ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Face Recognition System Using Embedded System

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ABSTRACT

Face recognition is most widely used in this world to verify a person's identity because this method is intrusive and more accurate than any other biometric measurement. The other biometrics are extracted by non-intrusive method ie., a physical contact is needed in this case. Here an embedded based system is designed to capture and process the images for face recognition. A test plat form is designed and tested with the developed system which shows that this system has a 91% accuracy in recognize the face when the threshold is fixed between 2000 and 3500.

KEY WORDS: Bio metrics, Camera, Eigen features, Face recognition, Face database, Raspberry Pi Board.

1. INTRODUCTION

Biometrics refers to measurement of physiological characteristics of human beings which are later used to check up human identity. The physiological characteristics which are most widely used. Behaviometrics is a new word coined by researchers, which describes the behavioral characteristics of human beings are also used to identify a personality through their voice, way of talking and body language. Duplicated or misused which made biometrics a great success methodology to recognize or verify a person's identity. Face recognition has many advantages than other system because other biometric methods needed to verify their identity. Another important advantage of face recognition is that it doesn't have any health risk like transmission of germs and diseases.

System design: Block diagram of the embedded image capturing and processing system for face recognition (EICPSFR) is given in Figure 1.The central module of the whole embedded image capturing and processing system for face recognition is Raspberry Pi board. It contain main processing chip, memory, power supply, HDMI Out, Ethernet port and USB ports. Software Python is used as the main programming language, with support for BBC BASIC, (via the RISC OS image or the "Brandy Basic" clone for Linux).

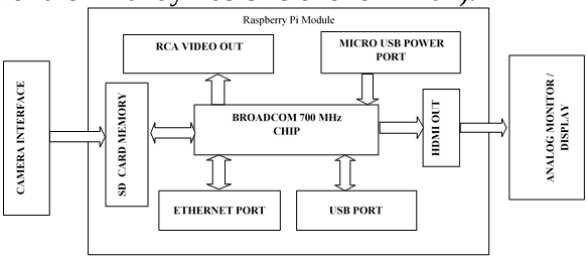

Figure.1. Block diagram of the embedded image capturing and processing system for face recognition (EICPSFR).

The Raspberry Pi camera module includes an image sensor and an interface. The image sensor converts an optical image to a digital image using a two-dimensional array of photo-detectors. The array of photo-detectors measures the intensities of specific colors (e.g. red, green, blue) throughout the optical image and the measurements, quantized over an interval (i.e. [0-255]), form the digital image. The interface delivers the digital image to the Raspberry Pi. Most digital cameras use ether a CCD image sensor or a CMOS image sensor. The Raspberry Pi Camera Board uses a CMOS sensor, which is cheaper than a CCD sensor. The Raspberry Pi Camera Board supports the following resolutions, measured in pixels, and frame rates, measured in frames per second (fps).

Python is the programming language used in this developed system, which takes care of capturing the images through Open CV (Open Source Computer Vision) program raspistill. Similarly raspivid program in Open CV must be used for capturing the videos. The captured images are stored in PNG format in the SD card memory. RPI NOIR CAMERA interfaced with the Raspberry Pi board must be initialized or configured by executing the instruction "sudoraspi-config" in Raspbian operating system.

2. METHODOLOGY OF WORK

Entire operation of the developed system can be explained in two parts, they are training session and recognition session. In training session, ten images of one person is taken and stored. These images are later used to verify the identity of a person to ensure that he/she is authorized person to access a device or to provide access to a place.

In recognition session ie as a real time application, the face images are captured first and then they are compared with the face database available in the memory. Here we use Eigen features algorithm for face recognition. Where N is the product of m (columns) and

$$\text{n(rows)}\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}_{m\times n} \xrightarrow{CONCATENATION} \begin{bmatrix} x_{11} \\ \vdots \\ x_{1n} \\ \vdots \\ x_{2n} \\ \vdots \\ x_{mn} \end{bmatrix}_{1\times N} = x \quad (1)$$

it is necessary to center the matrix. The values of Ψ, and then subtract that vector from each image vector (ϕ_i).

$$\Psi = \frac{1}{M}\sum_{i=1}^{M} x_i \quad (2)$$

$$\phi_i = x_i - \Psi (3)$$

Averaged vectors are arranged to form a new training matrix size N*M;

$$A = (\phi_1, \phi_2, \ldots, \phi_M) \quad (4)$$

The next step is to calculate the covariance matrix C, and find its eigenvectors e_i and Eigen valuesλ_i.

$$C = \frac{1}{M}\sum_{n=1}^{M} \varphi_n \varphi_n^T = AA^T \quad (5)$$

$$Ce_i = \lambda_i e_i \quad (6)$$

If eigenvectors are noted as v_i then equation 6 becomes

$$Cv_i = \lambda_i v_i \quad (7)$$

Finally we obtain

$$d(x,y) = \sqrt{\sum_{i=1}^{l}(x_i - y_i)^2} \quad (8)$$

In the Eigen features algorithm we have selected the parameters of library components as below

- Scale increase rate - 1.3.
- Minimum neighbor's threshold - 4.
- Minimum detection scale - 30x30.
- Euclidean distance (called as Threshold) - 2000 to 4000

These parameters are changed in the python code present in config.py.

3. EXPERIMENTAL RESULTS

To review the performance of the proposed system, the below parameters are defined which have an important role in the final decision:

Tp = True positive = correctly detected as with respective person is detected with six conditions

Fp = False positive = incorrectly detected with six condition.

Table.1. Performance Measures in Accuracy (%)

Persons	Matching	Non-Matching
Person 1	85	15
Person 2	79	21
Person 3	84	16
Person 4	97	3
Person 5	80	20
Person 6	99	1
Person 7	100	0
Person 8	84	16
Person 9	88	12
Person 10	91	9
Person 11	92	8
Person 12	82	18
Person 13	93	7
Person 14	95	5
Person 15	92	8
Person 16	99	1
Person 17	88	12
Person 18	99	1
Person 19	94	6
Person 20	95	5
Person 21	96	4
Person 22	97	3

Person 23	92	8
Person 24	100	0
Person 25	91	8
Person 26	90	10
Person 27	89	11
Person 28	87	13
Person 29	80	20
Person 30	90	10
Accuracy	**91%**	
Non-Accuracy	**-**	**9%**

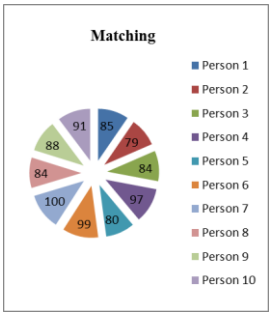

Figure.2. Matching accuracy for first 10 person

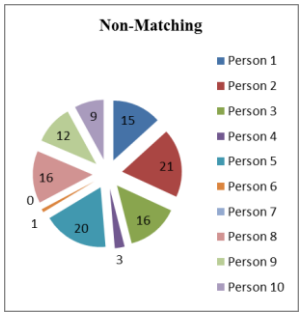

Figure.3. Non-Matching accuracy for first 10 person

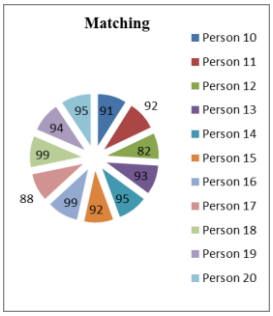

Figure.4. Matching accuracy for next 10 person

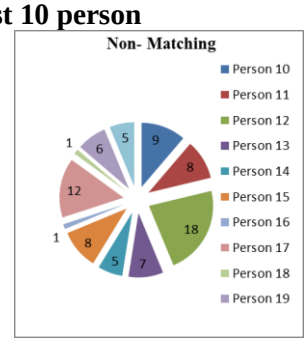

Figure.5. Non-Matching accuracy for next 10 person

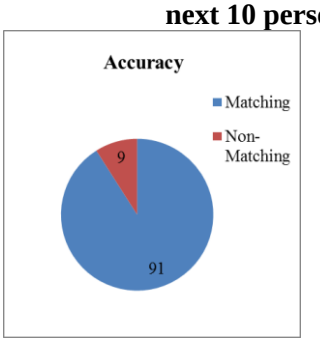

Figure.6. Total Accuracy for 30 people

Figure 2 to 5 illustrates the matching and non-matching accuracy of the trained face images. Total accuracy for this proposed face recognition is given in figure 6.In this face recognition work, we have looked into three different approaches; they are face detection, feature extraction and face recognition using Eigen features.

4. CONCLUSION

This paper has described about the operation of embedded image capturing and processing system for face recognition (EICPSFR).Using of Eigen features method the face recognition accuracy has been found as 91 % in the threshold value of 2500 – 3500. In future a pattern recognition algorithm may be included in the program, so that this system finds the odd one pattern generated.

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