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A Finger Vein Image-based Personal Identification System with Self-adaptive Illuminance Control

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Abstract – *Now a day's security system is most powerfull technique against froud people. A finger vein image based personal identification system with Self-adaptive illuminance control is a technique to extract the pattern of human finger vein using adaptive illuminance control algoritham. In this paper, introduced an observation model of finger imaging, upon which Self adaptive algorithm is proposed and integrated into image acquisition model. Adaptive illiminance control algorithm is used to avoid overexposure and underexposure problem. In the image processing stage, Gabor filter are used to enhance capture raw finger vein images. In the framework last stage is identification performance of the system is evaluated by recognition rate. A sparse representation algoritham is used to estimate the recognition rate.*

Key Words: **Finger vein image, Adaptive illiminance control algorithm, Gabor filter, Sparse algoritham.**

1. INTRODUCTION

When we looking few year back various security system has been evolving. For example fingerprint, face recognition, iris recognition etcetra. Fingerprint biometric application usually like a commercial application for attendance of student and workers in the firms. The drawback of fingerprint authentication is when pattern of fingers dislimn, in this situation system get failure (e.g. [1]). Another biometric application mostly have been consuming in the world called face recognition, but system has few limitation. Poor image quality will affect the recognition rate, that is we should use high definition camera. At the time face is enrolled we should care about face angle. Face angle must be frofile, frontal and 45 degree are common. Small image size make facial recognition more difficult. (e.g. [2]). Now a day's iris recognition is more popular for biometric system, but system has few limitation. Iris recognition more expensive because iris scanners are relatively higher in cost compare to other biometric modalities. Constant use of of this system may cause harm to the iris because it constant scan with IR light. It is difficult to scan in the first attempt because of movement of eye. (e.g. [3]). Above example we can consider biggest challenges to improve recognition performance. Numerous researchers have been working to improve the realibility of biometric that is highly effective and roboust. Finger vein is a biometric pattern for personal identification that has attracted considerable attention in the biometric recognition field. Compared with another biometric system the advantages of finger vein authentication is it difficult to steal or forge the vein pattern inside the finger body and is mostly invisible to human eye, so it is extremely difficult to spoof. The main challenges in finger vein recognition extraction of vein pattern from the captured images with irregular shading and noise.

1.1 Framework

Finger vein-based personal identification system consists of three modules:

1. Image acquisition module
2. Preprocessing module
3. Pattern classifier

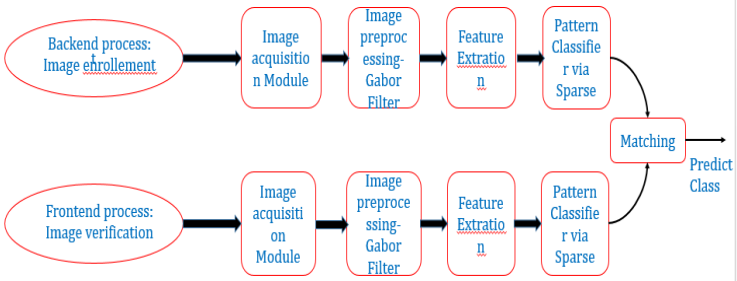


Fig -1: Framework of finger vein-based personal identification system

The figure shows for any biometric system has two phases first is image enrollement and second one image verification. Image enrollement is a backend process. For any biometric system first we should go for image enrolle with our name and physiological, behavioural and biological characteristics. Afterward we can proceed for verification of our saved data. In phase two first stage is appropriately acquired the image using light source. Image processing stage is used to preprocess over acquired image in terms of removing noise

and capture the vein pattern. And in third stage matching the data when we saved previously in the database.

2. Finger vein image acquisition module

The task of system to capture the finger vein images and Preprocessed over and store in database. To captured pattern of vein in such a manner that all the feature of finger vein needs to be detected. To capture the finger vein we have to go finger vein image acquisition module. When a finger is placed in position on our platform, microcontroller unit (MCU) will receive a control instruction from the host computer and change the output of the LED driver accordingly. Then, the illuminance distribution of the LED array will be adjusted repeatedly until desired a lighting condition is achieved. Then, a finger vein image will be captured at this adjusted lighting condition.

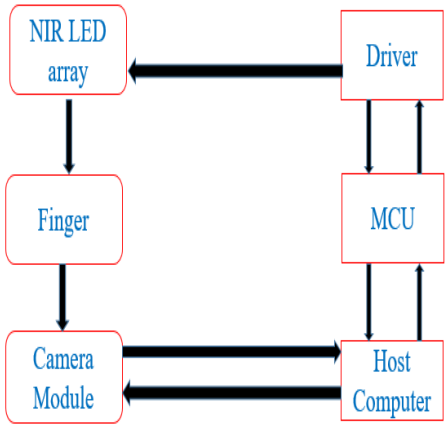


Fig -2: Finger vein image acquisition module.

Image acquisition module is used to acquired an image, but image is under low light vision. To remove low light vision to increase brightness of LED. brightness of LED adjusted by Adaptive illuminance control algoritham.

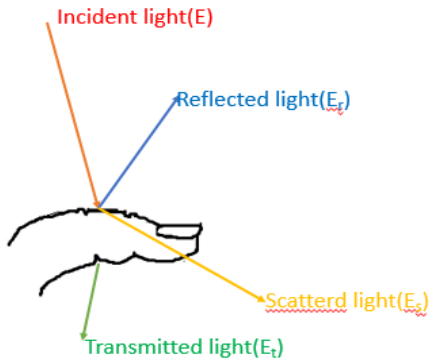


Fig -3(a): Observation model of finger vein imaging (a) optical model of finger body. When light is illuminate from light source, amount of light is incident denoted as E, after light incident, some amount of light is transmitted through vascular pattern in finger and transmitted light is denoted as E_t, some amount of light is reflected from finger tissue which is denoted as E_r, and some amount of light scatterd denoted as E_s.

2.1. Self-Adaptive illuminance control algorithm:

After capturing image, image has low light vision. System can not detect vein pattern. Image suffering overexposure and underexposure problem. Underexposure problems define image has more darkness part, and overexposure problem defines image has more brightness part. For preprocessing image, image should be in certain desired intensity range. For example image has 0 to 255 different shades it means that image has different color between black to white and it's average gives gray image. Consider E is a intensity from illuminance of LED; G is pixel intensity of original image. Consider maximum light intensity from LED is denoted as E_{max} = 255, and maximum pixel intensity of original image G_{max} = 255. The range [0 E_{min}] is a minimum range of light intensity from LED array, which cause underexposure problem. The range [E_x E_{max}] maximum intensity range from illuminance of LED array, which cause overexposure problem. To avoid mentioned intensity range we move towards Adaptive illuminance control algoritham. After capturing an image self-adaptive algoritham work based on region of interest (ROI). Assume in LED array we prefer 8 LED, then image is devide into 8 Region of interest(ROI), it mean's each individual LED has it's own ROI. Next task to adjust the intensity of each LED at a time and not individual LED. For example if we use j^{th} LED's in LED Array for n^{th} iteration (n^{th} iteration for adjusting intensity) which denoted as $E_{j,n}$. if $E_{j,n}$ (light intensity of LED) is adjusted then pixel intensity of image for j^{th} region of interest (ROI) for n^{th} iteration which is denoted as $G_{j,n}$ is adjusted. But the question is how to adjust intensity of LED array? LED driver used in this paper to control the brightness of each LED through pulse width modulation (PWM). Consider $L_{j,n}$ is a step of duty cycle of PWM signal output for each LED. The resolution for each channel (ROI) is 8 bit so total gray level is 256. Intensity illuminance of each LED is defined by PWM signal which has a step of duty cycle. If $L_{j,n}$ is 0, step of duty cycle is 0%, if $L_{j,n}$ is 255, yields 100% duty cycle. The aim of self-adaptive illuminace control algoritham to get desired average pixel intensity of image[G_p,G_q], which is corresponding to light intensity [E_p E_q] see in response curve .with this illuminance adaption, the algoritham increases illiminance of LED, which point to the thicker part of finger body, while decreases illuminance of LED, which point to the thinner part of the finger body.

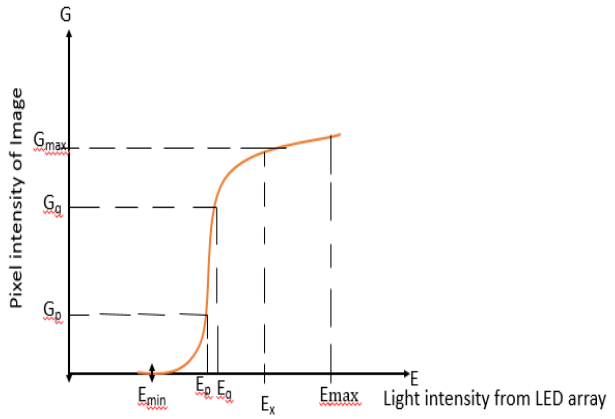
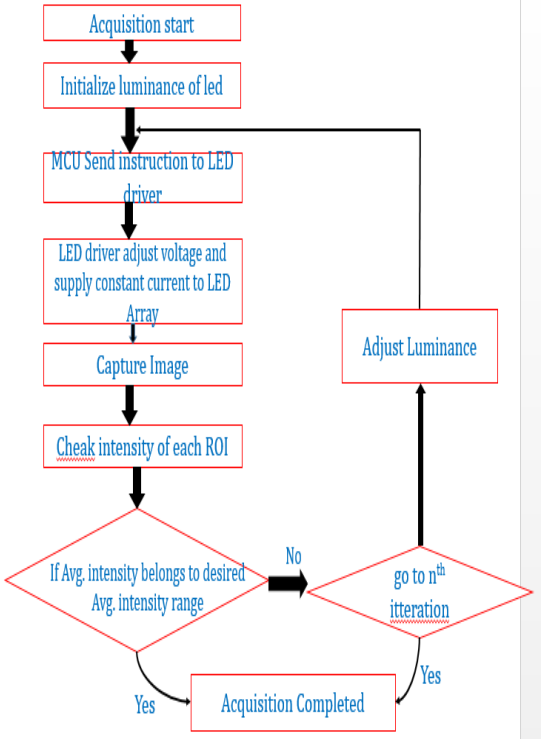


Fig -3(b): (b) Photoelectric model of camera or, namely, response curve, where transmitted light is converted from light intensity into pixel intensity through this nonlinear mapping.[G_p G_q] is a desired average pixel intensity range is adjusted when we get corresponding light intensity range [E_p E_q].

2.1.1. Flowchart for self-adaptive illuminance control algorithm



See 2.1.1. Self-adaptive illuminance flowchart, initially to capture image, should initialize luminance of light source. After microcontroller unit send control instruction to LED driver to adjust the illuminance of LED array. LED driver use to supply constant current to LED array. Then image is capture under lighting adjusting condition. After capturing image cheak desired intensity range. If we get desired intensity range of image acquisition completed. If not again go to next iteration for adjusting voltage of LED array then adjust the luminance and capture the image under adjusting lighting condition.

3. Image preprocessing using gabor filter

In this paper gabor filter are used to minimise noise and extract pattern of vein. Gabor filter are used to find the direction and used to find elliptical or circular pattern of vein. Multiscale and multiorientation Gabor filters are used, so that they could adapt to vein patterns of different orientations and widths. 2D Gabor filter is a Gaussian kernel function have been found particularly for texture representation and discrimination. Gabor filter is used enhance contrast level of original image.

4. Sparse representation algorithm

In the framework last block is matching. Matching block depends on recognition rate. Sparse representation algorithm could find the recognition rate. See flowchart 4.1 initially we define the number of images which called training sample. The training sample in the form of texture pattern. concating all images with class which represent full dictionary. Full dictionary images contain sparse images which is called test image. Use linear optimization technique to minimize the zeros component (i.e. noise). Linear optimization technique tepresent images in terms of vector norm. vector norm used to find distance between two or more classes. It is a technique to performed by checking which class has minimum error. In addition, it should be noted that all samples from the training set and the test set are downsampled before recognition process. The reason is that downsampling could effectively reduce the computing time. For instance, the image should be better off downsampled to the power of 2, e.g. 64 × 16, 64 × 32.

4.1. Flowchart of Sparse algoritham

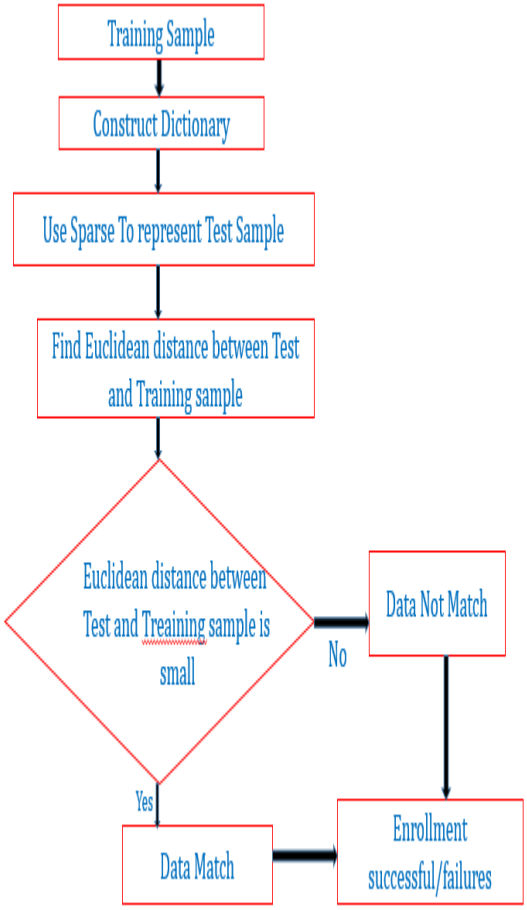


Fig -6: Flowchart for sparce representation

5. CONCLUSIONS

Self -adaptive illuminance control algoritham is a technique to adjust illuminance of light source. Under adjusting lighting condition, camera capture image. It helps to increase contrast level of original image and it could adapt vein present inside the finger body by transmitting light via finger. Self-adaptive illuminance control algoritham it helps to achive desire intensity range of original image. After acquired image preprocessed over image to remove the noise and extract the feature by Gabor filter and match the result using Sparse algoritham.

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