International Journal of Engineering & Technology, 7 (3.34) (2018) 313-315

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

HVS Based Face Recognition Using Slant Transform

K.Veearaswamy[1], M.Koteswara Rao[2], K.Anithasheela[3], Ch.Himabindu[4]

[1]Professor, QIS College of Engineering and Technology, A.P, India,
[2]Research scholar, JNTUCEH Hyderabad, India,
[3]Associate Professor, JNTUCEH, Hyderabad, India,
[4]Professor, QIS College of Engineering and Technology, A.P, India,
**Corresponding author E-mail: kilarivs@yahoo.com, koteshproject@gmail.comkanithasheela@gmail.com, hb.muvvala@gmail.com*

Abstract

There are many person identification technologies like password, PIN, key, and token are used in many applications. Present, popular identification technology is face. In many applications the database is large. Hence, recognition with high speed is major challenge. This paper presents a recognition using HVS features in transform domain. Human visual system identifies perceptual important information in the images. Slant transform basis vector is sawtooth. It efficiently represents linear brightness variations along an image line. Hence, in this work HVS features in slant transform domain is explored for face recognition. Feature vector is based on HVS parameters. In this method image is decomposed into subblocks using Slant Transform. Important elements are identified using HVS weightage. Experiments are performed on bench mark face databases. Proposed method has better recognition performance than existing methods. Retrieval time is also less.

***Keywords**: Slant Transform, HVS, Sub Blocks.*

1. Introduction

The face recognition is a system which is widely used for identifying the face from the face database. There are different types of approaches to recognize the face from the database. Firstly, the content of the information based on knowledge based facial expressions in between training images and test images. Most of the pattern recognition researchers follow knowledge based method due to less computational time and very easy to extract the features of the different databases. There are few drawbacks on knowledge method, one is difficult to translate human activities into specific domain and one more is difficult to extend to describe different facial expressions of the training images. Secondly, sometimes the training images are having different conditional approaches like that poses of the image, lighting conditions and change of the images varying with respect to scale and orientations. Thirdly, the database images are having different patterns. To separate those features with the help of template matching. An advantage of template matching is simple to construct or decompose the given input training images of the database. Disadvantage of the template matching method is difficult to specify the different poses of the images from the database. Finally, appearance based method is widely implemented in unpredictability of the images. The appearance based method is widely based on classifiers.

In section 2 describes basic concepts of Human Visual System and Slant transform. In section 3 represents proposed algorithm slant transform. In section 4 exposes the experimental results of the proposed scheme. In section 5 mentioned concluding remarks of the slant transform for face recognition.

2. Slant Transform and Hvs

2.1 Slant Transform

Shibata and Enomoto have introduced orthogonal transform containing a slant basis vector for data of vector lengths of four and eight. They have been applied it for reduction of transmission bandwidth of the given input image. They have been shown that the slant transform method is most powerful and popular because linear variation of brightness occurs in many sub-bands of images. The slant transform has concentrates on two parameters one is basis function and another one is linear. Slant vectors are mostly used in television encoding techniques for efficiently representing faces. There different properties of slant transform: i) variable size transformation ii) high energy compaction iii) orthogonal set basis vector iv) vector basis function v) consequence property vi) fast computational algorithm. The slant transform can be represented as given below.

$$S_2 = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

Let $[X]$ be the input image of size $M \times M$ and slant transform matrix is can be computed as

$$\mathbf{S}_M = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 & & 1 & 0 & \\ a_M & b_M & \mathbf{0} & -a_M & b_M & \mathbf{0} \\ \mathbf{0} & & \mathbf{I}_{M-1} & \mathbf{0} & & \mathbf{I}_{M-1} \\ 0 & 1 & & 0 & -1 & \\ -b_M & a_M & \mathbf{0} & b_M & a_M & \mathbf{0} \\ \mathbf{0} & & \mathbf{I}_{M-1} & \mathbf{0} & & \mathbf{I}_{M-1} \end{bmatrix} \begin{bmatrix} \mathbf{S}_{M-1} & \mathbf{0} \\ \mathbf{0} & \mathbf{S}_{M-1} \end{bmatrix}$$

Where I $_{M-1}$ represent identity matrix of the order (N-1) and the coefficients b $_M$ and b $_M$ can be obtain by iteration.

$$a_M = 2\ b_M\ a_{M-1}; \quad b_M = 1 / \left(\sqrt{\left(1+4(a_{M-1})^2\right)}\right)$$

Where $M = 4,8,16\ldots$

The slant transform coefficient vector

$$Y_M = [y(0)\ \ y(1) \ldots\ldots y(M-1)\ \ ]^T$$

$X_N = [x(0)\ \ x(1)\ldots\ldots x(M-1)\ \ ]^T$ can be expressed in matrix form

$$Y_M = S_M^{'}\ X_M$$

Then the inverse slant transform can be expressed in matrix form

$$X_M = S_M^{'}\ Y_M$$

Let $S_M = \sqrt{M}\ \ S_M^{'}$, the slant transform and the inverse slant defined as $Y_M = \dfrac{1}{M} S_M\ X_M\ ;\ X_M = S_M^{'}\ Y_M$

Then the iteration equivalent of S_N becomes

$$\mathbf{S}_N = B_N \begin{bmatrix} \mathbf{S}_{N-1} & \mathbf{0} \\ & \\ \mathbf{0} & \mathbf{S}_{N-1} \end{bmatrix}$$ Where $N = 4,8,16\ldots$

3. Human Visual System (Hvs)

Widely human visual system concentrates on how the image is to seen. Perceptual represents of HVS are two ways. One is focus on perceptually significant information and another one is discard perceptually insignificant information. Mainly biological and psychological issues are belongs to HVS. In psychological (contrast and brightness etc.) issues are perceived on brightness adaptation, spatial threshold vision, temporal vision, frequency threshold vision. In brightness adaptation, HVS can view large intensity range (10^{10}) but simultaneously perceived intensity range is much smaller. In spatial threshold vision, there are three major factors are identified. Firstly Weber ratio, which is concentrated on sensitivity to intensity difference differ at different background intensities. Where weber ration is intensity difference V_s background intensity ($\dfrac{\Delta_I}{I}$). Secondly, the spatial and temporal information increases than the intensity value of the threshold values is increased

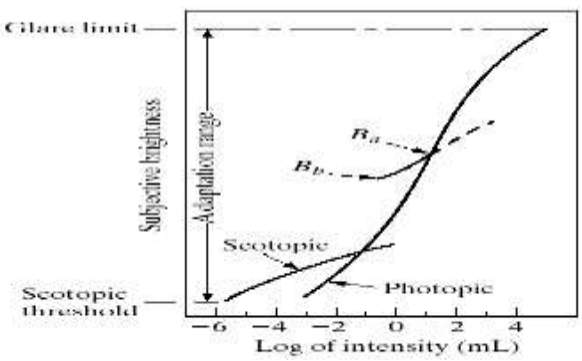

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Figure1: human visual system brightness adaption

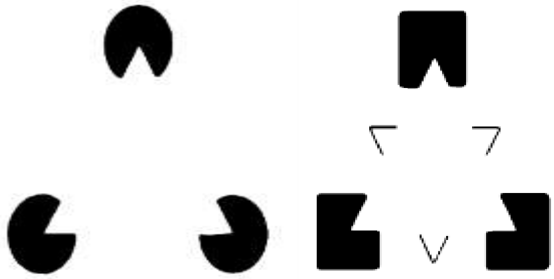

Figure 2: Examples of brightness difference induced by suggestion of edges

$$G(f) = x(y + zf)\exp\left(-(z(f))^w\right) \tag{1}$$

Where x, y, z and w are constants. f is the radial frequency in cycles/degree of the visual angel subtended and a, b, c, and d are constants.

Horizontal and vertical isolated functions are represented based on continuous periodic printing grid, then the dot pitch Δ and frequencies are describe that M by

$$f(a) = \frac{a-1}{\Delta M},\ \ f(b) = \frac{b-1}{\Delta M} \tag{2}$$

These radial frequencies, and scaling functions are shown in the followings

$$f(a,b) = \frac{\pi}{180 \arcsin \dfrac{1}{\sqrt{1+dis^2}}} \sqrt{f(a)^2 + f(b)^2} \tag{3}$$

Finally, to account for variations in visual MTF as a function of viewing angle, θ, these frequencies are normalized finction also can be represented as $s(\theta(a,b))$, such that

$$\hat{f}(a,b) = \frac{f(a,b)}{s(\theta(u,v))} \tag{4}$$

Where $s(\theta(a,b))$ is given by

$$s(\theta(a,b)) = \frac{1-\omega}{2}\cos(4\theta(a,b)) + \frac{1+\omega}{2} \tag{5}$$

With ω is a symmetry parameter

$$\theta(a,b) = \arctan\left(\frac{f(a)}{f(b)}\right) \tag{6}$$

Based on above expressions as ω decreases, $s(\theta(a,b))$ decreases.

4. Proposed Method

4.1. Proposed Algorithm

Proposed method is presented below:

1. The total number of face database images can be represented as N face images belonging to M persons. That can be denoted as N = N_1+N_2+N_3+…N_M. Where M is the total images.
2. Each image ($m \times n$) Images can be portioned into $k \times l$ by

using sub pattern method. Where m and n are no. of rows and columns of the input image respectively. k and l are number rows and columns of the partitioned image respectively

3. Then the images are preprocessing by PCA to reduce the dimensionality
4. Apply slant transform to the reduced images.
5. Then the slant matrices are multiplied the HVS matrices.
6. Compute the mean value to each sub pattern matrices.
7. To extract the features, input image is multiplied with slant matrix using slant transform. Slant matrix size should be equal to the sub-pattern matrix.
8. Then find the largest eigen vector features from the square matrix corresponding eigen values.
9. Similarly same procedure for all sub matrices.
10. To represent the global feature combine all the sub patterns locally specified information.
11. To retrieve the face images from the database calculate distance measure technique in between training and query image.

4.2 Feature Extraction Process

To find the average retrieval performance and computational rate for recognition of face image from the train set based on face performance on YALE database and ORL database. In this paper our face database set has implemented by selecting 40 classes and each class consisting 10 images of the face. These images of different individuals used for training and testing. Experimental results are tabulated in Table 1. To validate the effeteness of the recognition efficiency approaches, several methods of face recognition has been investigated in this paper. Figure1 shows indicate choosing an image from the training face database. Then the query image has been portioned as different sub-blocks and each sub-block size consisting [8*8] matrices. Then take slant matrices for [8*8] size by using slant transform as mentioned in section II. Take HVS matrices for [8*8] is shown in below. Then the slant matrix is multiplied with HVS matrix then the formation of new matrix is [8*8].finally apply Principal component analysis method to extract features of the test image and find the similarities between training data and query image. Final recognition results in shown in figure3.

Table 1: The weighting matrix of HVS for Slant transforms

1.0000	0.8746	1.0000	0.9599	1.0000	0.7684	1.0000	0.8746
0.6571	0.2480	0.4495	0.3393	0.6306	0.1828	0.5558	0.2480
1.0000	0.5912	0.7617	0.6669	1.0000	0.5196	0.8898	0.5912
0.9599	0.4564	0.6669	0.5419	0.9283	0.3930	0.8192	0.4564
1.0000	0.8404	1.0000	0.9283	1.0000	0.7371	1.0000	0.8404
0.7684	0.2948	0.5196	0.3930	0.7371	0.2278	0.6471	0.2948
1.0000	0.7371	0.8898	0.8192	1.0000	0.6471	0.9571	0.7371
0.8746	0.3598	0.5912	0.4564	0.8404	0.2948	0.7371	0.3598

Figure4: comparative recognition rates

5. Conclusions

In this paper, there are many person identification technologies like password, PIN, key, and token are used in many applications. Present, popular identification technology is face. In many applications the database is large. Hence, recognition with high speed is major challenge. This paper presents a recognition using HVS features in transform domain. Human visual system identifies perceptual important information in the images. Slant transform basis vector is sawtooth. Hence, in this work HVS features in slant transform domain is explored for face recognition. Feature vector is based on HVS parameters. In this method image is decomposed into subblocks using Slant Transform. Important elements are identified using HVS weightage. Experiments are performed on bench mark face databases. Proposed method has better recognition performance than existing methods. Retrieval time is also less.

Acknowledgement

Authors would like to express gratitude to Dr.S.Srinivasa Kumar, Director of Research & Development, JNTUK University, Kakinada, for his precious guidance and suggestions

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