Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 10, October : 2023

FACE DETECTION SYSTEM WITH FACE RECOGNITION USING MACHINELEARNING AND DEEP LEARNING

Peethala Chitra Harsha

M. Tech

Department of Computer Science and System Engineering

Andhra University College of Engineering

Visakhapatnam-530003

Abstract: The face is one of the easiest ways to distinguish the individual identity of each other. Face recognition is a personal identification system that uses personal characteristics of a person to identify the person's identity. Human face recognition procedure basically consists of two phases, namely face detection, where this process takes place very rapidly in humans, except under conditions where the object is located at a short distance away, the next is the introduction, which recognize a face as individuals. The stage is then replicated and developed as a model for facial image recognition (face recognition) is one of the much-studied bio-metrics technologies and developed by experts. Eigen face is a method that is currently popular in the development of face recognition pattern. Eigen face method is based on the reduction of face-dimensional space using Principal Component Analysis (PCA) for facial features. The main purpose of the use of PCA on face recognition using Eigen faces was formed (face space) by finding the eigenvector corresponding to the largest Eigen value of the face image. In this study, we evaluate the face recognition systems based on machine learning and deep learning algorithms (SVM, Logistic regression, Linear Discriminant Analysis and CNN) and Principal Component Analysis (PCA) for feature extraction. Here, the input images are obtained from Olivetti faces database. The area of this project is to finding the accuracy between machine learning and deep learning algorithm. The software requirement for this project is python software.

Keywords: Face detection, Eigen face, Face recognition, machine learning, Deep learning, Principal Component Analysis (PCA).

INTRODUCTION: Face recognition is the task of identifying an already detected object as a known or unknown face. Often the problem of face recognition is confused with the problem of face detection Face Recognition on the other hand is to decide if the "face" is someone known, or unknown, using for this purpose a database of faces in order to validate this input face. There are two predominant approaches to the face recognition problem: Geometric (feature based) and photometric (view based). Face recognition, as a biometric technology, is vital for security and authentication in numerous sectors, including finance, healthcare, law enforcement, and access control systems. Therefore, evaluating the performance of machine learning classifiers and deep learning algorithms in the context of face recognition is of paramount importance. This project aims to explore and analyze the effectiveness of several popular algorithms, including Support Vector Machines (SVM), Logistic Regression, Linear Discriminant Analysis, and Convolutional Neural Networks (CNN), in the realm of facial recognition. The face recognition process consists of two main steps is feature extraction and classification. The initial stage recognizes faces by calculating facial characteristics such as nose size, brow width, and forehead area. Face images can take much time to identify because they have substantial pixel sizes; hence, a dimensional reduction is required, usually accomplished by a feature selection or feature extraction process. Feature extraction aims to convert face space into feature space. One of the feature extraction processes uses Principal Component Analysis (PCA) in face recognition. PCA is probably the most popular multivariate statistical technique used by almost all disciplines. The next step, i.e., classification, aims to predict the class to which the input belongs, in other words, to identify the person. Face detection is a computer vision technique used to identify and locate human faces with in images or video frames. It plays a crucial role in facial recognition. Face detection typically involve analyzing pixel patterns and features to detect the presence and position of faces in a given visual input. Machine learning algorithms enable the computer to automatically learn and improve its performance over time by analyzing large datasets of labeled faces. These algorithms extract facial features and patterns, such as the shape of the eyes, nose, and mouth, and compare them to a database of known faces for identification. The process of face recognition involves multiple steps, including face detection to locate and extract faces from images. Deep learning models like Convolutional Neural Networks (CNNs) are commonly used to extract and process facial features for accurate recognition. Ethical concerns regarding privacy and data protection are critical considerations in

face recognition systems.

Literature survey: The literature survey on "Face Detection with Face Recognition Using Machine Learning and Deep Learning" reveals a growing body of research in computer vision and facial analysis. Numerous studies emphasize the significance of this topic in various domains, including security, human-computer interaction, and healthcare. Notable contributions include the Viola-Jones algorithm for face detection and the development of deep learning-based models like Convolutional Neural Networks (CNNs) and Siamese Networks for accurate face recognition. Recent advancements in deep learning, such as the introduction of attention mechanisms and one-shot learning techniques, have further improved the accuracy and robustness of face recognition systems. However, challenges persist, such as handling pose variations, occlusions, and privacy concerns, which have spurred research in privacy-preserving face recognition and multi-modal approaches. As the field evolves, interdisciplinary collaborations and ethical considerations remain essential for the responsible deployment of these technologies. Overall, the literature survey underscores the continuous progress and significance of face detection and recognition using machine learning and deep learning methods. A computer programme called face detection locates and measures a human face in any given (digital) image. Any other items in the digital image, such as trees, buildings, bodies, etc., are ignored in favour Finding the locations and dimensions of a known number of faces—typically one—is the task of face localization. In essence, there are two different approaches—the feature-based approach and the picture-based method—to identifying facial features in a given image. The feature base technique seeks to extract features from the image and compare them to the features of the face. While, the image-based approach seeks to match training and testing images as closely as possible. The literature review on face recognition using deep learning and machine learning techniques highlights the important developments and continuing research in this area. Convolutional Neural Networks (CNNs), which have demonstrated extraordinary success in extracting discriminative characteristics from facial photos, have attracted the attention of researchers in deep learning approaches. In order to increase model resilience, studies into data augmentation procedures and domain adaption approaches have been sparked by the literature's emphasis on the difficulties of occlusions, fluctuations in position, illumination, and expression. Additionally, there is a growing focus on ethical issues and privacy worries related to facial recognition, which has sparked discussions about fairness, bias, and rules for the use of such systems.

Methodology:

The face recognition system design determines whether the existing data is the same as the dataset on labels from 0- 39 obtained from the Olivetti faces database. The most optimal parameters were previously determined by feature extraction using PCA to the input image.

The proposed methodology outlines the steps involved in face regonition system as follows

The first step is to import the Olivetti faces dataset fromsklearn. The followed steps are:

1. **Data Preprocessing**: collecting ten variations of faces, separating training and testing data

with a ratio of 80:20. In total, there were 320 training samples and 80 test samples.

2. **Dimension Reduction:** The dimension reduction stage must go through feature extraction with PCA..

3. **Feature extraction with PCA**: finding the most optimal number of components with a data variance percentage ofmore than 90% while maintaining data authenticity.
4. **Extracted features**: the extracted features will be inputtedto each classifier used.
5. **Setting parameters of classifiers**: each classifier was assigned to the above parameter setting. The classifiers are SVM , Logistic regression,and CNN. The SVM and Logistic Regression classifier use the sci-kit- learn library, except CNN, which uses the Keras library.
6. **Training models and evaluation**: the next stage is to traineach classifier to fit the training data.
7. **Testing and evaluating the testing model performance**: these steps aim to test and evaluate the generated models using different face identities with 40 classes for everyone in the dataset.

Principal Component Analysis (PCA): PCA is a dimensionality reduction technique that identifies the most important patterns in data and transforms it into a lower-dimensional space, retaining as much variance as possible, useful for data compression and noise reduction. In face recognition, Principal Component Analysis (PCA) reduces the dimensionality of facial features, capturing essential facial variations, making it easier to compare and recognize faces while reducing computational complexity.

In the context of face recognition, PCA is applied to a dataset of face images. The result of applying PCA to this dataset produces a set of eigenvectors, which are known as Eigenfaces. These Eigenfaces represent the most significant patterns or features present in the face images.

The following are the machine learning and deep learning algorithms:

SVM : The Support Vector Machine (SVM) is a machine learning technique employed for tasks such as classifying and performing regression analysis. This algorithm is robust and versatile, suitable for addressing classification challenges in both linear and non- linear datasets. In SVM, the fundamental concept involves discovering the ideal hyperplane that effectively distinguishes between different data classes. The optimal hyperplane is the one that maximizes the margin, which is the distance between the nearest data points belonging to different classes. The data points nearest to the hyperplane are referred to as support vectors, and they are the sole data points that influence the positioning of the hyperplane. SVM operates by converting the input data into a feature space with a higher dimensionality, making it more convenient to locate a hyperplane that can effectively separate the classes. Subsequently, the algorithm identifies the optimal hyperplane by minimizing the error rate while simultaneously maximizing the margin. When dealing with non-linear data,

Logistic Regression: Logistic Regression is a binary classification algorithm commonly used for face recognition. In this application, it starts by extracting relevant features from facial images, such as pixel values or deep learning embeddings. These features are used to train the logistic regression model on a labeled dataset, where each face is assigned a binary label, typically 1 for

recognized faces and 0 for unrecognized ones. During prediction, the model calculates a probability score representing the likelihood of a given face belonging to the "recognized" class. A threshold is applied to this score to make a binary decision, determining whether the face is recognized or not. The model's performance is then assessed using various evaluation metrics like

accuracy, precision, recall, F1-score, and ROC-AUC to gauge its effectiveness in correctly recognizing faces.

Linear Discriminant analysis: LDA is a supervised learning algorithm used for classification tasks in machine learning. It is a technique used to find a linear combination of features that best seperates the classes in a dataset.

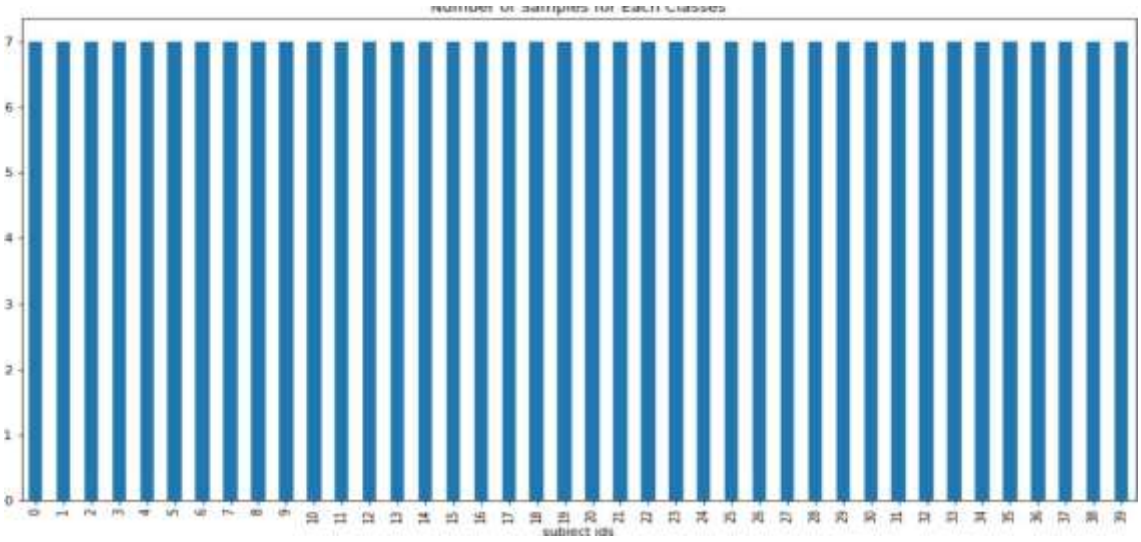
LDA, or Linear Discriminant Analysis, is a dimensionality reduction and classification technique in machine learning and statistics. It aims to find a lower-dimensional representation of data while maximizing the separation between different classes. LDA is commonly used for pattern recognition, feature extraction, and classification tasks, particularly in scenarios where there are multiple classes to distinguish. It operates by computing linear combinations of features that best discriminate between classes, making it valuable in various applications, including image and speech recognition, medical diagnosis, and more.

Convolutional Neural Network (CNN): It is a type of artificial neural network designed specifically for processing structured grid data, such as images and videos. CNNs are particularly well-suited for computer vision tasks, where they excel at tasks like image classification, object detection, facial recognition, and more. The key feature of CNNs is their use of convolutional layers, which apply convolution operations to input data using a set of learnable filters or kernels. These layers are capable of automatically learning and detecting various patterns and features within the input data. CNNs also typically include other components like activation functions (e.g., ReLU), pooling layers, fully connected layers, and output layers, making them capable of handling complex hierarchical feature extraction tasks.

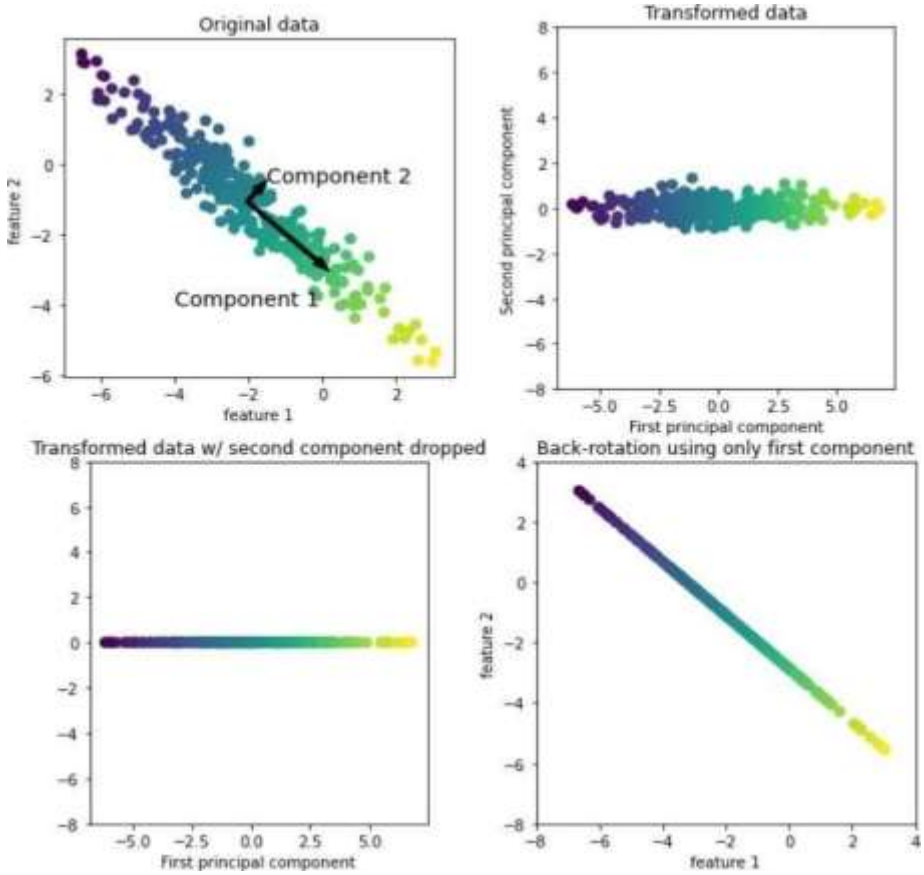
RESULTS

Fig: sample images of Olivetti dataset

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 10, October : 2023



number of samples of each class



The above illustration shows a simple example on a synthetic two-dimensional data set. The first drawing shows the original data points colored to distinguish points. The algorithm first proceeds by finding the direction of the maximum

variance labeled "Component 1". This refers to the direction in which most of the data is associated, or in other words, the properties that are most related to each other.

eigen faces

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 10, October : 2023

11	1.00	1.00	1.00	3
12	1.00	0.67	0.80	3
13	1.00	1.00	1.00	3
14	1.00	1.00	1.00	3
15	0.75	1.00	0.86	3
16	1.00	1.00	1.00	3
17	1.00	1.00	1.00	3
18	1.00	1.00	1.00	3
19	1.00	1.00	1.00	3
20	0.60	1.00	0.75	3
21	1.00	0.67	0.80	3
22	1.00	1.00	1.00	3
23	1.00	1.00	1.00	3
24	1.00	1.00	1.00	3
25	1.00	0.67	0.80	3
26	1.00	1.00	1.00	3
27	1.00	1.00	1.00	3
28	1.00	1.00	1.00	3
29	1.00	1.00	1.00	3
30	1.00	1.00	1.00	3
31	1.00	0.67	0.80	3
32	1.00	1.00	1.00	3
33	1.00	1.00	1.00	3
34	1.00	1.00	1.00	3
35	1.00	1.00	1.00	3
36	1.00	1.00	1.00	3
37	1.00	1.00	1.00	3
38	0.75	1.00	0.86	3
39	0.50	1.00	0.67	3
accuracy			0.92	120
macro avg	0.94	0.92	0.92	120
weighted avg	0.94	0.92	0.92	120

accuracy using PCA

```
========== LDA RESULT ==========
Accuracy score:0.93

========== LR RESULT ==========
Accuracy score:0.93

========== SVM RESULT ==========
Accuracy score:0.92
```

Accuracy for LDA,LR and SVM

```
5/5 [==============================] - 1s 208ms/step
5/5 [==============================] - 1s 193ms/step
array([[9.9175948e-01, 7.1128964e-04, 6.1305798e-07, ..., 6.6540029e-05,
        4.7684759e-03, 3.5416167e-07],
       [9.9192727e-01, 6.4029708e-05, 1.4818320e-07, ..., 4.4542237e-05,
        3.0147596e-04, 4.4973788e-08],
       [9.6138102e-01, 5.0184150e-05, 5.6252378e-07, ..., 7.1431838e-05,
        4.1666123e-04, 4.5842984e-07],
       ...,
       [3.5653638e-09, 5.9224162e-06, 1.6002310e-02, ..., 2.3811568e-05,
        5.6481532e-08, 9.7550744e-01],
       [1.2402441e-09, 2.4984845e-06, 3.3849191e-03, ..., 3.1780257e-06,
        1.6724687e-08, 9.9415755e-01],
       [1.5365458e-12, 1.2498603e-07, 1.0186777e-08, ..., 1.3220866e-08,
        8.4905256e-11, 9.9999857e-01]], dtype=float32)
```

```
score1 = cnn_model.evaluate(np.array(x_test),np.array(y_test), verbose=1)
```

```
5/5 [==============================] - 1s 219ms/step - loss: 0.3438 - accuracy: 0.9625
```

Fig: CNN accuracy archived in test data is 96.25%

CONCLUSION: In this project we represent the significance of face recognition as a personal identification system, drawing parallels with the human face recognition process. Face recognition system using PCAas feature extraction and machine learning algorithms as a classifier with the most optimal set of parameters resulted in varying accuracy. It emphasizes the two fundamental phases: face detection and face recognition. The latter is a crucial area of research, with the Eigen face method being a popular approach that leverages Principal Component Analysis (PCA) for dimensionality reduction in facial feature representation. Variations of image errors consists of aspect of facial expression(smiling or not smiling),eyes(open or closed), facial details(wearing glasses or not) It also mentions the evaluation of face recognition systems using various machine learning and deep learning algorithms, including SVM, Logistic regression, Linear Discriminant Analysis, and CNN, in combination with PCA for feature extraction. . Meanwhile, CNN produced the best accuracy among the other algorithms with 96.25%. Variations of image errors consists of aspect of facial expression(smiling or not smiling),eyes(open or closed), facial details(wearing glasses or not) and illumination. suggestions for future research are to use more datasets and focus on one error ,such as wearing glasses or not .

REFERENCES

1. Adelson,E.H.,andBergen,J.R.(1986) The Extra ction of Spatio-Temporal Energy in Human and Machine Vision,Proceedings of Workshop on Motion: Representation and Analysis (pp.151-155)Charleston,SC; May7-9

2. AAFPRS(1997). A newsletter from the American Academy of Facial Plastic and Reconstructive Surgery.Third Quarter1997, Vol.11,No. 3. Page3.

Baron, R. J. (1981). Mechanisms of human facial recognition. International Journal of Man Machine Studies, 15:137-178

3. Beymer, D. and Poggio, T. (1995) Face Recognition From One Example View, A.I. MemoNo.1536, C.B.C.L. Paper No. 121. MIT

4. Bichsel,M.(1991).Strategies of Robust Objects Recognition for Automatic Identification of Human Faces.PhDthesis, Eidgenossischen Technischen Hochschule, Zurich Brennan, S.E.(1982) The caricature generator.M.S.Thesis.MIT.

5. Brunelli, R. and Poggio, T. (1993), Face Recognition: Features versus Templates.

IEEE Transaction son Pattern Analysis and Machine Intelligence,15(10):1042-1052 Craw, I., Ellis, H., and Lishman, J.R. (1987). Automatic extraction of face features. Pattern Recognition Letters, 5:183-187, February.

6. Deffenbacher K.A., Johanson J., and O'Toole A.J. (1998) Facial ageing, attractiveness, and distinctiveness.Perception. 27(10):1233-1243

7. Dunteman, G.H.(1989) Principal Component Analysis.Sage Publications. Frank, H. and Althoen, S. (1994). Statistics: Concepts and applications. Cambridge University Press. p.110

8. Gauthier,I.,Behrmann,M.andTarr,M.(1999).Can face recognition really be dissociated from object recognition?Journal of Cognitive Neuroscience,in press.

9. Goldstein, A.J., Harmon, L.D., and Lesk, A.B. (1971). Identification of human faces.InProc.IEEE,Vol. 59,page74deHaan,M.,Johnson,M.H.andMaurerD.(1998)Recognition of individual faces and average face prototypes by 1- and 3- month-old infants. Centre for Brain and Cognitive Development, Department of Psychology, Birk beck College.

10. Hadamard, J. (1923) Lectures on the Cauchy Problem in Linear Partial Differential Equations,

Yale University Press
11. Haralick,R.M.andShapiro,L.G..(1992)Computer and Robot Vision,VolumeI.Addison-Wesley

12. Haxby,J.V.,Ungerleider,L.G.,Horwitz,B.,Maisog,J.M.,Rapoport,S.I.,andGrady,

C.L.(1996).Face encoding and recognition in the human brain.Proc.Nat.Acad.Sci.93: 922 - 927.

13. Heisele, B. and Poggio, T. (1999) Face Detection. Artificial Intelligence Laboratory.MIT.

14. Jang., J., Sun, C., and Mizutani, E. (1997) Nero-Fuzzy and Soft Computing. PrenticeHall. Johnson,R.A.,andWichern,D.W.(1992)Applied Multivariate Statistical Analysis .Prentice Hall p356-395.