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A Statistical Approach for Off-Line Signature Verification Technique using DWT

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Abstract: ***Now a days, signature verification is an important research topic in the area of biometric authentication. Off-line signature verification takes as input the image of a signature and is useful in automatic verification of signatures found on banks, financial sectors and documents. In this paper, we proposed a off-line signature verification technique using Discrete Wavelet Transform (DWT). A statistical approach -- the coefficient of variation -- to detect the varying portions of the original and forgery signature images with the help of discrete wavelet transform technique is proposed***

Keywords: coefficient of variation, discrete wavelet transform, signature, feature extraction

1. Introduction

Image analysis techniques are being increasingly used to automate the detection of variations (changes / strokes) in the signatures in off-line / on-line. In the recent past, wavelet transforms have been a popular alternative for the extraction of features. There are two categories of data (signature) acquisition – off-line and on-line verification systems. The off-line signature verification is more challenging part than the on-line verification systems. There is a need to develop efficient signature verification technique for authenticating an individual successfully.

Indrajit Bhattacharya et.al [4] proposed an off-line signature verification and recognition system using pixel matching technique. This technique is used to verify the signature of the user which is stored in the database with the Artificial Neural Network's (ANN) back propagation method and Support Vector Machine (SVM) technique. K.B. Raja et.al [5] proposed DWT based off-line signature verification using angular features. Khamael Abbas Al-Dulaimi [1] described a new method based on determinant values of the signature image blocks with their Euclidean distances. Jugurta Montalavao et.al [3] proposed a new approach for both hand image segmentation and feature extraction. Liton Devnath et.al [2] discussed off-line human signature recognition system based on Histogram analysis using MATLAB. Sivana Salahadin Muhamed et.al [6] proposed an approach based on DWT to extract significant features from each signature image. In our paper, a statistical approach is used to detect the variation portions in the original signature image and forgery signature image with the help of discrete wavelet transform.

2. Methodology

The offline signature images are acquired from traditional papers. This requires high specific signature image that can be achieved via high resolution scanner. In general, the first step of offline signature verification system is to extract these signatures from traditional papers using scanner. The offline signature approach for verification using DWT technique as shown in figure 1.

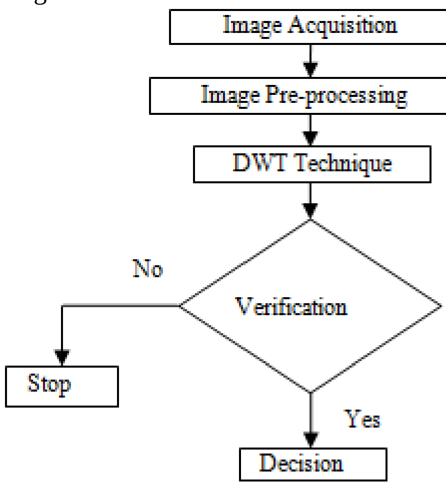

Figure 1: Signature Verification Block diagram

In this section, a method to identify the variations (portions) in signature image is discussed. From the original and forgery signature database, a sample of one original and one forgery signature image is taken for analysis. Some sample signatures are listed in figure 2.

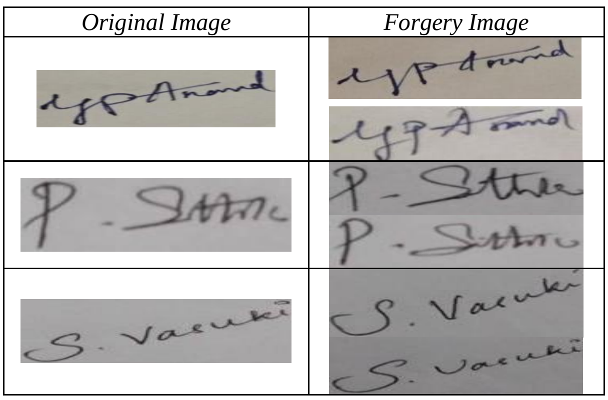

Figure 2: Sample Signature images

The image size is considered in powers of 2^j (j = 1,2,….). This image is divided into equal number of rows and columns (blocks). Every block contains 2^j (j=1,2,…) coefficients and is decomposed by Discrete Wavelet

Transform (DWT) technique. Taking approximation coefficients in each level of decomposition and finally a single wavelet coefficient is obtained. All the single approximation wavelet coefficients corresponding to each block for the image are tabulated. The coefficient of variation for every row (R_i) and column (C_j) corresponding to single approximation wavelet coefficient is obtained. The coefficient of variation values in which above the average values are marked. The intersection of marked high values corresponding to rows and columns indicate the varying blocks in the image. One original and one forgery signature image of same size has been taken for analysis. Normally, the size of the image is vary with respect to the length of the signature. The size of the image is considered 120 × 180 matrix. This is divided into four equal rows and six equal columns of 30 × 30 matrix size. Each block size is now considered as 2^5 (j=5). By using DWT technique, the image is decomposed. Every level of decomposition only approximation coefficients are considered. Continuing this way, finally a single approximate wavelet coefficient is obtained. Similarly, for each division, a single wavelet (approximate) coefficient is obtained. All the wavelet coefficients are tabulated into rows and columns of the image. The statistical measure, coefficient of variation (c.v.) is obtained for each row and column of the image and these values are analyzed statistically. Based on the comparison of the values in the rows and columns, the variation portion of the image is identified corresponding to higher variation.

3. Results and Discussion

Pre-processing step plays an important role in signature recognition to overcome any raised problem. The image captured is converted to other kinds of images (Binary and Gray Scale) suitable for the various detection algorithms used for the different types of defects. Gray scale signature images are taken for analysis. Table 1 shows the coefficient of variation values of the original signature image (figure 3).

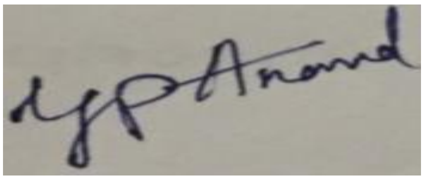

Figure 3: Original signature

Table 1: Wavelet Coefficients and C.V. Values

Blocks	1	2	3	4	5	6	Row-wise c.v. %
1	5281.8	5308.1	5320.1	5172.8	5263.7	4888.7	3.14857
2	5039.8	5006.0	4564.5	4261.5	4715.3	4805.6	6.15998
3	4604.3	**4102.5**	5108.3	**5379.5**	5428.0	5411.0	**10.8314**
4	5124.9	4774.7	5359.3	5371.5	5369.8	5346.5	4.59371
Column-wise c.v.%	5.7878	**10.6809**	7.1934	**10.5393**	6.2840	6.0611	

In table 1, the coefficient of variation values for each rows and columns are obtained. In order to locate the varying portion of the image, the average of coefficient of variations of all the 4 rows, r_{avg} c.v. is obtained.

$$r_{avg}\, c.v. = \frac{1}{4}\sum_{i=1}^{4} R_{cv_i} = 6.1834$$

The coefficient of variation values which are greater than r_{avg} c.v. are marked bold. From the table 1, it is clear that, coefficient of variation value of third row (R_{cv3}) is greater than r_{avg} c.v. value. Similarly, the average of coefficient of variations of all the 6 columns, c_{avg} c.v. is obtained.

$$c_{avg}\, c.v. = \frac{1}{6}\sum_{i=1}^{6} C_{cv_i} = 7.7577$$

The coefficient of variation values which are greater than c_{avg} c.v. are marked bold. From the table 1, it is clear that the second (C_{cv2}) and fourth (C_{cv4}) columns are having greater coefficient of variation than the c_{avg} c.v. value. It is identified that, the blocks corresponding to the intersection of row 3 with columns 2 and 4 as the variation portion of the original signature image 1. The variation portions are highlighted in the respective rows and columns of the image 1. These intersection blocks are identified as the dominant blocks to the corresponding original image.

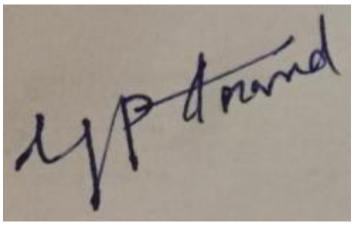

Figure 4: Forgery signature

Table 2: Wavelet Coefficients and C.V. Values

Blocks	1	2	3	4	5	6	Row-wise c.v. %
1	4895.5	4914.5	5028.4	5069.4	4937.8	4853.2	1.66973
2	4823	4826.0	4490.2	4049.0	4513.4	4931.4	7.09315
3	4224.5	4434.0	4650.3	4978.8	5182.6	5174.7	8.39003
4	4966.8	4705.6	5118.1	5151.5	5138.9	5139.5	3.49919
Column-wise c.v.%	7.2001	4.42813	6.2197	10.6738	6.1841	3.1209	

From table 2, the average of coefficient of variations of all the 4 rows, r_{avg} c.v. is obtained.

$$r_{avg}\, c.v. = \frac{1}{4}\sum_{i=1}^{4} R_{cv_i} = 5.1630$$

The coefficient of variation values which are greater than r_{avg} c.v. are marked bold. From the table 2, it is clear that, the second (R_{cv2}) and third (R_{cv3}) rows are having greater coefficient of variation values than r_{avg} c.v. value. Similarly, the average of coefficient of variations of all the 6 columns, c_{avg} c.v. is obtained.

$$c_{avg}\, c.v. = \frac{1}{6}\sum_{i=1}^{6} C_{cv_i} = 6.3045$$

The coefficient of variation values which are greater than c_{avg} c.v. are marked bold. From the table 2, it is clear that, the

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first (C_{cv1}) and fourth (C_{cv4}) columns are having greater coefficient of variation values than the c_{avg} c.v. value. It is identified that, the blocks corresponding to the intersection of rows 2, 3 with columns 1 and 4 as the variation portions of the forgery signature image 2 (figure 4). From figures 3 and 4, the identified blocks in original image is not exist in the forgery image. From the table 2, some of the variations are also identified, which are not available in table 1.

Using the coefficient of variation, variation portions of the original and forgery signature images are identified with the help of discrete wavelet transform technique. The statistical approach clearly shows that the values varied significantly in the portions of the image.

4. Conclusion

In this paper, a statistical approach for identifying the variations in signature images (both original and forgery) using discrete wavelet transform is analyzed. Using the coefficient of variation, varying portions of the signature images are identified with the help of discrete wavelet transform technique. This statistical approach effectively identifies the varying portions of the signature images. It is simple (complex free) and easy to use.

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