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An Efficient Approach of Finger Knuckle Print Based Recognition Using Googlenet Model

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Abstract: ***The need of personal recognition and identification became necessary in order to keep intruders away and to allow only the legitimate persons in order to protect privacy and to secure data from being altered. But, with the technological evolution and increasing risk of data theft, it has been a mandatory demand. A persons's identity is not limited to his/her name, password or PIN but today, their biometrics are being used as an integral part of their identification. The emergence of Deep learning, a subset of Artificial Intelligence, brought a revolution in the field of computer vision and biometric identification. The Convolutional Neural Network (CNN) models of Deep learning possess a resemblance to the human brain and it brought a revolution in the field of computer vision and biometric identification. I adopted a transfer learning approach by using a pre-trained CNN model, GoogleNetfor conducting my experiment. The GoogleNet model automatically does all the image processing operations as well as the extraction of features too. I chose a very unique human biometric trait for this experiment, which is a person's Finger Knuckleprint (FKP). It bears a complex pattern and unique structures. I requested the knuckleprint samples from The Hong Kong Polytechnic University and I used its Contactless Finger Knuckle Images Database (Version 1.0). An excellent result obtained by conducting this experiment.***

Keyword: Finger Knuckle Print, Convolution, GoogleNet, Feature Extraction, Classifier.

I. INTRODUCTION

Today, we are living in a world of Machine age where almost our all the activities are completely dependent on a mouse click. In the Artificial Intelligence dominated world, our digital identity, location and current status are known to everyone. Digitization has demolished the boundaries between countries and thus, it has united people across the globe. But, at the same time, it has raised a question mark against security, authenticity and privacy of data. Data is one of the main assets for a person or for any organization, so, its security is of supreme importance. Today organisations are considering many security measures to deal with cyber fraud, but in spite of all, intruders always try to find a way. Person verification and recognition become a crucial task in order to deal with the identity theft.

Today human biometric features have conquered and replaced the traditional password or paper based ID cards in many services due to its accuracy and hassle free availability.

When data security uses the flavour of human biometrics, it becomes more robust and almost impossible to breach. A lot of human biometrics has been studied till today, such as- face, fingerprint, palmprint, iris, ear, hand, signature, voice, DNA, ECG etc. Experiments are being done using other unique and irreplaceable biological properties of human being. Finger Knuckle Print (FKP) is a recently explored biometric trait which is present on the finger joints at outer palm area. FKP can be considered as a unique identifier as all the outer joints of each finger bear some uniqueness by having different lines and wrinkles.



Figure 1: Finger Knuckle Print of different fingers.

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II. LITERATURE REVIEW

Biometric based recognition recently gained attention in the field of computer vision but it is not new to the mankind as it has been the primary and natural source of identification for all times. Several experiments have been done using different human biometrics and researchers are trying their best to get maximum recognition accuracy.

Hammouche et al. [1] proposed a Finger Knuckle print (FKP) based identification system. He extracted features using Phase Congruency method with Gabor filters bank descriptors and he used PCA and LDA for dimensionality reduction. Finally he used cosine Mahalanobis distance method for matching. Waghode et al. [2] worked on FKP recognition. He used PCA for extracting features and matching was performed using LDA and Probabilistic Neural Network (P-NN) classifiers. Zhai et al. [3] introduced a Batch Normalized Convolutional Neural Network (CNN) architecture for FKP recognition. Muthukumar et al. [4] proposed a FKP based biometric system where he used short and long Gabor feature extraction methods. He used Hamming Distance (HD) and Support Vector Machines (SVM) for matching the features. Nigam et al. [5] developed a FKP authentication system by fusing multiple texture features. He extracted Region of Interest (ROI), by using curvature Gabor filter algorithm and he used Gradient-Based Ordinal Relationships technique for ROI enhancement. Finally, he adopted Dissimilarity Incorrectly Tracked Corners measure for matching purpose. Amira et al. [6] proposed an efficient multimodal identification system for FKP recognition by using Transfer learning approach. He proposed two popular pre-trained models of Deep Convolutional Neural Network, VGG–16 and VGG-19 for feature extraction.

III. ROLE OF CNN IN IMAGE CLASSIFICATION

The introduction of deep learning technology in the field of computer vision is like a new morning. It actually let us know the way the machines actually precepts or conceives the images and how do they perform transformation and manipulation on it. Deep learning uses neural networks which are actually derived from the working of biological neurons. In a typical neural network, as far as the no. of layers increase, the no. of parameters increase, which use to make training computationally complex and time taking [7]. Convolutional Neural Network (CNN) evolved to overcome such overheads. CNN is a feed forward, Deep Neural Network model having a set of layers where each layer is fully connected with other layers in the network. CNN was basically designed for image processing tasks but now it has set a milestone in text and speech processing too.

A. Working of CNNs on an Image

CNN has a layered architecture where each layer performs some actions and the output obtained so, are used by its consecutive layers. The first layer is input layer which accepts the image input in the form of matrix. The model selects some image filters having same depth as the image, which are meant for extracting features. A convolution operation is performed at the Convolutional layer of CNN where the small filters or kernels use to convolve across the input image. This convolution operation takes place from top to bottom and in left to right direction until the entire image is scanned. In this way, an element-wise matrix multiplication takes place and a new small matrix is obtained, which is known as feature map. After convolutional layer, an activation function is applied at ReLU layer which adds non-linearity to the network. This layer uses an activation function f(y) = max(0,x) to the feature maps which turns all the negative values to zero. ReLU actually activates the model for faster learning by minimizing computational overheads present in other activation functions. The feature maps obtained from convolution operation are of different dimensions and possess sensitivity to the location of the features in the input image [8]. So, it is required to make these feature maps prone to any change, whether it is translation, rotation and location by performing down sampling. The down sampled and flattened output data from Pooling layer is passed to the Fully connected layer. This layer provides full connectivity among all the neurons of one layer to another. The Fully connected layer is followed by a Softmax layer which best suits for multi classification problems. For any positive, negative or zero input value, the Softmax function always outputs in terms of probability between 0 to 1 [9]

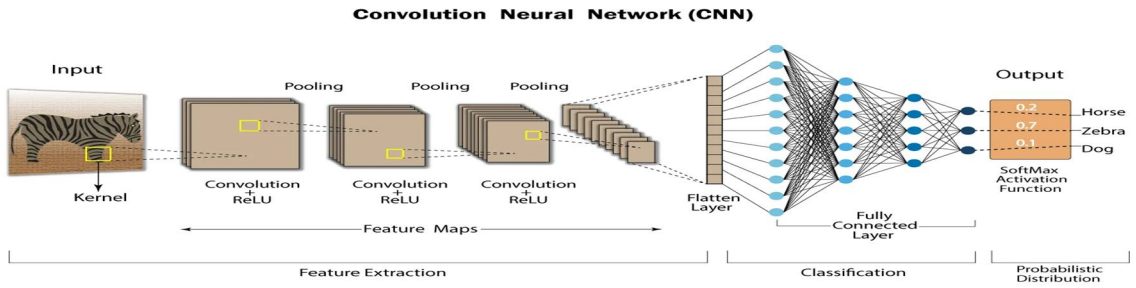


Figure 2: working of a Convolutional Neural Network [10].

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IV. THE PROPOSED MODEL

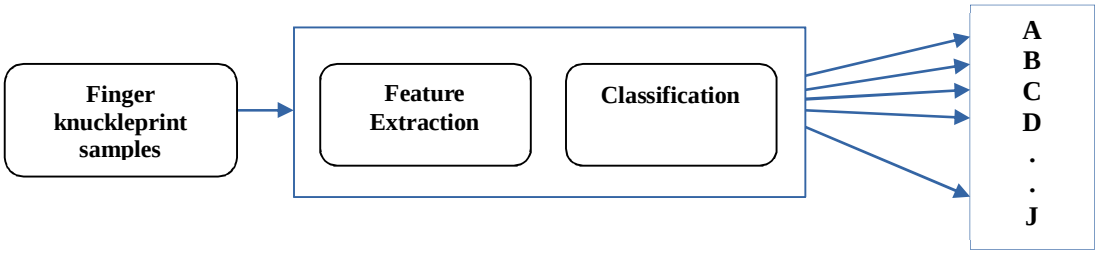


Figure 3 : Feature extraction and classification using GoogleNet

I have designed a CNN based Recognition system using a biometric trait Knuckle print. Several researches have been done using different CNN models. Here, I chose pre-trained Googlenet Model for image classification.

GoogleNet- The GoogleNet has 22 layers deep architecture with 27 Pooling layers. GoogleNet has been the winner of ILSVRC Competition held in 2014 with an error rate of 6.67% **[11]**. The basic idea behind designing this model is to obtain a deeper architecture with increased computational efficiency. GoogleNet model accepts input images in the dimension of 224x224 and uses small convolution filters of 1x1, 3x3 and 5x5 for reducing dimension.

V. METHODOLOGIES

1) I used Finger Knuckle print images from The Hong Kong Polytechnic University Contactless Finger Knuckle Images Database (Version 1.0)[12].
2) All the knuckle print images used in this experiment have been labelled and grouped properly.
3) The Finger Knuckleprint data is then loaded to the model.
4) I categorised the entire images into training and validation set.
5) I have a few dataset, so, I chose Transfer learning technique of Deep CNN.
6) I have conducted feature extraction using GoogleNet model which has already been trained on large set of images.
7) Then I used Fit multiclass models of Support Vector Machine classifier for classifying the images using proper label.

VI. EXPERIMENT RESULT AND DISCUSSION

The proposed work uses neural network approach for identifying a person based on his finger knuckleprint samples. I obtained the samples from the Hong Kong Polytechnic University Finger Knuckle Images Database (Version 1.0) on request. The knuckleprint samples belonging to a person is saved in a folder with that person's name. I have total 100 samples and the classification is to be done among 10 persons. The entire samples of finger knuckleprint data has been categorized into 80% of training and 20% of validation data. The experiment has been implemented using Matlab R 2018a.

The data has been loaded into RAM using **imageDatastore** function. Then **splitEachLabel** function groups the data into two new data stores namely- Training and Validation, where 80% of data is randomly reserved for training and the rest 20% for validation. I preferred to conduct my experiment using transfer learning technique because I have a limited amount of data and resources. Transfer learning is a simple approach of solving a problem by reusing a neural network model which has already been trained on a large amount of data. It saves our time to build a new model from scratch for similar type of problems. For this, I chose GoogleNet model to accomplish my work.

gnet = googlenet, net.Layers.....(1)

In equation (1), only the architecture of the GoogleNet model has been assigned to a variable **gnet**. The input image dataset is, then passed through a number of convolution layers and features are extracted which are finally obtained from **'loss-3 classifier'**. After getting the feature table, **fitcecoc** function has been used for classification. The **fitcecoc** is a powerful function, used to fit multiclass Support Vector Machine classifier. By using this function, the model predicts and classifies the given datataset with the associated labels. The output samples obtained here, is-

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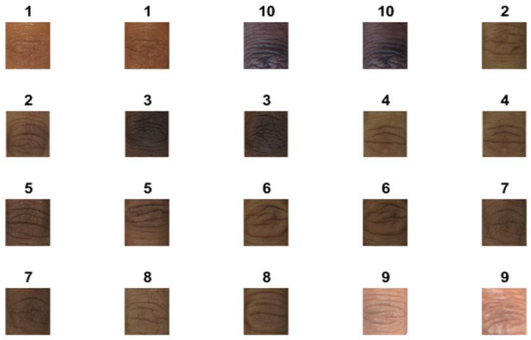


Figure 4: Classification result.

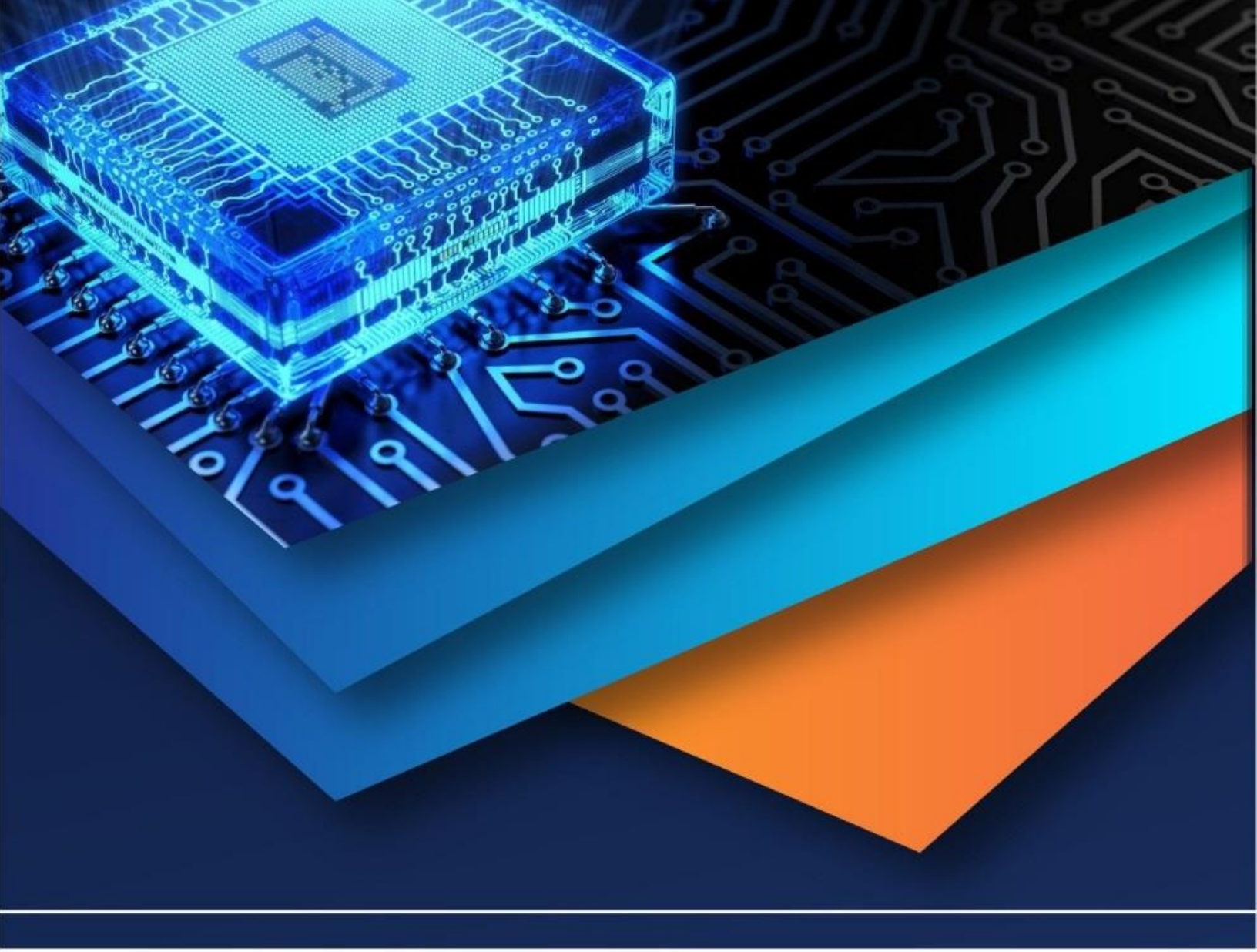
In the above figure, we see the knuckleprint images with their class names which have been grouped earlier into 1,2,3.....10 labels. This experiment has shown a very good result with 100% accuracy.

VII. CONCLUSION

In my paper, I presented a neural network approach for a person's recognition by using his/her Finger Knuckleprint images. A lot of studies have been conducted using traditional methods and by using the most prominent biometric features. But, I chose Finger Knuckleprint which carries its own peculiarities and the experiment was performed using transfer learning method of a CNN model. Rather than going through the conventional methods of feature extraction, I used Googlenet architecture for extracting features and a multiclass SVM model for classification. In this way, I achieved 100% recognition accuracy.

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