Design of face detection and recognition system to monitor students during online examinations using Machine Learning algorithms

M.Geetha[1]
Department of CSE
Kongu Engineering College,
Erode, Tamilnadu, India
geetha@kongu.ac.in

R.S.Latha[2]
Department of CSE
Kongu Engineering College,
Erode, Tamilnadu, India
latha@kongu.ac.in

S.K.Nivetha[3]
Department of CSE
Kongu Engineering College,
Erode, Tamilnadu, India
nivetha@kongu.ac.in

S.Hariprasath[4]
Department of CSE
Kongu Engineering College,
Erode, Tamilnadu, India
hariprasanth903@gmail.com

S.Gowtham[5]
Department of CSE
Kongu Engineering College,
Erode, Tamilnadu, India
deepakhqrshi18@gmail.com

C.S.Deepak[6]
Department of CSE
Kongu Engineering College,
Erode, Tamilnadu, India
begowtham.cse@gmail.com

2021 International Conference on Computer Communication and Informatics (ICCCI) | 978-1-7281-5875-4/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICCCI50826.2021.9402553

Abstract— **Today's pandemic situation has transformed the way of educating a student. Education is undertaken remotely through online platforms. In addition to the way the online course contents and online teaching, it has also changed the way of assessments. In online education, monitoring the attendance of the students is very important as the presence of students is part of a good assessment for teaching and learning. Educational institutions have adopting online examination portals for the assessments of the students. These portals make use of face recognition techniques to monitor the activities of the students and identify the malpractice done by them. This is done by capturing the students' activities through a web camera and analyzing their gestures and postures. Image processing algorithms are widely used in the literature to perform face recognition. Despite the progress made to improve the performance of face detection systems, there are issues such as variations in human facial appearance like varying lighting condition, noise in face images, scale, pose etc., that blocks the progress to reach human level accuracy. The aim of this study is to increase the accuracy of the existing face recognition systems by making use of SVM and Eigenface algorithms. In this project, an approach similar to Eigenface is used for extracting facial features through facial vectors and the datasets are trained using Support Vector Machine (SVM) algorithm to perform face classification and detection. This ensures that the face recognition can be faster and be used for online exam monitoring.**

Keywords- Face detection; face recognition; online test portal; image processing; Support Vector Machine; Eigenfaces.

I. INTRODUCTION

In our education system, exams play a major role in assessing and evaluating a student's knowledge. Exams, tests, and marks are some of the important aspects employed by educational institutions to evaluate the performance of the students. Most of the exams have strict set of rules and procedures that the student has to follow in order to write the examinations. These rules ensure that the students write their examinations in a proper manner and also to make sure that there is no cheating and malpractice in the examinations. Educational institutions are very much capable of conducting examinations and monitoring the students effectively.

In today's pandemic situation, it is impossible to conduct offline examinations. Hence, educational institutions are adapting to online classes and online examinations. Online classes and online examinations are the only possible practices in the current situation. Monitoring students during online classes and examinations becomes a difficult process. This problem can be solved by using effective face recognition systems.

A. Face Recognition

Face recognition [1-3] is one of the most successful applications of image analysis, which has recently gained significance in surveillance and security applications. It is the process of verifying the identity of a person using his/her face. It captures, analyzes, and compares the patterns based on the person's facial details such as eyes, nose, mouth and chin. It is used to provide authenticated and authorized access to a system or service. It is a biometric identification system which makes use of the biometric patterns from a human face.

B. Working of Face Recognition Systems

A face recognition system captures an incoming image from a camera device in a two-dimensional or three-dimensional way depending on the characteristics of the device [4]. It then compares the relevant information of the incoming image signal in a real-time image or video frame with the faces in a database. Obtaining this kind of dynamic information in real-time is trustworthy and secure than the information obtained in a static image. Biometrics is a widely used technique in face recognition, which maps the facial feature that are present in a still image or video frames. Face verification is a process of one-to-one mapping between one face and the other, which is

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used to identify the right person [6]. Biometrics [5] is method that is used to measure and analyze the unique physical and behavioral characteristics of a person. Existing biometric systems include facial recognition, fingerprinting, handwriting, hand geometry, iris, vein, sound scan and retina. Biometrics has been widely used to increase the security and provide improved personal privacy and human comfort.

II. LITERATURE REVIEW

A face recognition system using Eigenface method was proposed by Dhavalsinh [7] to monitor the attendance of the students, where the face acts as the main index. Eigenface is a set of eigenvectors used in face recognition and detection. it is used to determine the variation among multiple faces by performing a statistical analysis on the facial images. Sirovich and Kirby designed the Eigenfaces approach to do facial recognition and the same was used by Matthew Turk and Alex Pentland for face classification. Kranthikiran and Pulicherla [8] made use of Eigenfaces and Principal Component Analysis (PCA) to perform face detection for campus surveillance.

Continuous face biometric recognition has been used by Fayyoumi and Zarrad [9] in developing a prototype for conducting online examinations. The prototype has been evaluated by obtaining feedbacks from different experts through a survey using a five-point Likert scale. The proposed system contains a question bank to assist the instructors in generating different tests randomly. Kamencay et al. [10] suggested a face recognition system using Convolutional Neural Network (CNN). The authors used OLR dataset comprising 400 diverse entities (40 categories/10 images for every category) to carry out the experiments and validate their results. The detection accuracy of the suggested method has been compared with the three popular image recognition approaches like PCA, Local Binary Patterns Histograms (LBPH) and KNN. In comparison with these methods, the proposed CNN-based method performs better by achieving an identification accuracy of about 98.3%.

Traoré et al. [11] used a multimodal biometric framework to authenticate the participants in online examinations. The framework consists of three modalities such as mouse dynamics, keystroke dynamics, and face biometrics to check the authenticity. This framework has been included as a module in ExamShield which is an online exam monitoring tool. Continuous face biometric recognition has been used by Fayyoumi and Zarrad in developing a prototype for conducting online examinations. The prototype has been evaluated by obtaining feedbacks from different experts through a survey using a five-point Likert scale. The proposed system contains a question bank to assist the instructors in generating different tests randomly.

Zhu et al. [12] addressed various challenges in face detection systems by developing a novel approach namely Contextual Multi-Scale Region-based Convolution Neural Network (CMS-RCNN) which consists of two components: 1) region proposal component and) the region-of-interest (RoI) detection component. The proposed system deals with tiny face regions by grouping multi-scale information in both the components and also allows explicit body contextual reasoning.

Zehenguo Yuan [13] addresses the facial occlusion and improved the detection accuracy by developing a visual attention guidance model that guides in highlighting the visible area in an occluded face. This model avoids setting the additional parameters by using an activation map that predicts the location and scale of the face

The above methods are the ones that are currently available for face recognition. But there is a need for a faster and reliable method that could be used for monitoring the students during their examinations. In this project, an approach similar to Eigenface is used for extracting facial features through facial vectors and the datasets are trained using an Support Vector Machine (SVM) model which is one of the popular machine learning algorithms. This ensures that the face recognition can be faster and can be easily used.

III. PROPOSED SYSTEM

Educational institutions conduct online exams for a large number of people and it is difficult to monitor the students manually. The proposed system focuses on designing a suitable face detection and recognition model for monitoring the students during online examinations. Here, Eigenface method is used for extracting the facial features through facial vectors and the datasets are trained using an SVM model to improve the detection accuracy. The flow diagram for the proposed system is given in Figure 1.At first, the vector values are extracted from the images in the dataset. The extracted embeddings are then passed to the SVM classifier to train it for recognizing the faces from the input images or video frames.

A. Modules Description

The modules identified and implemented in the proposed system are listed below:

1. Extracting embeddings from the images
2. Training the SVM model
3. Recognizing faces from static images and video frames

1) Extracting Embeddings from Images: In this module, the feature vectors are extracted from the images. The 128 D feature vectors are called as embeddings. A Caffe based DL face detector has been used to locate faces in an image. This module makes use of Pytorch based embedder to extract the embeddings from the images in the dataset. The extracted embeddings are then stored in a pickle file in an encoded format.

2) Training the SVM Model: The extracted 128-D embeddings from the previous step each face. But to recognize different faces, we need to train a “standard” machine learning model (such as an SVM, k-NN classifier, Random Forest, etc.) on top of the embeddings.

Support Vector Machine is a well known machine learning algorithm that has been used to provide solutions to classification and regression problems. The main objective of SVM is to classify the input data points distinctly by identifying a hyperplane in an N-dimensional space. The hyperplane is the maximum margin which is the maximum distance between the data points of the classes. The data points that are closer to the hyperplane are called as support vectors which aid in maximizing the distance from the hyperlane to the data points in the classes. This maximization is done with the help of a loss function known as hinge loss which is given in Equation (1). This hinge loss function trains the SVM classifier to maximize the above said distance.

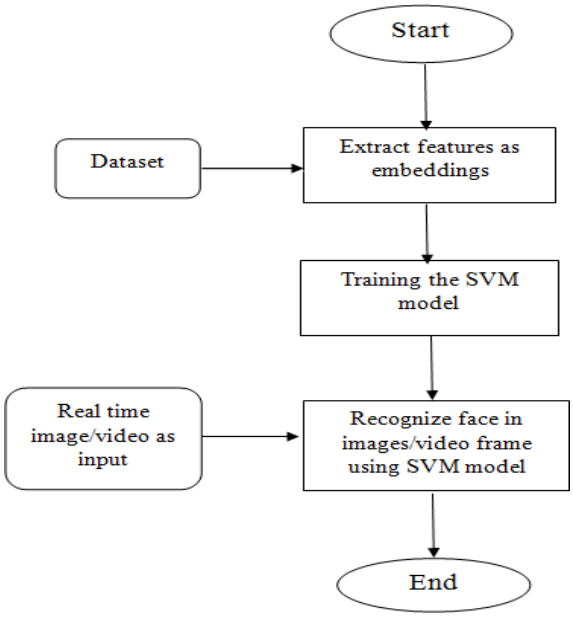


Figure 1. Flowchart for proposed system

$$l(y) = \max(0, 1 - y_i f(x_i)) \quad \text{- (1)}$$

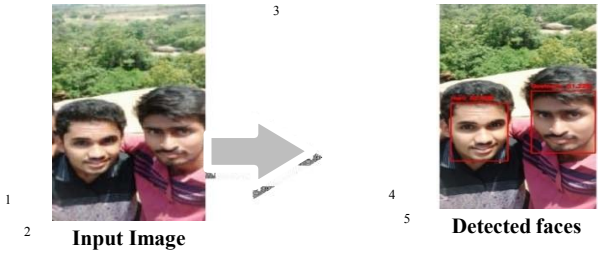
where $f(x) = w^T x_i + b$, where w^T the weight vector and 'b' is the bias.

In this module, the SVM model is trained with the face embeddings that are extracted from the input images in the dataset. Whenever a new image or a video frame is encountered by the SVM classifier, it makes use of the knowledge obtained through the training to recognize the face in the input image. Thus the SVM classifier is trained to recognize the students' face during their online classes and examinations.

3) Recognizing Faces from Static Images and Video Frames: We follow the same process of extracting embeddings from the real time input image. We use the trained SVM model and use it to recognise the faces and compare them and identify them. The accuracy of the face values is obtained by comparing the vectors using triplet lost function.

The input and output image differences are shown in the following Figure 2. The faces are detected and a square is drawn around the face boundary.

Figure 2. Image Comparison and Detection



IV. RESULT AND DISCUSSION

A. Dataset Description

The dataset used here consists of images of the our own students. Figure 3 depicts the sample images available in the dataset. Efficiency of this training model depends on the number of images present in the dataset.

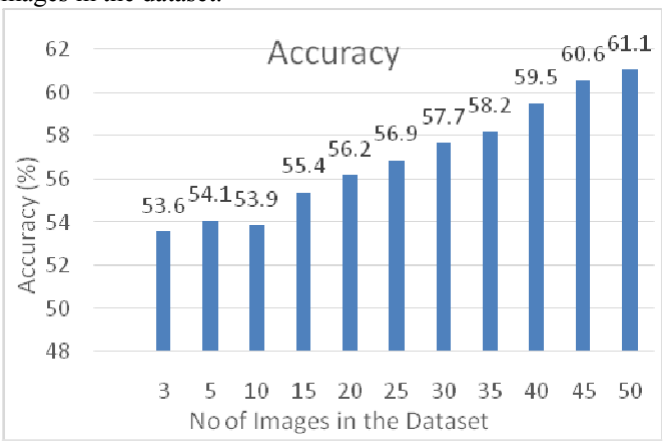
Figure. 3. Sample Dataset

B. Result Analysis

Mostly, the efficiency of any face recognition algorithm is measured by the accuracy of match. Accuracy is calculated by the ability of the algorithm to recognize the facial input and display the percentage of match. It is important that the algorithm should display the closest percentage of match. The proposed SVM-based face recognition system achieves a matching accuracy of about 61% with 50 real-time images in the dataset. Accuracy can further be improved by increasing the number of images in the dataset. The important parameters for evaluation are facial vectors, light intensity, pixel quality etc. This method is faster and less time consuming, hence can be easily implemented for student monitoring during examinations.

The efficiency of this method increases with the increase in the number of faces (i.e. dataset). Figure 4 presents

the obtained matching accuracy by varying the number of images in the dataset.



Fig, 4. No. of Images vs Accuracy

V. CONCLUSION AND FUTURE WORK

A machine learning based face detection and recognition system using SVM model is proposed to detect the faces of students for monitoring their activities during online examinations. The proposed system aids in detecting the faces in a faster manner by obtaining feature vectors from the input images. Several algorithms such as LBPH, Fisher faces, SIFT and SURF can also be applied along with this method to build more efficient recognition models that can detect faces in varying illuminations and light intensities. Still better optimal values can also be obtained by applying different algorithms. Higher accuracy can be obtained using convolutional neural networks.

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