance Management System Using Face Recognition leverages deep learning techniques, specifically Haar-cascade classifier algorithm for detecting the faces and CNN algorithm for recognizing the faces and this algorithm is used in the training the dataset. The below Fig 1 shows the working flow of the project.

A convolutional neural network (CNN) is a network architecture for deep learning that learns directly from data. CNNs are particularly useful for finding patterns in images to recognize objects, classes, and categories. They can also be quite effective for classifying audio, time-series, and signal data.

A convolutional neural network can have tens or hundreds of layers that each learn to detect different features of an image. Filters are applied to each training image at different resolutions, and the output of each convolved image is used as the input to the next layer. The filters can start as very simple features, such as brightness and edges, and increase in complexity to features that uniquely define the object.

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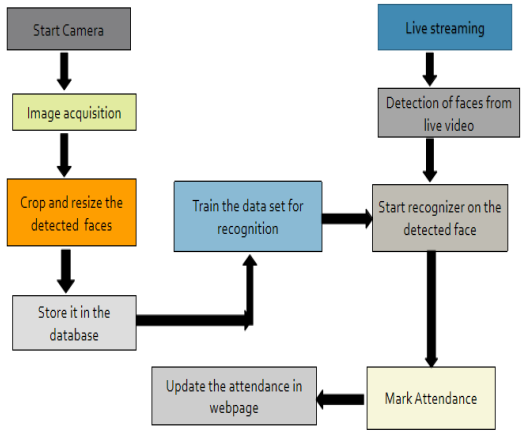

Fig 1 : Block diagram of the proposed methodology

The total system working on 10 stages. Student registration was done on the 1 st three stages. In the 1st block the web camera is opened on our system to take images of the students at the time of registration as shown in the Fig 2.

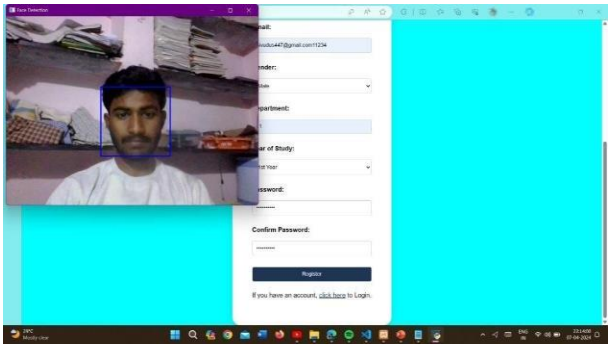

Fig 2 : Registration form

The second block is image acquisition. Image acquisition is the process of converting an analogue image into digital form. This usually happens in a camera or scanner, but it can be done with any device that produces analog images. Image acquisition is often used to create a digital representation of data from surveys and experiments, but it can be also used for other purposes such as printing pictures or other types of graphics[7]. The third block is Crop and resize the captured images. This block is very important to get 100% accuracy in the output. In this stage we are removing unwanted background noise and take only student faces for storing in the database. In the 4th block we are storing resized images in the database. It is very important stage for recognition process. We are using XAMPP server for database working. The next process is training the dataset for recognition purpose.

We are using CNN algorithm to train the data and taking main features in the face. The CNN algorithm is explained in the section. At the time of attendance taking we are comparing real images with the data set images. Up to now the whole process completed for taking the attendance. We are taking the student attendance from live streaming video. This process reduces the burden to the faculty. The next step is detect the faces in the live streaming video. To detect the faces we are using Haar-cascade classifier algorithm to identify the main features like eyes, nose and mouth. There are some xml files to identify these features. The xml files containing the different haar features. After that the real images are compare with the database values. Whenever match is found the attendance is marked on the webpage[8].

A. Haar cascade classifier for face detection

Face detection here is performed using Haar-Cascade Classifier with OpenCV. Haar Cascade algorithm needs to be trained to detect human faces before it can be used for face detection. This is called feature extraction.

The haar cascade training data used is an xml file- haarcascade_frontalface_default. The haar features shown in Fig.3. will be used for feature extraction.

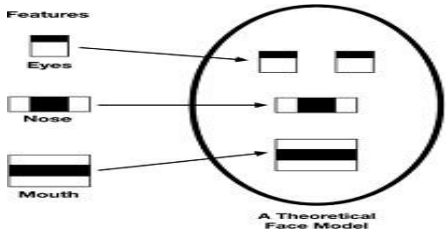

Fig 3. Haar Features

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Here we are using detectMultiScale module from OpenCV. This is required to create a rectangle around the faces in an image. It has got three parameters to consider- scaleFactor, minNeighbors, minSize. scaleFactor is used to indicate how much an image must be reduced in each image scale. minNeighbors specifies how many neighbors each candidate rectangle must have. Higher values usually detects less faces but detects high quality in image. minSize specifies the minimum object size[9].

B. CNN Algorithm for face recognition

There are many algorithms that can be used in the Image processing here we are using the CNN for the detection of the face images as we know that CNN is having the high accuracy rate than the other algorithms that makes this project unique. Classification with artificial neural networks is a very popular approach to solve pattern recognition problems. The output layer neurons amount is equal to the number of classifying classes. Thus, the output vector is the vector of probabilities showing the possibility that the input vector belongs to a corresponding class. Today, classifying with convolutional neural networks is the state of the art pattern recognition method in computer vision. Unlike traditional a neural network, which works with one-dimensional feature vectors, a convolutional neural network takes a two-dimensional image and consequentially processes it with convolutional layers. Each convolutional layer consists of a set of trainable filters and computes dot productions between these filters and layer input to obtain an activation map[10]. These filters are also known as kernels and allow detecting the same features in different locations. The activation function used is “ReLU”. ReLU is one of those non-linear activation functions that is used in multi-layer neural networks. The ReLU function is simple and less computationally expensivesince there are no complex mathematical calculations involved and thus makes the model learn and train faster. Our project using following structure as shown in the
Fig 4[11].

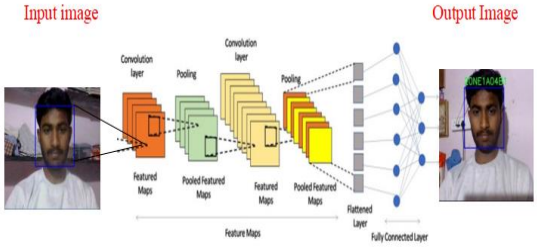

Fig 4 : CNN Architecture.

The CNN architecture contains the following three layers:

1. Convolution layer
2. Pooling layer
3. Fully connected layer

Convolution Layer:

The core block of CNN architecture is the convolutional layer. A set of kernals (or filter) can only receive a fraction of it, but spans the entire input depth Volume. Each filter is learnable and contained across the height and width of the input filter entry and entry. The first process creates a 2D feature map . Finally, the network learns from the activated filters while recognizing specific characteristics at the spatial position of the input full output of convolution a layer is formed by storing the activation maps of all filters along the depth dimension. A neuron's output is a small range of its input and the parameters are shared between neurons within the same activation map. There are three hyper parameters that control the size of the initial volume. Convolutional Layers: Depth, Stride, and Zero Padding. The depth of the output volume controls how many neurons in the layer connect to each other[12]. Same region of the input volume stride controls column depth mapping Enter spatial dimensions in terms of width and height. The valueof the the increment (S) must be greater than 0 and any integer. In practice, the length of S Usuallyless than 3. Output volume occurs due to less receptive field overlap the spatial dimension decreases while the stride length increases. Zero padding control spatial size of the initial volume. Equation is

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for calculating the number of neurons. Fits in a specific volume:

$$N = \frac{w-k+2p}{s} + 1$$

where W is the size of input volume. The kernel size of the convolutional layer neurons is denoted by K. The length of stride and the amount of zero-padding are represented by S and P, respectively.Generally, we set the zero-padding as

$$P = \frac{k-1}{z}$$

while s= 1, which make the input volume and output volume have the same spatial size.

Pooling Layer

Similarly, pooling layers serve to reduce the spatial size of convolutions special function. In addition to reducing computing consumption, It is used not only for dimensionality but also for extracting principal features. Also the pooling layer is there for convenience Set parameters and memory requirements to control overfitting that is It makes sense to pool layers across a set of convolutional layers (usually followed by a ReLU layer) in the CNN architecture[13]. There are two main types of pooling, including max pooling and average pooling. Max as the name suggests Pooling returns the maximum value from the portion of the image covered by the kernel. Average pooling returns the average of all values from the part of the image that the kernel covers. The most commonly used form of pooling is filter size. 2×2 step down and 2 sample step down. The depth of the volume is unchanged. The Max pooling mostly used than the average pooling.

Fully Connected Layer

In the fully connected layer, the neurons connect to all activations as seen in the regular neural networks. Generally, inserting a fully connected layer is a cheap way to capture the nonlinear combination of high-dimensional features as represented by the yield of CONV layer[14].

The architecture takes a color scale image with shape (200, 200, 3) and results the class label of the image as prediction. The total number of parameters of the CNN are 8,761,159 of which 8,761,157 are trainable and 2 are non trainable. The detailed description of the architecture is shown in Table-I

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 198, 198, 32)	896
max_pooling2d (MaxPooling2D)	(None, 99, 99, 32)	0
conv2d_1 (Conv2D)	(None, 97, 97, 64)	18,496
max_pooling2d_1 (MaxPooling2D)	(None, 48, 48, 64)	0
conv2d_2 (Conv2D)	(None, 46, 46, 128)	73,856
max_pooling2d_2 (MaxPooling2D)	(None, 23, 23, 128)	0
flatten (Flatten)	(None, 67712)	0
dense (Dense)	(None, 128)	8,667,264
dense_1 (Dense)	(None, 5)	645

Table I . Architecture of the proposed CNN

III . EXPERIMENTAL RESULTS

In this section, dataset and performance measures of the system for Attendance Management System Using Face Recognition are discussed. The performance metrics of model consist of accuracy, recall, F1-score and precision. These performance characteristics are evaluated based on the confusion matrix.Figure 5 shows the all the student images in the dataset for taking attendance.

Fig 5 . Dataset for face recognition

Collecting different facial expressions of 100 images from each studen as shown in Fig 6.

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All the images were collected in JPG format, with a fixed resolution of 1024×768. The images in this dataset are in RGB, where each color channel contains 8-bits per pixel. The images were captured at different dates and times. The below Table II shows the student details in the dataset. Based on the id we are taking the attendance[15]. The dataset contains student id, name, password for proctoring their profile, image path, phone number, email id, branch and date of registration.

S. No	Name of the student	Roll Number	Phone numbe r	Gender	Email Id
1.	Lahari	21NE5A0414	8374032632	Female	nerallalahari2003@gmail.com
2.	Samabasivudu	20NE1A04B1	9381984656	Male	sivudu447@gmail.com
3.	Priyanka	21NE5A0408	7891953989	Female	korivipriyanka1@gmail.com
4.	Vijay raju	20NE1A0478	9866863353	Male	Vijayraju755@gmail.com
5.	Durvasulu	20NE1A0475	9346658176	Male	katepallidurvasulu@gmail.com

Table II. Student details dataset

The performance of any classification model can be evaluated with the help following measures:

- Accuracy
- Recall
- Precision
- F1-score

To evaluate the performance characteristic confusion matrix model was chosen..

Accuracy - Accuracy is one metric for evaluating classification models. Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observation to the total observations.

Recall (Sensitivity) - Recall is the ratio of correctly predicted positive observations to all observations in actual class .

F1 Score- The F1 score is the harmonic mean of precision and recall taking both metrics into the account

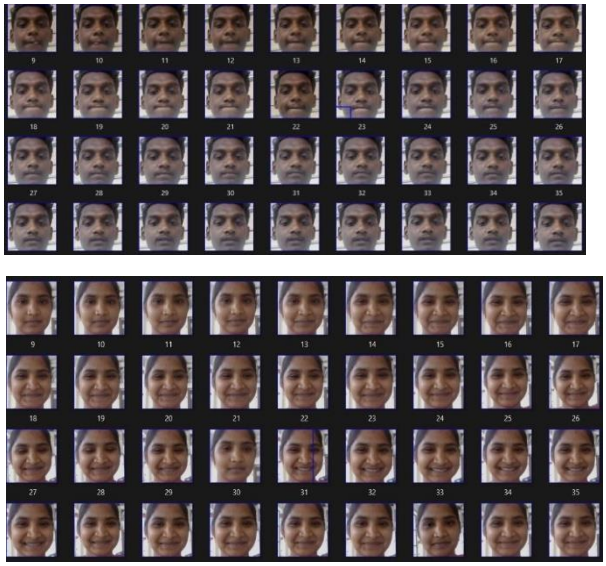
Precision – it is the ratio of correctly predicted positive observations of the total predicted positive observations.

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}} \quad (1)$$

$$\text{Recall} = \frac{\text{True postive(TP)}}{\text{True postive(TP)+False Negative(FN)}} \quad (2)$$

$$\text{F1 score} = 2*((precision * recall)/ (\text{precision + recall})) \quad (3)$$

$$\text{Precision} = \frac{\text{True postive(TP)}}{\text{True positive(TP)+False positive(FP)}}$$



(4)

The below images show the predicted output and representing the person by their faceId when face is detected in the live streaming video.

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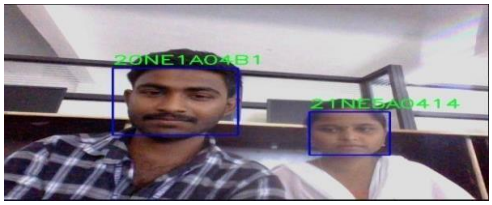

After the face is recognized from the live streaming video the Attendance will be updated on website to their label as shown in the Fig 7.

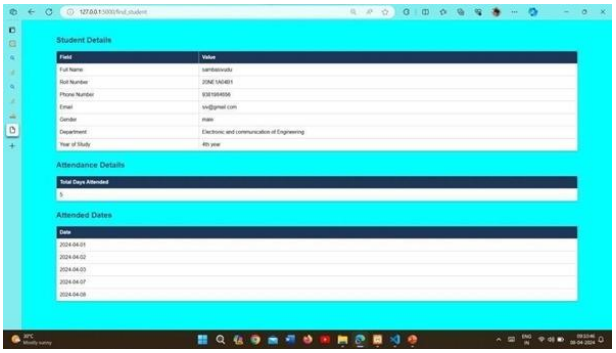

Fig 7 : Upadated Attendance in the website

The overall analysis of the attendance management system using different Algorithms shown in the Table III

Algorithms	Accuracy	Precision	Recall	F1SCORE
LBPH	0.60	0.50	0.72	0.68
SVM	0.75	0.68	0.79	0.78
MLP	0.82	0.72	0.84	0.82
CNN	0.92	0.91	0.99	0.90

Table III. Overall Analysis

From this table it is observed that CNN algorithm achieved the highest accuracy(0.92), precision(0.91), recall(0.99), F1 score(0.90), indicating superior performance in recognizing faces accurately. MLP also showed strong results, especially in F1 score (0.82). The LBPH has very less in all the metrics.

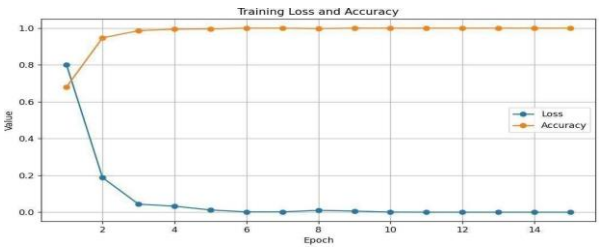

Fig. 8: Increase of accuracy w.r.t #epochs , Decrease of loss w.r.t #epoch

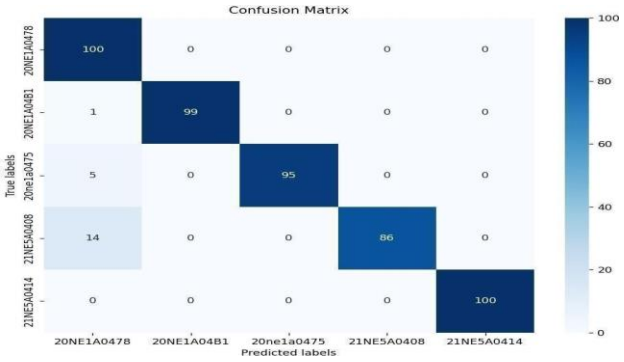

Fig 9: Confusion matrix

IV CONCLUSION

This system proposed a Attendance Management System using Face Recognition using Deep Learning Algorithms. The experimental results show that the CNN Algorithm is the best Algorithm for the Face Recognition when compared to other models in terms of all the performance measures like accuracy, sensitivity,precision, F1-score. Through rigorousexperimentation and testing, we achieved impressive accuracy rates of 92 percent. The success of our project underscores the

effectiveness and potential impact of leveraging deep learning models for attendance management applications. The LBPH, SVM, MLP and CNN achieves the testing accuracy of 60%, 75%, 82% and 92% respectively to our project. Face recognition with CNNs typically offers higher accuracy than traditional ML algorithms due to their ability to automatically extract complex features. However, CNNs are more computationally complex and require more data for training. Both CNNs and CV algorithms are optimized for real-time processing, making them suitable for attendance management systems. ML algorithms might be less suitable for real-time applications due to their slower processing speeds. In the future, this deep learning model will test our approach on bigger data sets. Moreover, these models can use in large companies, factories, schools, colleges for taking attendance with a best accuracy. We should try to increase the accuracy of this system by using best quality cameras in future. Also faces of more number of persons in different environments can be used for classification to increase accuracy.

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