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Palm Vein Image Classification using Neural Network

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***Abstract:** Image classification is the process of identifying and deciding what the image is by analysing the numerical properties of the different features of image and then organizing these data into categories. Image classification consists of training and testing. This is implemented using Raspberry Pi and an IR Camera module. And the classification is done using artificial intelligence. The various steps related to this are pre-processing of image, detecting ROI, extraction of features, neural network etc. Image classification is core for computer vision and has numerous practical applications. Two of these are baggage scanning and palm vein recognition. The technique of image processing and artificial intelligence can be used to scan the objects in a baggage and to indicate whether the object is dangerous or not. Palm vein recognition is a very useful and reliable tool for biometrics. Its advantage is that it can detect whether a person is dead or alive and since it is hidden inside the skin it is almost impossible to be imitated and won't be affected by various skin problems as in the case of fingerprint recognition technique. Thus the results from our experiment can be used for wide variety of applications.*

***Index Terms:** Palm vein, Pre-processing, PNN, CNN.*

I.INTRODUCTION

Identifying various components or extracting and analysing different features from an image is a very important function of computer vision and can be used in each and every field. As in baggage scanning in airports, determining various diseases like cancer or diabetes in medical science or for segregating different materials in an industry etc. there are some of the innumerable ways we can make use of image classification. Therefore this is an area where good amount of research work is taking place. In this paper we employed image processing in real time images and then classified the objects with the help of neural networks. We mainly focus on palm vein image classification which is a biometric technique which is one of the latest technology today. Biometric is derived from the Greek words bio and metric, which means life and measure. Biometrics is the way of identifying or authenticating people by taking into consideration various physical or behavioural patterns that are unique to each and every individual. Some of the ways include iris recognition, fingerprint recognition, face recognition, voice recognition, vein recognition, typing recognition etc just to name a few.

In a Palm vein recognition the blood vessel pattern of the person is taken into account. Palm has a more intricate pattern of vessels and are devoid of hair and it is less prone to change in colour hence it's an ideal part to take for identification [1]. Using palm vein we will able to know whether a person is dead or alive. It is unique even for identical twins, hard to be destructed and difficult to be imitated. It is also not much affected by epidermis problems So it's a good approach to recognize humans[2].The absorption wavelength of deoxygenised haemoglobin is in the order of 760nm.The accuracy and robustness of the Palm vein recognition system is better when compared to the Dorsal vein recognition system [3]. Thus palm vein recognition system has high level of accuracy because of the complexity and uniqueness of palm vein patterns.

II.METHODOLOGY

In this paper we would be demonstrating the design and implementation of image classification with the help of raspberry pi. The database for the recognition of Palm Vein recognition is created using an IR camera. First image is captured using the IR camera and converted to pixel form. Pre-processing is employed to enhance the feature of image. During pre-processing the image is converted to grayscale and various filters are used for noise reduction and the histogram of the image is obtained. Then the ROI is detected to extract the features. The background subtraction is performed and the extracted features are applied to the neural network for classification. Respective dataset is also provided to perform training and testing for recognition. The script given by us is learned by the neural network and when the image is obtained by it, it compares the obtained image with the data learned by the network and recognises the object.

III.HARDWARE SETUP

Hardware setup plays an important role in the design of a palm vein recognition system. WE need perfect lighting to provide accurate images. We are using an IR night vision surveillance camera for capturing the real time images. This camera is connected to a Raspberry pi. A box is setup with IR led to create an IR environment and the camera is placed inside it to capture real time images and this setup is made with the sole purpose of avoiding the unwanted light. IR environment is used because the tissues of the hand will disturb the vein image. Since we are trying to extract the features of vein the tissues will act like a noise, and we have to remove them.

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We make a small opening in the box at the top for the user to keep their palm and the camera will take the image. We have also attached some pins at the top of the box so that they will act as a reference point. IR environment makes it possible to take good images because of the temperature difference of the vein and the surrounding skin [1].

The imaging character equation of palm vein is:

$W = \varepsilon * \sigma * T^4$ [1] where,

W= Radiance, ε=Radiation Frequency, σ=constant and T=Temperature

ε for Human skin is 0.98-0.99.

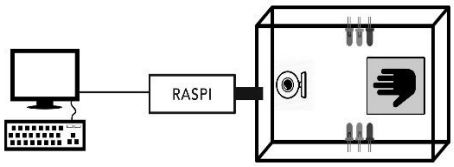

Fig. 1: System block Diagram

IV.SYSTEM MODEL

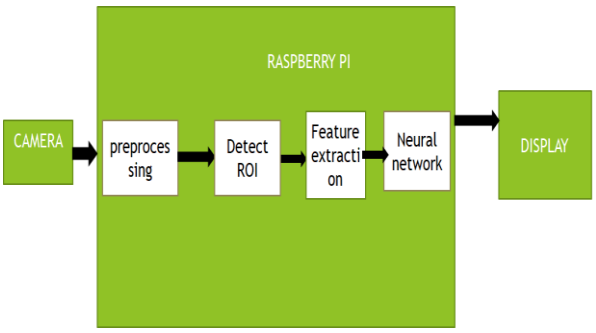

Fig. 2: System model

V.IMAGE PROCESSING

Since the captured image is having noise we have to remove the noise and normalize the image. Pre-processing is done to de-noise the image. Pre-processing involves improvement of the image by suppressing various unwanted distortions or it enhances the features of the image so that it will lead to much better accuracy during classification. First we convert the RGB image to grayscale. We did smoothening and blurring of the image using Gaussian filter.1D Gaussian filter with zero mean is given by:

$$g(x)=e^{-\frac{x^2}{2\sigma^2}} \quad [4]$$

Then we applied histogram equalization to the image obtained from Gaussian filter. A good image will have pixels from all the areas of an image. A bright image will have all the pixels confined to a high value, this is not preferred so we use histogram equalization. Histogram equalization technique is used to enhance the adjustments and contrasts of an image. It reassigns the intensity value of pixels so that the distribution of intensity of the image is almost uniform. Histogram is given as

$$h(rk) = nk/N \quad [5]$$

Where rk refers to intensity level and nk refers to the number of pixels in image with intensity.

Clahe(contrast limited adaptive histogram equalization) is formulated by dividing the image into multiple equally sized non overlapping blocks. The histogram of each block is found out. A limit called clip is set and it's taken care that each individual histogram is not crossing the clip. This is done by comparing each block with its nearby blocks and then doing the equalization.[6]

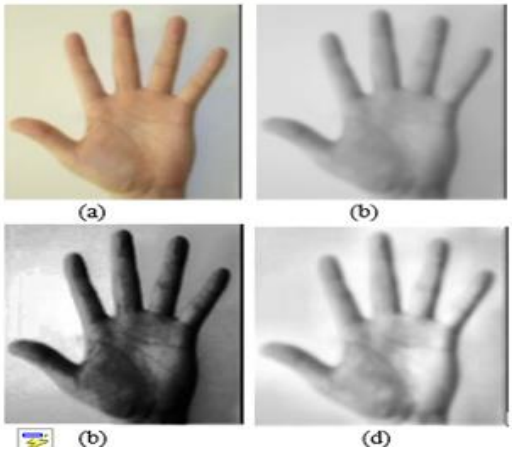

Fig. 3: Preprocessing (a) input image (b) Gaussian filter (c) Histogram equalization (d) CLAHE

VI.ROI SELECTION AND FEATURE EXTRACTION

For palm vein recognition we don't require the full image of hand. Therefore we remove the fingers and take only the palm which is our region of interest. For this the grayscale image was binarized using thresholding, dilated , contours were found and finally we obtained the ROI. Once the required part is taken it is given for feature extraction.

From the collected palm vein images we can use texture and vein patterns for extraction. The feature extraction can be divided into holistic and line/curve matching by extraction of vessel. Techniques like PCA (principle component analysis), SIFT (scale invariant feature transform) and (LPP (locality preserving projection), belongs to the former group. And Gabor filters, SUSAN edge detector cut off Gaussian filters, orthogonal Gaussian filters, matched filters etc belongs to the later one.

There are some fusion of features used for the palm vein [12]. Local texture features are used for classification. The local binary pattern (LBP) operator, the local derivative pattern (LDP) operator and the fusion them are used [13].

a novel parameter selection method is presented for efficient feature extraction using optimized the Gabor filter.[14] a dynamic ROI extraction using the steps of hand segmentation, hand boundary tracing, hand boundary distance profile, image alignment, ROI detection, and extraction is proposed [15].

A 3-D image of palm vasculature is formulated with an algorithm for robust recognition. The mechanism proved that the system provides deeper imaging depth and offering securer biometric features to fight against counterfeits [16].

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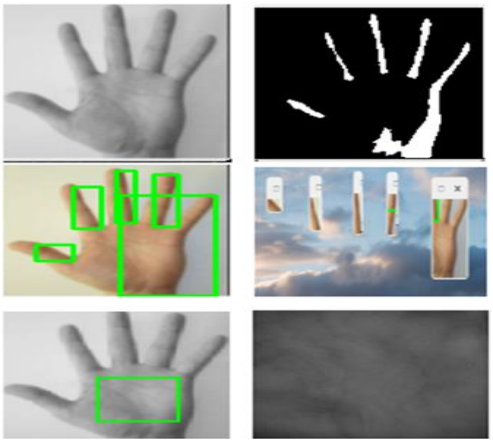

Fig. 4: ROI Process

VII.RECOGNITION

After the feature extraction the next step is to feed through the image to the neural network for classification. The recognition is done by studying the features of the image.

A neural network basically functions like a brain and can be called the brain of the system. Neural network in the initial phase learns the various features like weight and various other parameters of the image and compares what it has learned with the data given to it. Neural networks however requires a large amount of processing. There are various algorithms to train a network. Artificial neural network used for the recognition of the image can be classified as Probabilistic Neural Network (PNN) and convolutional neural network (CNN). Convolutional neural network is basically a back propagation neural network (BPN).

In [7],[8] back propagation neural network is used. It is used to calculate weights which is used as a parameter for recognition in neural networks. It is used to train deep networks.

In [2],[9],[10] and [11] PNN is used for classification. PNN is mostly used for classification and recognition problems. It is a neural network which uses feed forward method. There are different layers in a PNN which carries out the recognition in small steps.

Table 1: Classification accuracy

Palm vein image	Classification accuracy
Male age 25	98.5%
Male age 40	99.5%
Male age 68	97.5%
Female 25	98.75%
Female 40	99.55%
Female 68	96.95%

In order to calculate the accuracy of classification 600 image samples are taken in six category as in table .1 by taking 100 sample from each .Table .1 gives the accuracy of classification by the neural network which is evaluated for afferent age group of Male and female .It is evident form the table that maximum of 98.5% of accuracy of classification of the people is achieved. It is also evident that the accuracy of the classification is not varying much based on age factor and gender.

VIII.CONCLUSION

The proposed system is to make a low cost palm vein recognition system with raspberry pi and IR camera setup. Palm vein method is an excellent method for verification since it's embedded inside the skin and hence cannot be forgotten or stolen. The image captured is pre-processed and ROI and features are extracted and neural network is applied to identify a person. Thus it provides various applications in biometric authentication like passport office, ATMs, access control to buildings etc.

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