Webology (ISSN: 1735-188X)
Volume 18, Number 6, 2021

Face Recognition Using SVM Based Machine Learning: A Review

Rahul Nandal[1] , Dr. Anil Dudy[2]

[1]Research Scholar Department of Electronics & Communication Engineering, Baba Masthnath University, Rohtak, Haryana.

[2]Associate Professor Department of Electronics & Communication Engineering, Baba Masthnath University, Rohtak, Haryana.

Abstract-: The recent scenario of face recognition has recently received the most attention and established itself as the most reliable option for identification due to the availability of realistic technology after extensive research in this area and holes in other techniques of identification. The system is still in the process of being improved to make it more user-friendly and accurate in order to secure the assets and privacy. As the authentication of people by face provide access to both virtual and physical domains by analysing their behavioural and physiological traits and features, as compare to traditional systems of recognition which are ambiguous. As compare to face recognition system, remembering PINs and passwords is notoriously tough in authentication system. The face recognition with various techniques is challenging task for researcher. This technology was being used to preserve private information and identify users promptly. This paper suggested in a variety of methods. As this study found that still face recognition is quite difficult due to complexity of the face attributes and face complexity with variety of elements. A variety of elements, such as partial facial occlusion, illumination, and postural variation are the main hurdles to recognise with the capturing machine. This paper explores basis of face recognition using ML algorithms as the recent development of machine learning is very great enhancement in variety of technology.

Keywords: - Face Recognition, Machine Learning, SVM

I. Introduction

There are several sub-disciplines of artificial intelligence, including machine learning. When it comes down to it, artificial intelligence is all about simulating human intellect in machines (computers). It is essential for each living being to have skill in order to carry out any task. In the beginning of each day, people can identify one item from another. There are several ways to make a computer as intelligent as a

person. The optimum classification method has yet to be discovered for any data set. As a kind of artificial intelligence (AI), machine learning is a subset of AI that can be learnt without having to be explicitly programmed. Data classification challenges were solved using machine learning techniques. There has been a dramatic increase in the usage of machine learning in several scientific domains in recent years. As shown in Fig. 1, ML algorithms may be broken down into three categories: supervised, unsupervised and reinforcement learning. Artificial neural networks, k-nearest neighbours' classifier, decision trees, Bayesian classifier, and Support Vector Machine (SVM) algorithm are some of the best classification methods available in the literature. SVM is one of the best-known methods for optimising the predicted result from these approaches.

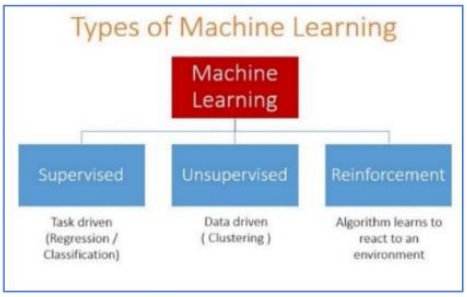

Fig.1. Machine Learning and its Types [8]

A supervised machine learning method based on statistical learning theory, the SVM algorithm is one of them. As a result, the classification of a subset of characteristics is comparable to dividing a larger dataset into subsets of characteristics. Various classification issues have been solved effectively using the SVM. As a result, it has a very wide range of applications because of its exceptional learning capacity. Examples include intrusion detection, facial expression classification, prediction of time series and more. Among them are voice recognition and picture identification, signal processing and detection of genes. Other examples include text classification, recognition of typefaces and other domains. The SVM method has clear benefits when it comes to addressing classification difficulties. There is less of a lag time. The global optimum solution may ensure the target detection classifier's accuracy. However, there are certain downsides, such as the fact that the detection model has been around for a while. The difficulty of large-scale data processing increases exponentially with the amount of data being processed. Comparatively, SVM is more competent than other classification algorithms to deal with fewer samples, nonlinearity, and high dimensionality issues. In this scenario, SVM is a good tool for modelling both linear and non-linear relationships. Comparatively speaking, compared to nonparametric approaches like as ANN, the measurement time is rather quick. When it comes to mechanical training, a wide range of data sets might be a barrier, yet SVM continues to generalise itself even with little training knowledge.

1.1 Machine Learning and Face Recognition

Due to breakthroughs in AI, ML, and deep learning, the face recognition technology business is fast growing. People may be identified by their faces using facial recognition technology. As a result, it uses machine learning algorithms to identify people by their facial traits by capturing, storing, and analysing them. A thorough description of face recognition technology is beyond the scope of this essay, and it

would be impossible to do it here. This section explores four most important issues that a face-recognition system must address. Face detection, face alignment, feature extraction, face recognition, and face verification are all part of this process. For a computer to identify a face in an image or video, it must first find it. Face recognition is now a standard feature in most cameras. Social networking services such as Snap Chat utilise face recognition to add effects to photographs and videos that are taken using their mobile applications. Turning the face away from the focal point changes the way appear on a computer screen entirely. Faces in the database must be normalised using an algorithm in order to be consistent with each other. Using a variety of general face landmarks may help achieve this goal. As an example, the chin, the tip of the nose, the outsides of the eyes, different spots surrounding the mouth and the eyes, and so on. Next, an ML system be trained to detect these locations on any face and turn the face toward the centre.

It was initially unclear which characteristics should be collected and extracted until researchers determined that the optimal strategy was to allow the ML algorithm choose which measurements to gather for itself. These neural networks employ deep convolutional learning techniques called "embedding," which teach the system to create many measurements of a single face in order to better differentiate one from another. Finally, an ML algorithm will use the unique measures of each face to compare the measurements of the face to known faces in a database. The database produced the closest match based on the dimensions of the face in question. When comparing two faces, face verification considers the distinctive characteristics of each one. Confidence values are generated by an ML algorithm to determine whether two faces are similar.

II. Literature Review

Asaithambi et al. (2021), proposed in this paper that two major processes, referred to as the "big data (BD) pipeline" and "machine learning (ML) pipeline," be used in conjunction to create a big data framework for pre-processing and categorization of images and text. It's a unique end-to-end workflow that incorporates all the necessary steps to cleanse the information before it is analysed. It is the first of its type to include sentiment analysis into a distributed big data platform for face recognition. Big data may be ingested and processed using state-of-the-art distributed technologies that apply applicable ML techniques such as k-NN and logistic regression to get actionable insights from the data. As a result, they illustrate the usage of our big data platform for face recognition utilising open sources by creating a prototype. They mainly focus on the big data sets, Machine learning and the face recognition in this investigation along with data processing.

Faridi et al. (2021), introduced the face recognition using neural learning methods. This research used to extract features and train a module. This is not the first time that these approaches have been used to extract characteristics from human photos. There are several detecting systems that can scan the whole body, including iris and finger print devices. For safety and security reasons, certain systems have been implemented. This study compares several facial recognition machine learning methods. SVM, LDA, PCA, and 1-nearest neighbour (1-NN) are just a few of the machine-learning classifiers being evaluated for face recognition. Additionally, several categorization algorithms' ability to accurately recognise a face

is examined. Datasets containing photos of people's faces saved in databases are made accessible via a process known as Face Recognition. These datasets have been the subject of a slew of studies. Comparison of machine-learning algorithms reveals which is the most accurate in terms of detecting images. Due to its non-intrusive nature and the fact that it is the most convenient means of personal identification for individuals, face recognition has remained a key focus of study. The outcomes of this research might help identify an appropriate machine learning method for greater facial recognition accuracy, as shown in this study.

Büyüktaş et al. (2021), They describe a new face-recognition method based on convolutional neural networks (CL). A curriculum-based approach to learning assumes that people learn best when they are presented with knowledge in a sequential order. Several studies have shown that CL may improve machine learning by allowing greater convergence to a local minimum. Based on an absolute total of yaw, pitch, and roll angles, they split the training set of face photos into groups of increasing complexity for face identification. The complexity of these subgroups is progressively brought to the deep CNN. Experiments on the massive CASIA-Web Face-Sub dataset reveal that using CL improves face recognition performance statistically significantly compared to randomly structuring the training data.

Hung (2021), studies on face recognition using deep neural networks that have presented in this article. In this paper, researchers offer a methodology for solving the challenge of facial recognition that might be used to identify individuals straight from a camera. There are two processes in particular: face detection and face recognition. They employ HOG features and an SVM linear classifier for face identification. CNN convolution neural network is offered as the basis for the proposed facial recognition model. In order to test the model's performance, the FEI, LFW, and UOF datasets were used to assess its correctness.

Abdullah (2021), presented his article on Facial recognition. This is used in a variety of real-world applications, including video surveillance, school attendance tracking, human-machine interaction, and security systems, among others. Because of the difficulties in identifying several faces in a single frame and the difficulty in recognising faces with inadequate resolution, the detection and recognition of numerous faces is still a challenging issue. The processing speed and accuracy of deep learning algorithms for face recognition beat those of standard machine learning algorithms when it comes to face identification.

Loey et al. (2021), presented an article on SVM used in detection of face mask. This is the very use full exploration during the covid scenario. As the COVID-19 pandemic is generating a worldwide health disaster. According to the World Health Organization, wearing a face mask in public places is an effective means of protection (WHO). In this work, a face mask identification model that incorporates both deep and traditional machine learning techniques will be discussed. There are two parts to the model that they have come up with. Using Resnet50, the first component extracts feature from the data. Decision trees and Support Vector Machines (SVMs) are used in the second component for face mask categorization. For this study, three face-masked datasets have been chosen as it is necessary to use three different sets of data.

Murugappan & Mutawa (2021), presented an article on interpersonal communication and social well-being benefit greatly from the use of emotion. Humanoid robots and human-computer interfaces (HCI) are increasingly including facial expression detection in their design. Haar-like traits are used to identify the subject's face. Automated application of a mathematical model to the placements of eight virtual markers on the subject's face. To create five triangles, eight markers are shifted to make the edges of each triangle. When individuals enunciate their facial expressions, the Lucas-Kanade optical flow algorithm tracks these eight indicators in real time. Triangular area (AoT), circumference (ICC), and ICAT are used to categorise face expressions by extracting these three parameters. Distinct machine learning methods may be used to identify six different face expressions from these characteristics.

Chandrakala & Devi (2021), presented an article on Biometric applications, surveillance systems, and computer vision which associated with face recognition. Pose variation, backdrop lighting invariance, and facial emotions all contribute to the difficulty in identifying faces. Using k-NN and SVM, the proposed two-stage classifier tries to identify provided face photos. Two distinct classifiers, one after the other, enhances the system's accuracy. In order to extract the most significant characteristics from the pre-processed face photos, we use the Histogram of Oriented Gradients (HOG). Face photos that were not identified by the k-NN classifier were evaluated next with the SVM classifier. They used Cascading k-NNs and SVMs to improve recognition accuracy 95.2 percent of the two-stage classifier's recognition accuracy was attained.

Gupta & Gandhi (2020), They use recordings from the Dec Meg Human Brain dataset provided from Kaggle to train our SVM model. In addition, they were able to identify the cluster of sensors responsible for visual identification and the dynamic interaction among sensors with the passage of time utilising brain coordinates of the magnetometer sensors with a 74.85 percent accuracy. Because of its vast variety of applications, object recognition has long been one of the most important study fields in contemporary times, notably in the healthcare and engineering industries. Shape matching, colour matching, sliding window approach, etc., have all been used to recognise and classify objects. They presented a new approach for detecting and analysing the process of object identification from human brain magnetoencephalogram (MEG) signals has been proposed in this work. This might be achieved by utilising machine learning to categorise the item as a face/scrambled face (SVM).

Tabassum et al. (2020), illustrated in their article to variety of techniques which have been explored in recent research to improve object recognition accuracy. Four distinct techniques are merged in this paper as PCA error vector, eigen vector of PCA, eigen vector of Linear Discriminant Analysis (LDA) and Convolutional Neural Networks (CNN). The four outputs are mixed using entropy of detection probability and Fuzzy system. The results explored in this study as the accuracy of identification is determined to be reliant on picture and database variety. An overall identification rate of 89.56% is possible in the worst-case scenario, while an overall recognition rate of 93.34% is possible under ideal conditions; this is an improvement over prior work in which each approach was applied to just one set of photographs.

Sharma et al. (2020), presented an article on face recognition and its association with artificial intelligence. A facial recognition method based on machine learning and principal component analysis is

the explored of this study. Uses linear discriminant analysis, multi-layer perceptron's and Naive Bayes as well as support vector machines investigated and apply on the face recognition though simulation. Furthermore, it has obtained a recognition accuracy of 97% and 100% using PCA and linear discriminant analysis, respectively.

Selitskaya et al. (2020), investigate a Face Recognition issue caused by considerable differences in ace pictures, which might be the result of varied positions, emotions, haircuts, or cosmetics on the person being studied in this article. In the face of considerable fluctuations, present Artificial Neural Networks (ANN) approaches are still poor, but they have attained a high recognition accuracy equivalent to or even better than human recognition. They use the BookClub creative makeup data, a new benchmark data set of face photos with varied make-up, haircuts, and occlusions, to test the ANNs' performance under various circumstances. They found that in real-world situations when the test photographs incorporate unseen sorts of cosmetics and occlusions, the accuracy of facial recognition drops. A person's identity may be concealed from the ANN algorithms, but likewise an incorrect identification can be faked using cosmetics and other occlusions.

Okokpujie & Apeh (2020), presented an article on Face-recognition technologies which are becoming more used in a broad variety of industries. Trait Aging is a unique problem for face recognition algorithms. Trait Aging reduces the accuracy of face recognition over time. Using transfer learning, a Convolutional Neural Network (CNN) known as Inception-Resnet-V2 was used to construct an age-invariant face recognition system. Image datasets from the MORPH database were used to test and train the customised neural network model. The dataset has a median age of 33, with a minimum age of 16 and a maximum age of 77. Each picture in the dataset had a mean separation in days of 164 days, with a minimum and maximum of 1 day and 1681 days, respectively. All photos in the sample had a standard deviation of 180 days in days of separation. An experimental study found training and testing loss to be as low as 0%, with a 100% accuracy rate for training and testing. All of this, even though the MORPH database has a characteristic ageing component.

2.1 Comparison

S. No.	Author	Year	Methods	Result
1.	Asaithambi et al.	2021	Big data along with ML methodology	They showed how our big data approach may be used to a face recognition system by constructing a prototype.
2.	Faridi et al.	2021	machine-learning classifiers with Principal Component Analysis (PCA)	They improved the accuracy of facial recognition; this research might help identify an appropriate machine-learning method.

3.	Büyüktaş et al.	2021	novel curriculum learning (CL) algorithm	They applied CL in their research, they found the accuracy of facial recognition became statistically significant.
4.	Hung	2021	uses HOG features and SVM linear classifier	This research indicated that the proposed model has good accuracy when it is tested for efficiency using FEI, LFW, and UOF.
5.	Abdullah	2021	a combination of Viola Jones, Face-net, and Support Vector Machine (SVM),	Face-net and Support Vector Machines (SVM) were used in their solution, which reached 94 percent accuracy for 100 people and 100 percent for 10 frames through 9 seconds for real-time face identification.
6.	Loey et al.	2021	decision trees, Support Vector Machine (SVM), and ensemble algorithm.	In RMFD, the SVM classifier has a testing accuracy of 99.64 percent. While in SMFD, it was 99.49% accurate, it was 100% accurate in LFW (LFW).
7.	Murugappan & Mutawa	2021	Haar-like features, Random Forest (RF)	Applied Random Forest (RF) classifier having the classification rate of 98.2 as compared with other machine learning.
8.	Chandrakala & Devi	2021	k-NN and SVM	Cascading k-NN and SVM improved recognition accuracy. Classification accuracy was 95.2% for the two-stage classifier.
9.	Gupta & Gandhi	2021	support vector machine (SVM	Sensor clusters important for visual recognition and dynamic interactions between sensors throughout time were identified using magnetometer sensors' neural coordinates with a 74.85 percent success rate, according to this author.
10.	Tabassum et. al.	2020	Principal component analysis (PCA), eigen vector of PCA and Convolutional Neural Network (CNN) along with eigen vector	A recognition rate of 89.56 percent in the worst-case scenario and 93.34 percent in the best-case scenario may be compared to prior studies where an individual approach was applied on a particular group of photos.
11.	Sharma et al.	2020	principal component analysis (PCA), linear discriminant analysis	Employing PCA and linear discriminant analysis, 97 and 100 percent recognition accuracy was attained.

III. Support Vector Machine (SVM)

As this paper used a SVM compatibility to Face recognition. The SVM is well known machine learning algorithm. The most of the researcher used to investigate the face recognition suing the SVM on universal

data sets. SVM is a supervised learning technique that may be used to classify and predict outcomes. Using SVM, the goal is to select a single hyperplane with the greatest margin that can split the classes linearly (Fig2). When using a high number of statistical tests, the best answer cannot be guaranteed when there is only a limited quantity of training data available.

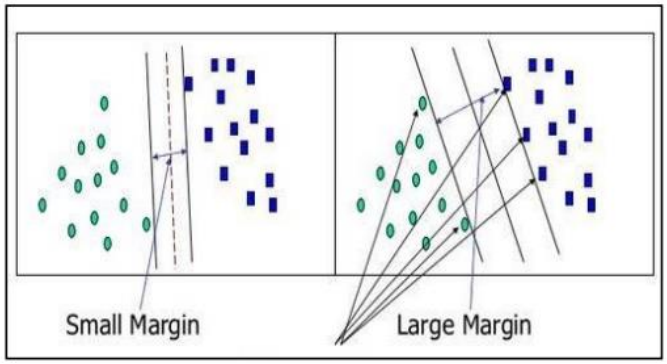

Fig 2: Margin and Support Vectors. Left: small margin between 2 classes Right: large margin between 2 classes

When linear separation in the kernel functionality gets simpler, the training data are projected to a higher-dimensional feature space in the input space. Use of various kernel functions, such as the RBF or polynomial kernel, helps SVM discover a hyperplane that better splits data into its groups, and when used for limited training sets, it has high classification performance. Therefore, the SVM method needs an appropriate kernel function in order to assess hyperplanes and minimise classification errors. The kernel form is a critical component of the SVM approach. The greater the density of the kernel, the better the SVM performs, and this is especially true for smooth surface similarity. Furthermore, the kernel function is a critical and challenging decision in machine learning, unlike in some other approaches. As a result, the SVM algorithm's value lies in its ability to improve itself via the modification of its kernel feature, making it computationally expensive to adapt the problem's dimensionality in order to enable SVM segregation. Researchers in a wide range of domains have investigated and used SVM as to investigate the face. Training vectors need more computation and storage space as the number of training vectors grows. This is proved in many real issues that are beyond their capabilities.

3.1 Other aspects of Support Vector Machine (SVM)

SVM is primarily concerned with accurately classifying unknown data. There are several uses for this technology across a wide range of industries. Among the many potentials uses for SVM are the following:

- Using an SVM classifier, sections of the picture may be identified as either a face or not, and a square border can be drawn around the face that has been detected.
- diagnostics for illness SVM Classifiers might make a significant contribution to medicine by providing a fast and accurate means of diagnosing disease. Detection of sickness has the most significant function in the field of health care. Many people's lives can be saved if an illness is caught early enough.

- In the field of image processing and machine learning, character recognition is becoming both a challenging and exciting issue. SVM is one of the most often employed algorithms in a variety of pattern recognition applications. Machines have a difficult time recognising letters, numbers, and other figures, including humans. There have also been several methods presented in this field.
- SVM Classifiers using emotive analysis have generated forums with SVM Classifiers where positive, negative, or neutral viewpoints may be readily distinguished. When it comes to analysing the public opinion, the results may be used to a wide range of topics such as politics, criminal justice, and economics as well as global affairs such as movies and fashion. People's ideas and feelings about a new trend may be gathered mostly via social networking. Studying people's emotions is one of the most popular methods of psychological research.
- Intrusion Detection System - Detecting and preventing network intrusion has long been a top priority in information security. False positive rates and classification accuracy will be improved by an effective intrusion detection technology. Consequently, several SVM-based intrusion detection algorithms have been developed.
- Because they solely deal with data and prioritise the consequences of such actions, machine learning methods like (SVM) may be utilised for the diagnosis of illnesses in plants. This makes it possible to determine the stage of a disease in general in vegetables.

IV. Conclusion and Future Work

Face recognition has lately gained the greatest attention and has established itself as the most trustworthy alternative for identification owing to the availability of realistic technology after substantial study in this field and the existence of gaps in other identification methods in the recent past. The system is still being enhanced in order to make it more user-friendly and accurate in order to protect the assets and privacy of the people who rely on it. As opposed to conventional methods of recognition, which are ambiguous, facial authentication provides access to both virtual and physical realms by analysing a person's behavioural and physiological characteristics and features. Remembering PINs and passwords in an authentication system is notoriously difficult, especially when compared to facial recognition systems. Face recognition using a variety of methodologies is a difficult challenge for researchers to complete. This technology was being utilised to keep private information safe while also identifying people as quickly as possible. This study made many recommendations using a variety of methodologies. According to the findings of this research, face recognition is still relatively challenging owing to the complexity of the facial characteristics and the complexity of the face with its diversity of aspects. For the capturing machine to recognise the subject properly, a range of factors must be considered, including partial face occlusion, lighting, and postural fluctuation. This study investigates the fundamentals of face recognition using machine learning methods, since the recent advancement of machine learning has resulted in a significant improvement in a wide range of technological applications.

References

1. Asaithambi, S. P. R., Venkatraman, S., & Venkatraman, R. (2021). Proposed big data architecture for facial recognition using machine learning. AIMS Electronics and Electrical Engineering, 5(1), 68-92.
2. Faridi, M. S., Zia, M. A., Javed, Z., Mumtaz, I., & Ali, S. (2021). A comparative analysis using different machine learning: An efficient approach for measuring accuracy of face recognition. International Journal of Machine Learning and Computing, 11(2).
3. Büyüktaş, B., Erdem, Ç. E., & Erdem, T. (2021, January). Curriculum learning for face recognition. In 2020 28th European Signal Processing Conference (EUSIPCO) (pp. 650-654). IEEE.
4. Hung, B. T. (2021). Face recognition using hybrid HOG-CNN approach. In Research in Intelligent and Computing in Engineering (pp. 715-723). Springer, Singapore.
5. Abdullah, I. A. (2021). Face Recognition Using Face Embedding Method. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(10), 3383-3394.
6. Loey, M., Manogaran, G., Taha, M. H. N., & Khalifa, N. E. M. (2021). A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID-19 pandemic. Measurement, 167, 108288.
7. Murugappan, M., & Mutawa, A. (2021). Facial geometric feature extraction based emotional expression classification using machine learning algorithms. Plos one, 16(2), e0247131.
8. Chandrakala, M., & Devi, P. D. (2021). Two-stage classifier for face recognition using HOG features. Materials Today: Proceedings.
9. Gupta, S., & Gandhi, T. (2020). Identification of neural correlates of face recognition using machine learning approach. In Computer Vision and Machine Intelligence in Medical Image Analysis (pp. 13-20). Springer, Singapore.
10. Tabassum, F., Islam, M. I., Khan, R. T., & Amin, M. R. (2020). Human face recognition with combination of DWT and machine learning. Journal of King Saud University-Computer and Information Sciences.
11. Sharma, S., Bhatt, M., & Sharma, P. (2020, June). Face Recognition System Using Machine Learning Algorithm. In 2020 5th International Conference on Communication and Electronics Systems (ICCES) (pp. 1162-1168). IEEE.
12. Selitskaya, N., Sielicki, S., & Christou, N. (2020, September). Challenges in face recognition using machine learning algorithms: Case of makeup and occlusions. In Proceedings of SAI Intelligent Systems Conference (pp. 86-102). Springer, Cham.
13. Okokpujie, K., & Apeh, S. (2020). Predictive Modeling of Trait-Aging Invariant Face Recognition System Using Machine Learning. In Information Science and Applications (pp. 431-440). Springer, Singapore.