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A Review: Facial Recognition Using Machine Learning

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Abstract

A facial recognition system can verify or identify a person from a video or a digital image. There are various techniques in which these systems work. Popularly, they work by first matching the facial characteristics picked from the image to the faces stored in the database. It is called a Biometric Identification based application that uniquely identifies each individual by analyzing their voice, facial expression, face, or fingerprint. Even though it was initially used as a computer application, it has gained broader uses in mobile platforms and other technology sectors, such as robotics. It has a vast application in security systems. Although this system's accuracy as biometric technology is lower than that of fingerprint recognition and iris detection, it is broadly used due to its non-invasive and contactless features. It has recently grown in significance as a tool for retail and marketing. Another application is video surveillance to identify missing people or criminals. It is gaining importance in the healthcare sector. Facial recognition technology has become very popular and is being used everywhere from shopping centers, airports, venues, and by law enforcement. This technology can also be used to prevent crimes such as shoplifting by identifying ex-cons. Although this technology is gaining widespread use, there are many concerns about privacy and safety.

Keywords - *Convoluted Neural Networks, Facial Recognition, Machine Learning, Support Vector Machine.*

I. INTRODUCTION

CNN (Convolutional Neural Network) can be used for image recognition. CNN consists of hidden layers, and these layers receive inputs, and they transform the input to give outputs, which are again passed as inputs to the next layers. These convolutional layers detect patterns by using a matrix having weights depending upon the pattern it is trying to recognize. Furthermore, these weights get updated depending upon the error and loss after classifying the input. There are also different activation functions used. [2] Biometric identification (B.I.) is explored a lot in recent years. Facial recognition is one of the most essential techniques for BI. [4] Neurons of the temporal lobe are responsible for recognizing faces. [5] Learnings in Machine learning can be classified into supervised learning, unsupervised learning, and reinforcement learning. [9] Emotions can be text, vocal, and expression of verbal information. [11] Deep learning models have shown better results in terms of accuracy than machine learning for recognizing images.

II. LITERATURE SURVEY

Sanghyuk Kim et al.[1] proposed a facial expression recognition system that was based on features of images. There were a couple of processes related to the detection of the face and recognizing facial expression. In the process related to detecting the face, the area of interest is set again to reduce changes. After extracting a histogram of directed gradients (H.O.G.), features from each facial region, the F.E.R. process is performed to identify the final expression of the face.

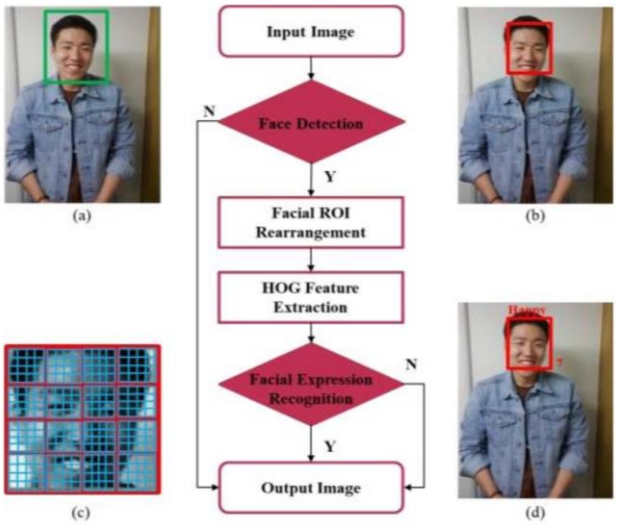


Fig. 1. Proposed flow chart [1]

E. García Amaro et al.[2] in this paper proposed a facial recognition system. A face detection algorithm is used to extract the face from video frames and creating a database. Next, preprocessing is performed on images of faces obtained. Next, specific ML algorithms are trained using images of faces obtained as inputs. And then, classifiers are used to classify. Results show that this approach is suitable for analyzing videos where previous face labels are not available.

D. V. Sang et al.[3] in this paper apply recent advances in deep learning to introduce deep CNNs that can automatically decode semantic data in faces without hand-designing feature descriptors. Few distinct types of CNN architectures for recognizing facial expressions were proposed. The different layers were convolution, pooling, and fully connected layers. Some changes are also proposed to avoid overfitting. Data preprocessing and

normalizing is implemented. Data augmentation techniques are also applied. In the training phase, the loss function is minimized. For testing, the original data set was divided into training and validation sets. FERC 2013 dataset was used. Data augmentation improved the model's accuracy.

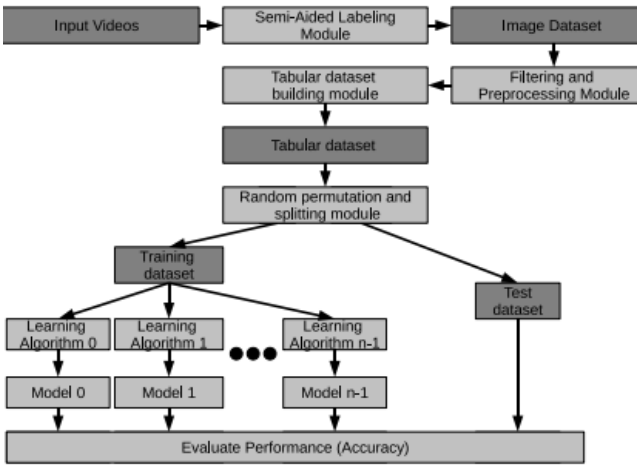
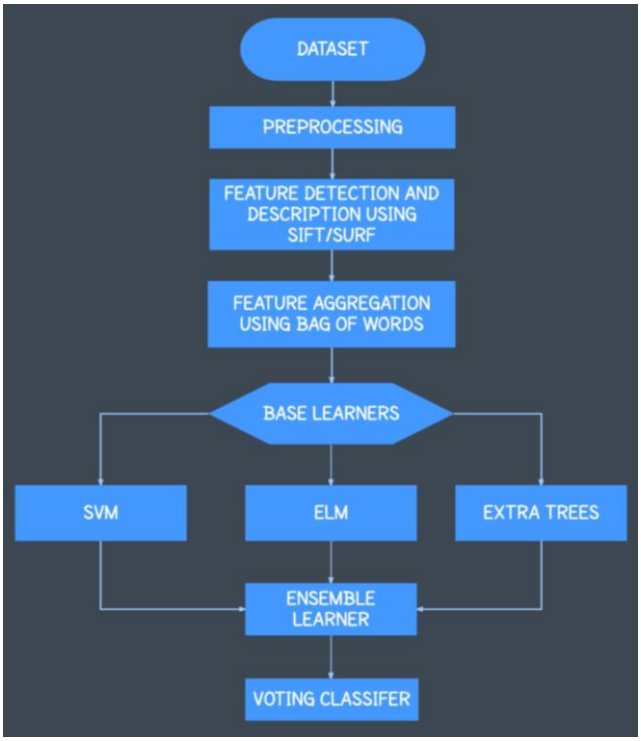


Fig. 2. Block diagram of the proposed face detection and recognition system [2]

Fig. 3. Data Augmentation example [3]

Q. Liu et al.[5] in this paper, the study to have a detailed overview of current security risks from two aspects: the preparation process and the testing / inferring process. Machine learning security threats were categorized into different categories. A description of relevant works on machine learning security was then issued. Adversaries can decrease the performance of classification or regression models in terms of accuracy. Illustration of poisoning attacks was given and also types of poisoning. A comparison was offered for various strategies of attacking against machine learning. They illustrated and compared different defensive techniques. Then trends in research into safety risks and defensive machine learning strategies were provided.

A. Vinay et al.[4] in this paper, E.L.M. is explored, and its performance is studied. It finds promise in real-time applications thanks to its fast learning. The purpose of this paper is to assess the performance of the extreme learning machine algorithm for facial recognition when used as a stand-alone interface, as well as when used with an ensemble learner, and then concluded with a final prediction vote classifier. A Block Diagram depicting the same[4]:



Xue-Fei Bai et al.[6] in this paper, an approach for understanding facial expression is proposed based on a neural network ensemble. First, facial expression features are derived by multi-expression processing of the eigenspace, and then multiple neural networks are trained with specific expressions. In the end, their training outcomes are aggregated as classifier inputs, which will provide not only the final recognition results but also the approximate knowledge of expression.

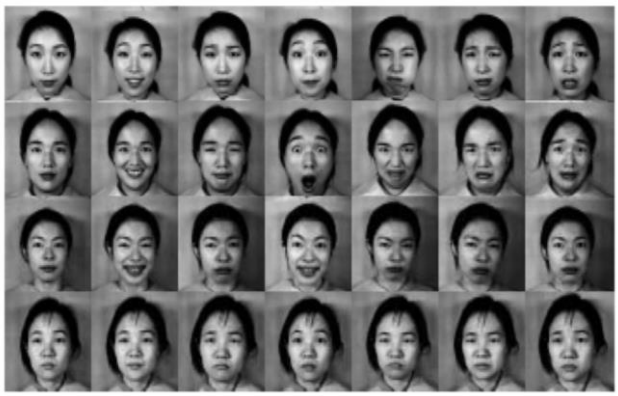


Fig. 4. JAFEE dataset images [6]

M. Ishii [7], in this paper, proposed an approach for developing a facial expression recognition model that could deliver adaptive learning. [7] It has been suggested that the model needs to retain existing knowledge and, at the same time, learns to continue adding new knowledge. Moreover, the classifier should be evolved to become adaptive.

Mullainathan Sendhil et al.[8] This paper shows a machine learning way of thinking that gives it its place in the econometric toolbox. It is given that, [8] machine

learning revolves around the issue of prediction: generate predictions of y from x and other economic implementations; instead, it revolves around parameter estimation: generate reasonable estimates of parameters β that underlies the relationship between y and x, and it is essential to remember that machine learning algorithms are not built for this reason. Different categories of applications of ML to economics are given. Then how machine learning works and how machine learning can be applied is given.

T. Kundu et al.[9] in this paper, Describe recent developments in approaches and methods used to gauge the 5 primary emotions or moods often recorded in human-faced photographs. The primary emotions are normality, happiness, drowsiness, disgust, surprise by automatic machines. The focus is on ANN and SVM in classifying emotions. First, the technique analyses the information retrieved by the facial regions of the eye and mouth into a combined new image and used as an input to a neural network trained in backpropagation. The second approach demonstrates the use of Oriented Fast and Rotated (O.R.B.) to extract texture information on a single frame of images.

A. Mostafa et al.[10] this paper presents emotional recognition models using facial expression technology by detecting the face in videos and getting local features to establish geometric characteristics to differentiate between a collection of 5 emotional expressions (fear, amusement, disgust, sadness, and anger).

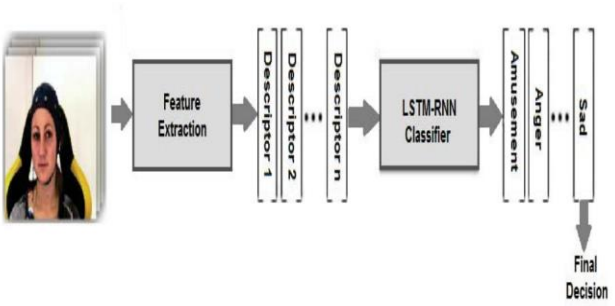


Fig. 5. Classification using R.N.N. [10]

Coşkun et al.[11] this paper proposed an updated architecture for the CNN by applying two standardization operations to 2 levels. The general structure of the facial recognition process is made of 3 stages. It starts with the preprocessing step, continues with facial characteristics extraction, and is subsequently classified as an extracted feature set. Methodology and CNN architecture are introduced, and various layers like convolutional, pooling, ReLU layer is introduced. Then the proposed algorithm is given. Different tests were implemented by making changes in sizes of batch and image, rate of learning. The Caffe framework is used to train and test two databases, the ORL face database, and the A.R. face database.

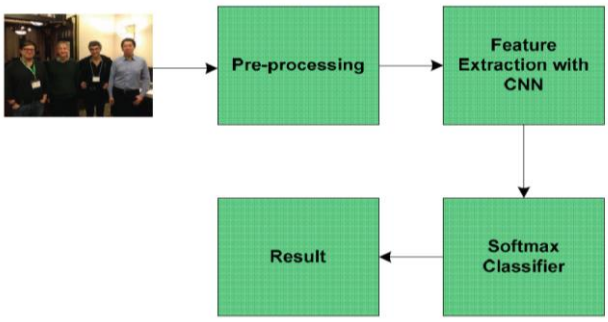


Fig. 6. Proposed Algorithm block schema [11]

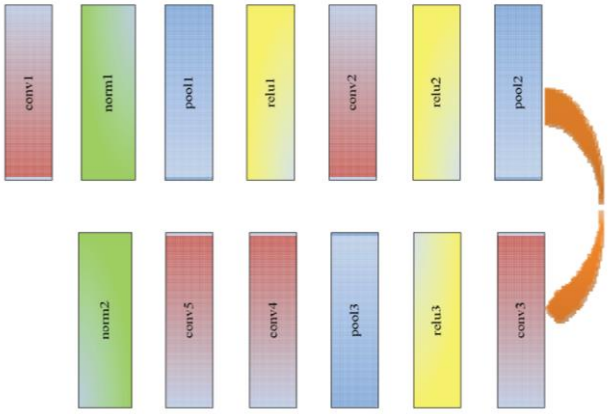


Fig. 7. Feature Extraction in proposed CNN [11]

J. C. T. Kwong et al.[12] in this paper, 12 potential variations of Key Facial Detecting, Saliency Mapping, Local Binary Sequence, and Oriented Gradient Histogram was investigated along with 6 machine learning classification algorithms that produce a total of 72 models. The emotions are listed as fear, sadness, joy, surprise, neutral, disgust, and anger. For "in the wild" image processing and analysis, a stratified tenfold cross-validation is conducted on both the CK+ dataset and the locally gathered data collection. Via this analysis, it was determined that of the 72 simulations, the RBF SVM HOG+LBP model achieved the highest average accuracy of 0.94, with an F1 score of 0.93 across the seven emotions.

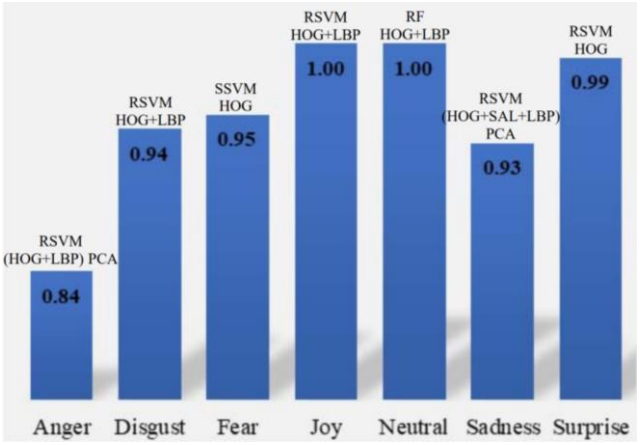


Fig. 8. Highest accuracy models for each emotion [12]

X. Han et al.[13] in this paper, the emphasis is on face recognition work hotspots focused on deep learning in the biometrics field, along with specific theory and methods in deep learning, facial recognition techniques based on deep learning, facial recognition framework for beginning research. Different face space models are proposed. Then factors that affect face recognition are deeply analyzed and studied. DBN (Deep Belief Network) framework is given. The necessary components of the face recognition program and essential face recognition methods are provided. The application of facial recognition dependent on deep learning is given. Problems with existing deep learning are given.

Farhad Navabifar et al.[14] in this paper, New facial recognition techniques are classified as the classifier of faces and non-faces based on four traditional machine learning techniques. The methods for evaluating different techniques are compared with one another. A general face detection block diagram is given. The reported performance is given as a classifier for face detection systems of some different approaches and different machine learning. It was found that while it was possible to detect multiple frontal faces in pictures, detecting faces in complex surroundings with subjective perspectives and different speech and occlusion would require further attention.

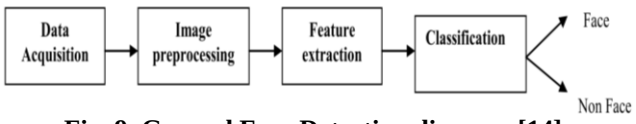


Fig. 9. General Face Detection diagram [14]

Stephen Balaban [15], in this paper, attempts to include a description and overview of the state-of-the-art, deep learning approaches used. A brief historical description is given of face recognition and describes learning representation and deep learning. It also shows how those fields impact facial recognition state of the art. For future research, a new benchmark and framework are being introduced for face-recognition analysis. The problem with today's benchmarks and datasets is listed.

III. APPLICATIONS

The Facial Recognition system has been used in a variety of fields for many applications. Day by day, the use of this technology is increasing. It is used from business solutions to solutions for the home.

One of the most important uses of this facial recognition technology is for personal and public protection by the federal authorities. Some of the personal uses of facial recognition and the most important ones are access to personal mobile phones, laptops, and other devices and access to other personal information. Apple, Samsung, and many other companies have made use of this feature to unlock phones. It is a perfect way to protect private information in case the phone is stolen or lost. The perpetrator cannot access the sensitive data.

Another critical use of Biometric technology is to grant only authorized people entry to sensitive areas of offices, labs, boardrooms, bank vaults, government buildings, and public events for security reasons. It is challenging to prevent fraud at banks. Many banks have started making use of two or three-step authentication to prevent any frauds, but this will affect the user experience. Thus, we can make use of facial recognition to prevent any fraud by just using a single-step authentication. Similarly, A.T.M.'s also have multiple step authentication, where we can make use of this technology.

This technology can also be used by customs to keep any unnecessary visitors out of the country. The U.S. Custom ad Border Protection is already using this to ensure that the person in the passport is the same as the person showing the passport. Another application that can be done is to make use of facial recognition at polls or vote booths. This must be predominantly used in India, where many people's voter I.D. is being illegally used to put "proxy" votes in exchange for money.

Facial recognition technology can also be used to trace lost children and sex trafficking victims if their information is available in the database, which will reduce the burden and work of the law enforcement by alerting them when a missing person is found anywhere. Three thousand missing kids were found in just four days in India by using facial recognition. Similarly, this can be used to identify criminals and shoplifters. It has been found that this reduces violent incidents in retail stores by up to 91%.

An essential application of facial recognition technology is its use in the healthcare sector. Another application of facial recognition technology is securing patients' information using their unique photo instead of usernames and passwords. This will help hospitals deal with people posing as patients to access treatments and their medications. Facial recognition technology can also be used to identify the visitors in healthcare facilities, which will help secure the facilities and prevent patient fraud.

Diseases that cause detectable changes in appearances can be diagnosed with Face recognition. It can be embedded in mirrors along with a camera and existing technologies like SkinVision's skin analysis and Nuralogix's transdermal optical imaging technique for assessing the amount of tension and blood sugar, most of which can be measured by just staring at the mirror. It can also recommend you take medications when you look too stressed or depressed.

The use of this technology in the Advertising field is gaining importance. Facial recognition technology can be used for target advertisements; if the person is a male between the age of 14 to 22, the screen might show an ad about a FIFA game. If it is a girl between the ages 18 to 20, it might show an ad about the latest makeup brand, which is very useful and can promote products more efficiently. Some apps determine the tone of the skin and suggest skincare products which the customer might purchase. Face-recognition is on its way to gaining widespread use in the advertising industry by becoming an omnipresent advertising technology.

IV. CONCLUSION

As we step into the fourth industrial revolution, we can rest assured that everything revolves around technology and automation. We are witnessing changes in the industries that require technological advancements. These advancements have not only changed the way businesses operate, but they are transforming our day to day lives. Although it has been around ever since the 1960s, recent developments have led to a vast proliferation of the technology. Face recognition technology is continuously evolving day by day due to the extensive help from machine learning algorithms enabling the systems to read facial expressions and detect emotions, thus uniquely identifying a person by analyzing the various patterns based on the shape, facial textures, color, and the distance between the person's facial features. It has complete applications across various platforms. It is used in mundane as well as high-security activities.

Right from being used to unlock mobile phones or personal gadgets, a powerful method to protect one's data ensuring that sensitive information remains inaccessible by any perpetrators to aid in forensic investigations. This is done by identifying individuals from security footage or recognizing dead individuals at a crime scene. According to recent statistics, facial recognition reduces violent crimes in retail stores. Software companies leverage facial recognition systems to help users access their technology. This technology can be further developed in other lanes such as banking, A.T.M.s, and payments, accessing confidential files or other sensitive data. It has the potential to make other security measures such as passwords and keys obsolete. It is used in healthcare not only for security purposes but also to help diagnose diseases, used widely for access control along with individual biometrics including fingerprint or iris recognition systems. However, facial recognition provides the added benefit of a contactless and non-invasive process.

We have focused on how machine learning has rapidly taken charge of the world of artificial intelligence where deep learning and a wide range of algorithms and concepts such as Support Vector Machine, Neural Networks, Convoluted Neural Networks(CNN), Ensemble of classifiers, Extreme Learning Machine(E.L.M.) have been used to exploit the ever-growing potential of Facial Recognition.

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