International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

# Face Recognition in Infrared Imaging using Deep Learning

**Fabian Baretto[1], Hadi Khan[2], Umer Karbari[3], Sajjad Syed[4], Umer Zhaga[5]**

[1]*Professor, Dept. of Electronics and Telecommunication, Xavier Institute of Engineering, Mumbai, Maharashtra, India*

[2,3,4,5]*Student, Dept. of Electronics and Telecommunication, Xavier Institute of Engineering, Mumbai, Maharashtra, India*

---

**Abstract -** *Face recognition is a rapidly growing research area due to increasing demands for security in commercial and military applications. Systems based on visible spectrum are sensitive to illumination changes, pose and expression changes leading to reduction in accuracy. Thus, there is a need of Infrared(IR) imaging as they are invariant to changes in illumination and can capture even in low light conditions. This paper presents a deep learning approach based on convolution neural networks for face recognition in infrared imaging.*

***Key Words***: Face Recognition, Visible, Infrared, Illumination, Deep Learning, Convolution.

## 1. INTRODUCTION

### 1.1 Deep Learning

Deep learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks. Machine Leaning fails to train very large datasets, thus Deep Learning approach has been taken. Basically deep learning is used to classify high dimensional data. There are multiple layers in deep learning to process features, and generally, each layer extracts some piece of valuable information. Out of many architectures, we are using Convolutional Neural Networks for our face recognition model because they allow us to extract a wide range of features from images.

### 1.2 IR Spectrum

IR imaging have been suggested as an alternative source of information for detection and recognition of faces, when there is no control over lighting conditions. The IR spectrum can be divided into four sub-bands: near IR (NIR; wavelength 0.75 – 1.4μm), short wave IR (SWIR; wavelength 1.4 – 3μm), mid wave IR (MWIR; wavelength 3 – 8μm), and long wave IR (LWIR; wavelength 8 – 15μm) [1]. IR energy is also less affected by scattering and absorption by smoke or dust than visible light [2]. Unlike visible spectrum, IR imaging can be used not only to extract external, but also useful subcutaneous anatomical information, such as a face's vascular network [2].

### 1.3 IR Face Recognition

Among all kinds of face recognition methods, the most important thing is to extract the essential features and eliminate part of the impact of non-identity factors (environmental illumination, posture , facial expression and decoration). Specifically, uncontrolled illumination change is a most important issue to be resolved for the practical application. To solve the illumination-dependent problem, researchers conduct face recognition using images beyond the visible spectrum, such as near-infrared and thermal range.

Recently, near infrared imagery (NIR) has been used in many FR systems because of the high robustness of NIR cameras to illumination variations and the high quality of the acquired images [3]. As a result, FR systems based on NIR imagery are more accurate than those based on visible imagery [3].

## 2. LITERATURE REVIEW

This section summarizes some of the scholarly articles and research works in the field of Deep Learning and Convolutional Neural Network for face recognition applications. In [4], A face recognition method based on Convolution Neural Network (CNN) was presented. The network consisted of three convolution layers, two pooling layers, two full-connected layers and one Softmax regression layer. Stochastic gradient descent algorithm was used to train the feature extractor and the classifier, which extracted the facial features and classified them automatically. In [5], the authors proposed a convolutional neural network(CNN) architecture for NIR face recognition where they obtained the images from the PolyU-NIRFD database and extracted, classified the features by CNN, which automatically learned features from NIR face data. In [6], the authors presented a CNN method for thermal face recognition on RGB-D-T face database based on three conditions, i.e. head rotation, expression variation, illumination variation, which affect recognition rate and concluded that CNN is a promising method for the thermal face recognition under extreme conditions, such as side face view and rapid changing illumination environment. In [7], the authors presented a near infrared (NIR) image based face recognition system. They described a design of NIR image capture device which minimized influence of environmental lighting on face images. Both face and facial feature localization and face recognition were performed using local features with AdaBoost learning.

## 3. PROPOSED METHOD

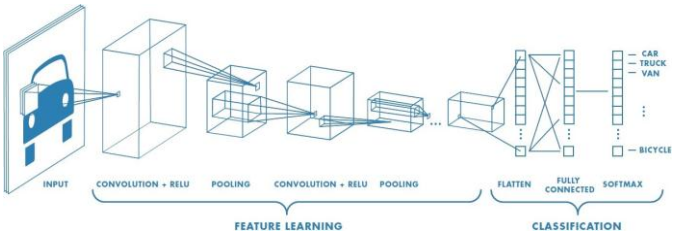


**Fig -1**: Neural Network with many convolution layers [8]

In neural networks, Convolutional neural network (ConvNets or CNNs) is one of the main categories to do images recognition, images classifications[8].

### 3.1 Convolution

Convolution is the first layer where features are extracted from an input image. Convolution maintains the relation between pixels by using small squares of input data to learn image features. It is a mathematical operation that takes two inputs like the matrix of the image and a filter or kernel.

### 3.2 Strides

Stride is the number of pixels transferred over the matrix of the data. When the stride is 1 we move the filters at a time to 1 pixel. If the stride is 2 we switch the filters at once and so on to 2 pixels.

### 3.3 Padding

Sometimes, the filter does not perfectly fit the input image. Here we have two options, either pad the picture with zero-padding so that it fits, or drop the part of the image where the filter did not fit.

### 3.4 ReLU

We have selected Rectified Linear Unit (ReLU) as our activation layer. The output is f(x) = max(0,x). The purpose of ReLU was to introduce non linearity in our ConvNet. Since, the real world data would want our ConvNet to learn non-negative linear values.

### 3.5 Pooling

The principal idea of pooling is down-sampling to reduce complexity of further layers. Spatial pooling reduces the dimensionality of each map but retains the important information. We have used Max pooling which takes the largest element from the rectified feature map as it is one of the most common types of pooling methods.

### 3.6 Fully Connected Layer

The layer we call as FC layer, we have flattened our matrix into vector and feed it into a fully connected layer like a neural network.

## 4. IMPLEMENTATION DETAILS

The program used is a python programmed CNN which makes use of multiple convolutions to train, validate and test the data fed into the program. The program is edited by increasing the number or decreasing the number of convolutions, various parameters to get an optimum accuracy.

### 4.1 DATASET

We have used Near Infrared Face Database. The video database contains faces with different facial rotations as well as varying facial expressions. The subjects were from different geographical regions of India, which ensures diversity in the database. The database consists of 60 subjects in various poses, facial expressions and occlusion conditions in NIR illumination [9].

**Fig -2:** Sample pictures

### 4.2 Data Pre-Processing

Images were extracted from the video database and the dimensions were reduced to 128x128. Data labelling was performed and it was then given as an input.

### 4.3 Training and Testing Phase

For training the model, 80% of the data was allotted and 20% of the data for testing phase.

### 4.4 Training Parameters

Learning Rate : 0.01
Batch Size : 5
Epochs : 20
Hidden Neurons : 100

## 5. RESULT

The training of the CNN on the Near Infrared Face dataset resulted in an accuracy of 90-95%. The system is able to correctly identify the faces, on which the model has been trained, and authenticate them.

## 6. CONCLUSION

In this paper, a CNN-based face recognition method is developed as CNNs are widely used for image classification. CNN implements a powerful learning capability. The individual face features are automatically learnt from the feedback information. The use of infrared imaging can be applied to overcome illumination, pose and facial expression changes, and facial disguises over visible spectrum.

## REFERENCES

[1] Shoja Ghiass, R., Arandjelović, O., Bendada, A., & Maldague, X. (2014). Infrared face recognition: A comprehensive review of methodologies and databases. Pattern Recognition, 47(9), 2807–2824.

[2] Ghiass, R. S., Arandjelovic, O., Bendada, H., & Maldague, X. (2013). Infrared face recognition: A literature review. The 2013 International Joint Conference on Neural Networks (IJCNN).

[3] Farokhi, S., Flusser, J., & Ullah Sheikh, U. (2016). Near infrared face recognition: A literature survey. Computer Science Review, 21, 1–17.

[4] Yan, K., Huang, S., Song, Y., Liu, W., & Fan, N. (2017). Face recognition based on convolution neural network. 2017 36th Chinese Control Conference (CCC).

[5] Zhang, X., Peng, M., & Chen, T. (2016). Face recognition from near-infrared images with convolutional neural network. 2016 8th International Conference on Wireless Communications & Signal Processing.

[6] Zhan Wu, Min Peng, & Tong Chen. (2016). Thermal face recognition using convolutional neural network. 2016 International Conference on Optoelectronics and Image Processing.

[7] Li, S. Z., Lun Zhang, ShengCai Liao, XiangXin Zhu, RuFeng Chu, Meng Ao, & Ran He. (n.d.). A Near-infrared Image Based Face Recognition System. 7th International Conference on Automatic Face and Gesture Recognition (FGR06).

[8] https://medium.com/@RaghavPrabhu/understanding-of-convolutional-neural-network-cnn-deep-learning-99760835f148

[9] S L Happy, A. Dasgupta, A. George and A. Routray, "A Video Database of Human Faces under Near Infra-Red Illumination for Human Computer Interaction Applications," in IEEE Proceedings of 4th International Conference on Intelligent Human Computer Interaction, Kharagpur, India, 2012.