Fingervein Detection Using Image Processing

Keerthi N
Dept. of Compute Science&Engg.
K S INSTITUTE OF TECHNOLOGY
keerthin321@gmail.com

Meghana G R
Dept. of Computer Science & Engg.
K S INSTITUTE OF TECHNOLOGY
reddymeghana9931@gmail.com

Shriraksha S Kanago
Dept. of Computer Science & Engg.
K S INSTITUTE OF TECHNOLOGY
shriraksha2000@gmail.com

Meghana H S
Dept. of ComputeScience&Engg.
K S INSTITUTE OF TECHNOLOGY
meghana.hs12@gmail.com

Vijayalaxmi Mekali
Assistant Professor
Dept. of Computer Science & Engg.
K S INSTITUTE OF TECHNOLOGY

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Abstract— Finger vein detection is a technique used to recognize a person using their finger vein patterns which are present beneath the skin which intrinsic trait of human. Authentication using intrinsic biometrics such as finger veins provides high security, low forgery rate and confidentiality. This paper presents finger vein identification process, including four steps which are finger vein image acquisition, image processing , feature extraction and classification.

Keywords - Near Infrared Rays, Convolution Neural Network, Personal Identification Number, Finger vein, Image pre-processing, confidentiality, security

I. INTRODUCTION

Earlier people use to identify each other according to their various biological traits for ages. People identify others by their face when they meet each other and by their voice during conversation. The earlier ways to recognize or identify a person with private information is by the use of passwords or Personal Identification Numbers (PIN), magnetic swipe cards, keys and smart cards that are easy to implement but can be spoofed easily as they are extrinsic traits .Therefore, extrinsic biometric traits can be spoofed easily.

As a result, biometrics that involves analysis of human biological, physical and behavioural characteristics has been developed to provide more reliable security. Many systems using these have been developed and implemented which uses extrinsic traits, namely face, iris, finger print, palm print, voice, signature and so on. By using biometric identification which identifies a person using his/her finger vein recognition, where the condition of the finger surface such as dryness, sweat and skin distortion decreases the recognition accuracy and also security. Each and every individual has a unique pattern of veins which is different in case of identical twins also. As the individual grows, the vein patterns does not change and also it is resistant to weather conditions.

For identifying the pattern of the finger vein is stored in a database. The finger vein image is scanned by using NIR-near infrared rays with web camera. The hemoglobin present in the blood absorbs the near infrared light and makes the vein to appear as dark pattern then the earlier. The recorded image is processed and stored in the database. During identification, the finger vein is scanned and is compared with the image in the database. The proposed paper deals with the identification process of finger vein using CNN.

Table-1: Various Intrinsic and Extrinsic Biometric Features

Technique	Security	Cost	Drawback
Face	Normal	Low	Lighting
Voice	Normal	Low	Noise
Iris	Excellent	High	Glasses
Fingerprint	Good	Low	skin
Finger	Excellent	Low	Disease

II. OBJECTIVES

Our main aim is to identify a person using his/her finger vein pattern. This involves image acquisition, image pre-processing, feature extraction and classification using Convolutional Neural Network.

III. METHODOLOGY

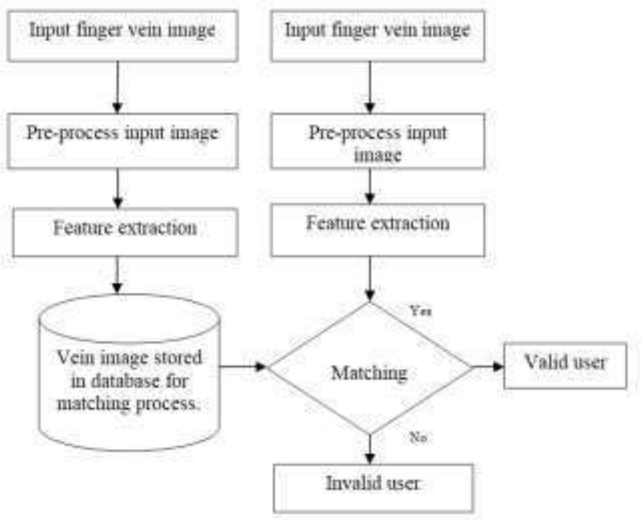

Fig 2.1: Flow Chart of Finger Vein Identification System

The above fig 2.1 shows flow of finger vein authentication system.

The different steps involved in finger vein image identification includes image acquisition, image pre-processing, feature extraction and classification.

Fig 2.2: Design

A. Image Acquisition

Image acquisition is the first step in the finger vein recognition system. Image acquisition is of two types off-line and online. On-line images are the images which are taken in real time using webcam and led lights and off-line images means the images which are taken from already created database .

We have collected database from Kaggle website which provides dataset for many projects.

There are 106 folders, in which each folder have two subfolders consisting of right and left finger samples. Both Right and left folder having 18 images of each person which includes index, middle and ring finger images.

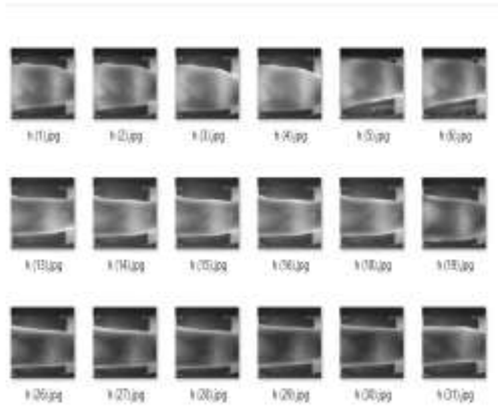

Fig 2.3: Datasets from Kaggle website

The images in real time can be obtained by normal web camera or by designing a finger-vein imaging device based on light transmission for more distinct imaging. The NIR (near infra-red) light that can pass through a finger, haemoglobin in the blood that can absorb more NIR light than other tissues. When the vein of a finger absorbs infrared light, the image of the finger vein can be acquired as a dark line. Near Infra-red Ray imaging is secure because it passes through the finger to capture the images.

B. Pre-Processing

Pre-processing is the second step in our project, a number of pre-processing methods are required to enhance the image quality, such as filtering techniques, brightness, edge detection, noise removal, sharpen image, etc, further, to produce a better quality of image that will be used on the further steps and ensure that relevant information can be detected. The good quality of image will give the good accuracy rate to the biometric system itself. In this paper we proposed 3 pre-processing methods that are required for proposed system.

I. Gray Scale Conversion

RGB to Gray scale conversion is required only in case of real time image acquisition as our dataset is already in gray scale format. Converting the image to gray scale reduces the complexity in processing images.

II. Median Filtering

We considered various filtering technique like averaging, gaussian filtering and median filtering. Since our data is non-linear and execution time is less for median filtering .Among the three considered filtering technique median filtering is chosen for filtering the obtained image.

Median filtering is a nonlinear method which is used to remove the salt and pepper noise from the obtained images. It is widely used because of its nonlinearity. It is very useful at removing noise without disturbing edges. It removes salt and pepper type noise which degrades the image quality. The median filter is applied on image pixel by pixel, replacing each value with the median value of neighbouring pixels forming a pattern of neighbours called window which will be as a matrix. Then the median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel with the median value.

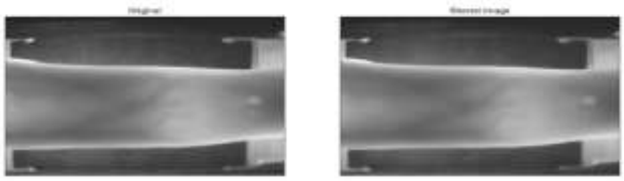

Fig 2.4: Median filter output

III. Canny Edge Detection

The Canny edge detection is an edge detection algorithm that uses a multi-stage algorithm to detect a wide range of edges in images. This reduces the execution time further by taking the content in the image which is bounded by the detected edges. Before edge detection the image must be filtered using median filtering technique to decrease the calculation complexities and to increase accuracy of the system. Calculate the values that helps to identify the edge intensity and direction. The maximum intensity value of edge is calculated. If the intensity is greater than max value that edge is taken into consideration and all the neighbouring edges with more intensities are considered. The edges with less intensities are discarded.

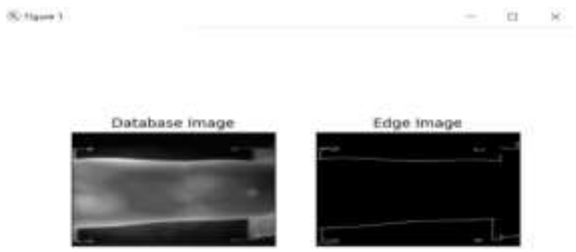

Fig 2.5: Canny edge detection

C. *Feature Extraction*

Feature extraction is the most significant step in this authentication process. The finger-vein patterns are extracted by calculating various features like vein width, height, horizontal & vertical flips of vein. Then they are stored in the database which can be used for identification purposes.

It is a form of reducing dimensions which reduces execution complexities. It is a transformation of input data into the set of features. In the proposed paper for this feature extraction process, we use CNN algorithm. The CNN consists of: Convolutional Layer, Pooling Layer, activation functions (Relu), and Fully-Connected Layer. Keras Sequential model is used which is appropriate for a plain stack of layers where each layer has exactly one input tensor and one output tensor. Features like height, width, horizontal and vertical flips are extracted from the fully connected layer.

The convolutional layer processes the input image and extracts many kinds of features by applying suitable number of filters and Relu activation function. Then further pooling layers maps the feature and shrinkens the image into one single vector which is fed into FCL which will process the feature through the network. This steps are repeated until we have a well-defined neural network. Finally, the obtained features are compared which can be used for person identification uniquely.

D. Classification

When the training code is executed the model will be generated in the background which consists of all the features.

After features are extracted from the vein image classification is performed to measure the similarities or dissimilarities between the input finger vein image features and the previously enrolled ones in the database.

After training the model with obtained images through dataset or real time captured image. The trained model is tested for classifying the results based on the height, width, horizontal & vertical flips features. Execution of training code results in log file which consists all extracted features. Then np.argmax() is used to predict which feature is matching based on which the classification is done on users.

IV. EXPERIMENTAl RESULTS

Firslty, user has to login using his login details and upload the image of his finger vein or through camera .We have used filedialog python library to upload the image.

Pre-processing is done after images are acquired from the image acquisition step. Gray scale conversion is done for images which are captured from real time. Median filtering is performed, which removes noise and unwanted background which reduces complexities. Filtered image edges are detected using canny edge detection.

Fig 2.6: Snapshots of login page and fetching image from device for identification

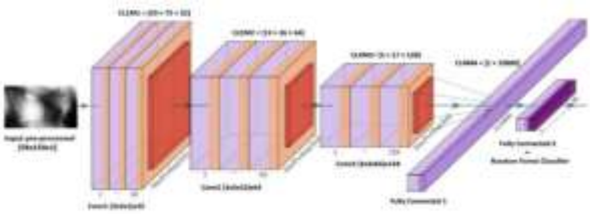

Fig 2.7: CNN diagram

Convolutional Neural Network is build using Keras sequential model. The model has 4 layers: Convolutional layer, Relu layer, Max pooling layer, Fully connected layer. Firstly ,a convolutional layer with 32 kernels of size and Relu activation is applied. A max-pooling layer with a stride of two in both directions, dropout with a probability of 0.3.A second convolutional layer with 64 kernels of size and Relu activation. A second max-pooling layer with a stride of two in both directions, dropout with a probability of 0.5.A third convolutional layer with 128 kernels of size , dropout with a probability of 0.8. A fully connected generates a log file which consists all the extracted features. The top fully connected layer consisting of nodes followed by a softmax activation.

Convolutional layer contains multiple number of kernels each performing convolution on its input data. Each convolution kernel is a two-dimensional array of certain weights. Features are generated from a convolutional layer with the number of them equivalent to the number of convolution kernels in the layer. Features are obtained by rotating the input maps with their kernels respectively by applying an activation function (Relu) only the wanted part of the image is sustained all other edges are set to 0 in the matrix.. Each of these convolutions, in the software level, involves various matrix multiplications, which take up 80-90% of the execution time. Therefore, convolutions are highly computation and memory intensive when training the CNN they make up the majority of floating point operations in neural networks designed for image classification ,object recognition etc.

Further each and every convolutional and pooling layer contains a rectified linear activation layer (Relu) at its output. In Relu layer activation function is applied to every input after adding learnable bias. The rectified linear activation function itself outputs if the input is greater than 0, otherwise the function outputs 0. The softmax layer is basic to multi-class classification problems. The softmax layer applies the softmax activation function to each input after adding a activation function. The softmax activation function outputs a regularised form of its inputs. By doing so, it gives the confirmarion that the sum of its outputs is exactly equal to 1. This allows classification to choose the index of the node that has the greatest value after softmax activation as the final class prediction.

After features are extracted according to the obtained features like length, width and horizontal and vertical flips we will predict the results based on mentioned features using np.argmax() which gives maximum matched feature for classification. Classification status is stored in .csvfile which is further used for application purpose.

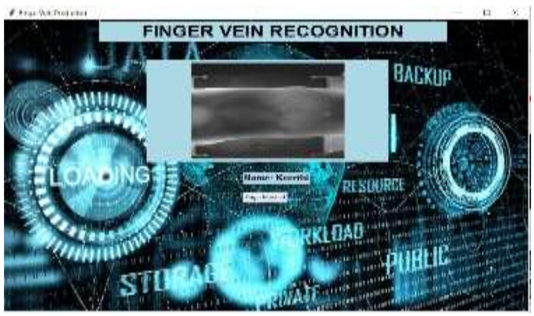

Fig 2.8 :shows the snapshot of how the finger vein image is classified.

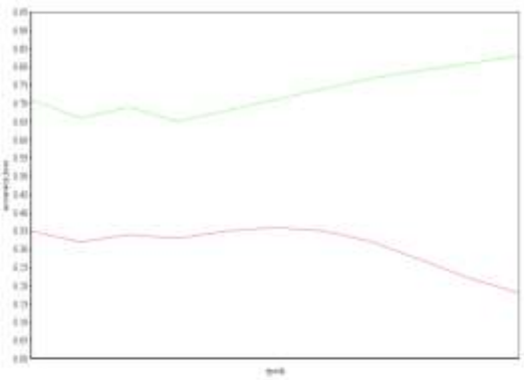

Fig 2.9: Accuracy & loss versus epoch distribution

The above graph shows the accuracy and loss versus number of epoch given for proposed system.

We are getting 91% accuracy for software part. In each right & left folders we will take 33 images for training the model and 3 images for testing for prediction.

V.CONCLUSIONS

In this paper, various steps in finger vein authentication system were discussed. This paper walks through the deep learning methods which are emerged to extract finger vein patterns to improve the accuracy of the recognition system was presented. In recent times, various algorithms have been developed to address the security problem, but there are still requirement for fast and efficient biometric recognition which identifies the person uniquely. Reducing training time thereby improving verification performance is still an area to be explored.

As part of future work we are planning to implement the same thing by taking real time images which require monochromatic IR based high resolution camera with IR led's.

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