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Face Identification based on different Convolutional Neural Network Models for Security System: A Review

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Abstract:

Computer based authentication system is reliable and mature in technology driven world. When this authentication is based on biometrics then it is more secure. Face is most prominent identifier in biometric system. Many challenges have come in recognition process when environment is unconstrained. In this paper, different pre trained deep learning models like: VGG16, VGG19, ResNet50, MobileNetV2 are applied to the LFW dataset for Face Recognition. These models are pre trained on ImageNet dataset and for LFW dataset, we achieved the accuracy for fine tune model 73.51%, 74.70%, 87.76%, 90.49% respectively. It has been observed that highestaccuracy has been found by the MobileNetV2which is pre trained on ImageNet dataset.

Keywords:Deep Learning, Face Recognition, VGG16, MobileNetV2, ResNet50.

1. Introduction

In today's technology-driven world, face recognition has come out as an innovative application that bridges the gap between human identity and computational analysis. Humans have a remarkable ability to recognize and distinguish faces. Machines are now being trained to replicate that skill. Face recognition technology has significantly developed, enabling a wide range of applications across various industries, from security and surveillance to user authentication. Since the wide-spread use of computers, authentication has become more requisite. For user's identification, we use three types of data [1]. As we see in figure [1], Authentication system is based on knowledge, possession and inheritance.

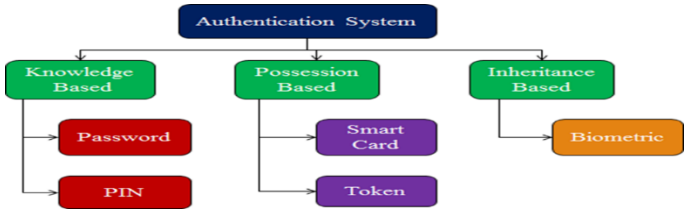


Figure 1:Classification of Authentication system

In smart cities, biometric application is very important [2]. When we have images or videos of crime scene then by the using of face recognition technique play very important role in law enforcement techniques [3, 5]. For authorization purpose, biometric system uses facial features like nose, eyes, forehead, mouth or other features like thumb, iris etc. for discriminating one person to another person [4]. Among all biometric factors, face is one of the main identifier of a human identity.

Figure 2: Types of Image signal analysis

Biometric system mainly based on the images. Figure [2], shows two main basic domain of image signal analysis which are spatial domain and frequency domain [6]. In Each step of frequency domain, frequency distribution is transformed and represented by H as the High frequency band and L as the low frequency band.

Spatial domain refers to the coordinate system for image processing and it works on the pixel value [7]. At its core, face recognition is the process of identifying and verifying of individuals on the basis of their facial features. It leverages advanced algorithms and computational models to extract distinctive facial characteristics from images or videos and match them against known patterns in a database. This technology draws inspiration from the human brain's ability to differentiate faces through complex combinations of eyes, nose, mouth, and other facial attributes.

As we see in Fig 3, in face recognition system three main modules exist: [2]

1) Face Detection

2) Feature Extraction

3) Face Recognition

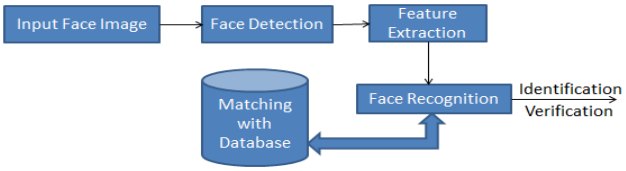


Figure 3: Face Recognition Process

2. Literature Work

In biometric authentication, we identify any person by their behavioral and physiological characteristics and biometric factors play important role in this process. When we use biometric factor in authentication process then only presence of any person in front of the sensor which is captured images, is sufficient to recognize that person. There is no need to remember any code or password. Many recognition systems are suggested by different authors, which are based on different biometric features like fingerprints, iris, faces [8], voice [9] have been deployed.

For user's identification, only eyes coordinates are used of the images and non-face area are excluded by the elliptical mask [10]. For identity classification, face recognition is the primary task and illumination, pose and expression are the secondary task, called Multi-Task Learning [11].

Face shape, head motion, skin color all these combined parameter are used for face recognition [12]. For classification the face and non-face area, support vector machine is used [13]. Sparse Network of Windows (SNoW) learning architecture is used for face identification [14].

Extended local binary pattern is used to improve the discriminating capability of local binary pattern [15]. Local Binary pattern are combined with Gabor wavelets using different methods [16]. In [17] a technique is suggested which using LBP and wavelet. In this method wavelets are used for decompose the images in four different frequency images , i.e. vertical high frequency, diagonal high frequency , low frequency , horizontal high frequency [17].

3. Convolutional Neural Network

Due to the rapid advancement in technology, large volume of data generated and traditional computing resources are not sufficient in processing the data. Recently deep learning technique is in trend because preprocessing, features extraction and recognition all steps are done by the single model of deep learning and provides efficient results [18] .In CNN model , self-optimized learning neuron which are the basic building block of CNN model. Learning of the neurons are done by the adjusting in the neuron's weight. Different layers like Convolutional layers, pooling layers, fully connected layers exist in CNN architecture. As we see in figure 4.

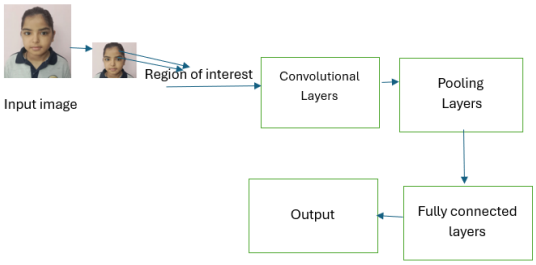


Figure 4: steps of basic CNN architecture

- Convolutional layer: This core block of CNN extract the features from input data by the using of convolution operation. Later, this obtained feature map is transfer to next layer.
- Pooling layer: Down Sampling is done by the pooling layer without the loss of crucial information.
- Rectified Liner Unit (ReLu): Non linearity id provide by this unit.
- Fully connected layer: Classification or Recognition is done by FC layer.

4. Analysis of LFW dataset accuracy on different Convolutional neural network models

In Deep Learning, for train any model we required large size of dataset. When we discuss about face recognition, then class represent the number of identity. In dataset, one person has multiple images with different poses, illumination, and expression. So when we compute the accuracy of any model

then four basic calculations are done. These are TP, TN, FP, FN. On the basis of these calculation, Accuracy is calculate by the given formula in eq. 1.

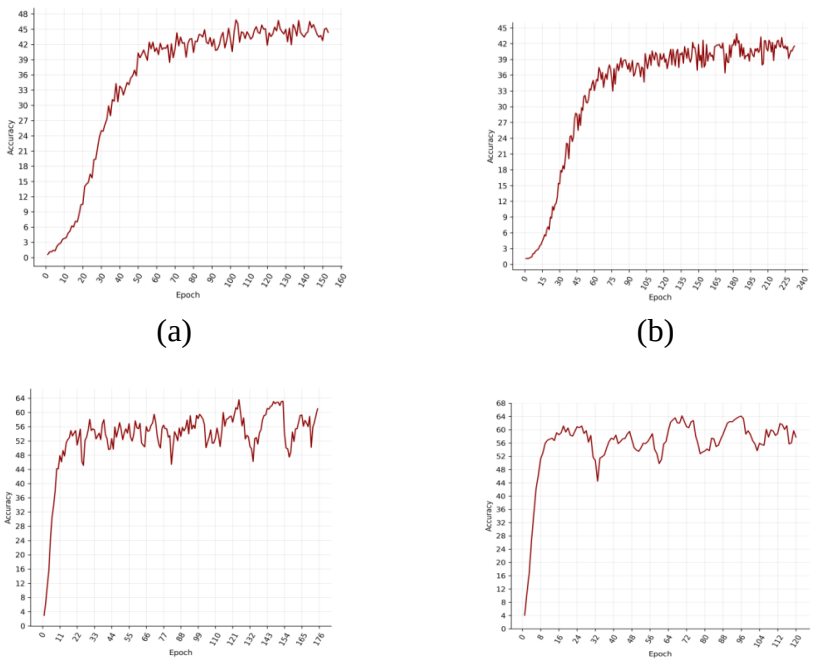
$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

In this paper, we have reviewed the convolutional neural network models on LFW dataset. LFW is used for face recognition in uncontrolled environment. In this dataset 13000 labeled images of 5749 persons. All faces in this dataset are detected by Voila Jones Technique. Some images are coloured and some are gray scale.

In CNN model ,basic unit is self-optimized learning neuron which are the basic building block of CNN model. For any image processing application, we can use pertained CNN model or we can scratch the model from starting. In this paper, we study "VGG16", "VGG19", "Resnet", "MobileNet" model. These models tested on LFW dataset. Table 1 shows the obtained results of implementing different convolutional neural network models, which are pre trained on Imagenet dataset.

CNN Architecture	Accuracy in %
VGG16	73.51
VGG19	74.70
ResNet50	87.76
MobileNetV2	90.49

Table 1: Result of different CNN architectures on LFW dataset



(a) (b)

(c) (d)

Figure 5: Accuracy curves for (a) VGG16 (b) VGG19 (c) ResNet (d) MobileNetV2

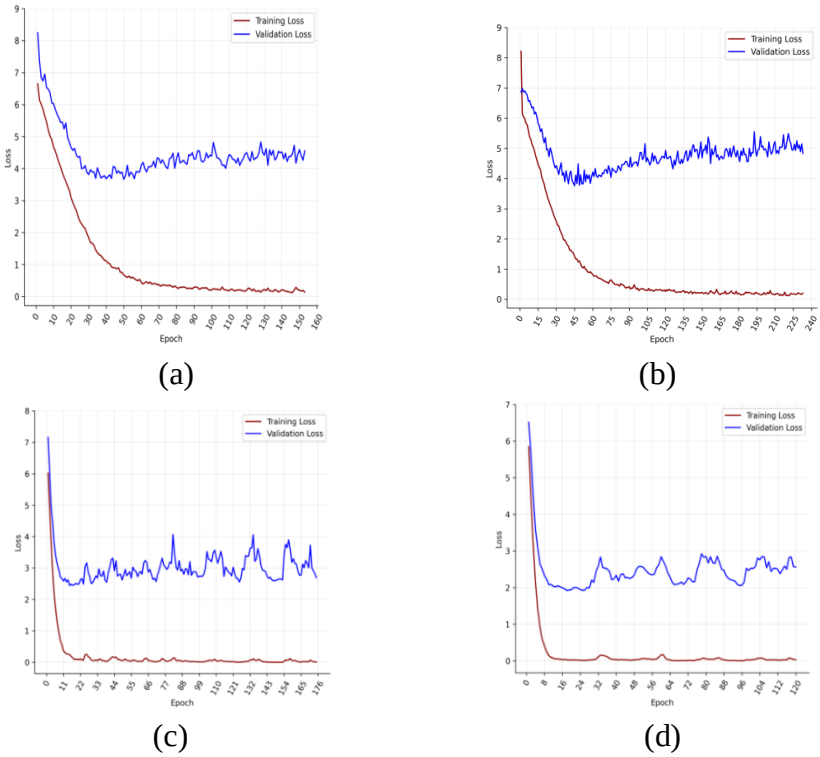


Figure 6: Loss curves for (a) VGG16 (b) VGG19 (c) ResNet (d) MobileNetV2

In Deep Learning, on the basis of model performance on training set and validation set, loss is calculated. Loss represents the total number of errors in validation set or training set. Figure 6 shows loss curves of each CNN models.

In figure 5 and 6 , we have seen that best result given by MobileNet model and worst result given by VGG19 for LFW dataset.

5. Discussion and Conclusion

In the field of image processing, face recognition is very popular application due to widely deployed in many areas. In this paper, a comparative study of Face recognition on LFW dataset is presented and analysis the results of different techniques. We found that results depend on the datasets because many challenges are come like: dataset size, image quality, illumination, poses etc. Due to advancement of Artificial Intelligence techniques, large size dataset required large computational resources. We found that Deep learning techniques given good results in less time. In deep learning, if we use pre trained model on similar type of dataset, then we achieve better results in comparison to other techniques.

Dataset link http://vis-www.cs.umass.edu/lfw/.

References

[1] Maria Papathanasaki, Leandros Maglaras and Nick Ayres, “Modern Authentication Methods: A Comprehensive Survey” AI, Computer Science and Robotics Technology, (2022).

[2] Yassin Kortli , Maher Jridi , Ayman Al Falou and Mohamed Atri, “Face Recognition Systems: A Survey”, Sensors (2020).

[3] Insaf Adjabi, Abdeldjalil Ouahabi , Amir Benzaoui and Abdelmalik Taleb-Ahmed, “Past, Present, and Future of Face Recognition: A Review”, Electronics, 2022
[4] Umarani Jayaraman, Phalguni Gupta, Sandesh Gupta, Geetika Arora, Kamlesh Tiwari, “Recent Development in Face Recognition”, Neurocomputing ,(2020).
[5] Jamal M. Alrikabi a , Kadhim H. Alibraheemi, “Feature Level Combination for Face Recognition Based on Convolutional Neural Networks”, Journal of Al-Qadisiyah for Computer Science and Mathematics Vol. 13(2021).
[6] Yang, A., et al.: “CDF-net: a convolutional neural network fusing frequency domain and spatial domain features”, IET Computer Vision 17(3), 319–329, doi.org/10.1049/cvi2.12167, (2023).
[7] Louis Asiedu , Bernard O. Essah , Samuel Iddi , K. Doku-Amponsah,and Felix O. Mettle, “Evaluation of the DWT-PCA/SVD Recognition Algorithm on Reconstructed Frontal Face Images”, Hindawi , Journal of Applied Mathematics, Article ID 5541522, doi.org/10.1155/2021/5541522, (2021)
[8] Yang,W.;Wang, S.; Hu, J.; Zheng, G.; Valli, C. “A fingerprint and finger-vein based cancelable multi-biometric system”. Pattern Recognition. (2018).
[9] Patel, N.P. Kale, “A Optimize Approach to Voice Recognition Using IoT”. International Conference on Advances in Communication and Computing Technology, Sangamner,India, (2018).
[10] Ahonen T, Hadid A, Pietikainen M, “Face recognition with local binary patterns”.European conference on computer vision. (2004).
[11] Yin X, Liu X. “Multi-task convolutional neural network for pose- invariant face recognition”. IEEE Trans Image Process. (2018).
[12] Jain AK, Li SZ. “Handbook of face recognition”. Springer; (2011).
[13] Osuna E, Freund R, Girosit F. “Training support vector machines: an application to face detection”, IEEE computer society conference on computer vision and pattern recognition. (1997).
[14] Yang MH, Roth D, Ahuja N. “A SNoW-based face detector”. Advanced Neural Information Process System. (2000).
[15] Ojala T, Pietikinen M, Harwood D. “A comparative study of texture measures with classification based on featured distributions”. Pattern Recognition, (1996)
[16] Shan S, Zhang W, Su Y, et al. “Ensemble of piecewise FDA based on spatial histograms of local (Gabor) binary patterns for face recognition”. In: Null. (2006).
[17] Tan X, Triggs B. “Fusing Gabor and LBP feature sets for kernel-based face recognition”.International workshop on analysis and modeling of faces and gestures. (2007).
[18] A tutorial survey of architectures, algorithms, and applications for deep learning. Deng, L. s.l. : APSIPA Trans Signal Inf. Process, Vol 3, (2014).