Palm Print Recognition Based on Correlation Features

Ritika Raturi[1], Deval Verma[2]

[1]*Department of Mathematics, Chandigarh University, Punjab- 140413*
raturiritika2000@gmail.com
[2]*School of Computer Science Engineering and Technology*
Bennett University, Times Group
Greater Noida-201310
deval09msc@gmail.com

Abstract

The performance of a palmprint recognition system is determined by one of its essential components, the comparator. However, in the realm of palmprint recognition system, the purpose of analysis and comparator development is weakened. The main contribution of this study is the analysis of comparators using theory and experiments. The investigation investigates the possibility that a ground truth of palmprint images could contain identical data. Experimental analysis makes use of the receiver operating characteristic (ROC) curve. It has been found that comparators based on the similarity measure functions of the normalised correlation coefficient (NCC) perform well.

Keywords. Palmprint Recognition, NCC, Comparators, Metrics, ROC curve, Correlation

1. INTRODUCTION

Biometrics is an approach of automatically recognising a person based on his physical or behavioural features. Wherever there is a need for user verification, biometric solutions are necessary [1]. Over the last decade, palm-print-based biometric identification systems have gotten a lot of attention. Principle lines, wrinkles ridges, tiny points, unique points, and texture patterns are some of the traits that might be referred to as biometric characteristics [2]. The tri-radiated region, also known as the inter-distal region, is the area beneath the finger that is bordered by the cardiac line. This part of the palm comprises traits that are both distinctive and generally distinguishable [14]. Palm prints are a more accurate way to identify people than fingerprints because they cover a larger surface area. Palm print sensors are therefore larger and more expensive than fingerprint sensors [3]. The use of these systems for large-scale personal authentication will necessitate additional work to increase performance significantly [11].

In the field of biometrics, the objective is to generate a data representation that separates the real and imposter score distributions well. Numerous effective faces and palmprint recognition systems utilise conventional image processing methods to extract features utilising image filters that improve discriminative information while decreasing noise [13].

The most cutting-edge biometric technology, with over 20 decades of research and development, is automatic fingerprint verification. There are still certain challenges to be resolved despite the abundance of scanning methods, feature extraction, pre-processing, and matching algorithms that have been propounded for fingerprint verification [15, 16]. Hand geometry can only provide limited precision in accordance with the simple aspects of the hands, and its capacity to differentiate individuality is still an open subject [17].

Palm region extraction is the process of selecting and orienting the core section of palmprints, also termed as the region of interest (ROI). It's used to match different palmprint photos by aligning them. Many algorithms have been developed to extract the ROI of palmprints for effective feature extraction [12,18]. There are five components of a standard palm print recognition system. The first is a palm-print scanner, which gathers photos of palm prints. Pre-processing establishes a coordinate system for aligning palmprint images. The third stage, known as feature extraction, extracts useful features from pre-processed palmprints. The fourth feature is a palmprint matcher, which compares two palmprint attributes. This study looks at how different comparators affect the palm matching process while assuming that a correlation coefficient must be treated similarly to the positive.

Additionally, a formula for calculating a comparator parameter for the pattern matching system's maximum decision accuracy is obtained by theoretical research.

To analyse the comparator and confirm the formula, experiments are conducted on a variety of palmprint matching systems. Here is a description of the remaining paper. There are definitions of preliminaries in section 2. Proposed methodology is discussed in section3. Experiments and results are discussed in section 4 and 5.

2. PRELIMINARIES

2.1. Dataset Description

For research purposes, the Casia palmprint database [18] has been used. 312 persons are represented by 5,502 images in this database. The format of the palmprint pictures is "xxxx m/f l/r xx.jpg". These jpeg photos of palm prints are in 8-bit grayscale. Where the letters "xxxx" stand for a person's unique identification number, which spans from 0000 to 0312, "m/f" for male or female, and "l/r" for left or right palm, respectively.

2.2. Normalised Cross Correlation coefficient (NCC)

The degree of similarity between two photographs is calculated using the normalised cross correlation coefficient (NCC) [8]. Because NCC is less sensitive to direct changes in the amplitude of brightening in two compared images [14,10], it is more significant than cross correlation. With the aid of palm lines, one common use of pattern matching is palmprint matching, which is used for fortune telling. Mathematical formula is given in Figure 2.21.

FIG:1 0001_m_l_01

FIG:2 0001_m_l_02

$$\eta(x_1, y_1) = \frac{\sum_{l=1}^{M}\sum_{m=1}^{N}\{x_1(l,m).y_1(l,m)\}}{\sqrt{\sum_{l=1}^{M}\sum_{m=1}^{N}\{x_1(l,m)\}^2}.\sqrt{\sum_{l=1}^{M}\sum_{m=1}^{N}\{y_1(l,m)\}^2}} \in [0,1]$$

Figure2.21. Evaluation of NCC, η (x1, y1)

3. PROPOSED METHODOLOGY

A comparator consists of two components: a function and a threshold that determine how similar two palm images are to one another. If there is a greater degree of resemblance between two palm images than the threshold, the two are considered to match. palm images are not matched if this is not the case. A general comparator is defined mathematically as follows in Figure 3.1:

$$C_{(\tau,\ \mathrm{sim})}(x_1, x_2) = \begin{cases} \text{match} & \text{if } \mathrm{sim}(x_1, x_2) \geq \tau \\ \text{no match} & \text{otherwise} \end{cases},$$

Figure 3.2. Evaluation of Similarity (x1, x2)

False positive rate (FPR) and false negative rate (FNR) for both measures are calculated by using following equations in Figure 3.2.

$$FPR = \frac{\sum(FP)}{\sum(TP) + \sum(FP)} \qquad FNR = \frac{\sum(FN)}{\sum(FN) + \sum(TN)}$$

Figure 3.2. Evaluation of Similarity (x1, x2)

4. EXPERIMENTS, RESULTS AND ANALYSIS

In this section, we've discussed our experimental work. The major goal of this research is to compare two images using the performance factors NCC to determine how comparable they are. then use a ROC curve to compare how similar they are. Both parameters have [0, 1] ranges. Casia database contain 5,502 images in this database, out of them the results of 30 palm images are shown in given Table 4.1. NCC values are computed for both left and right hand in Table 4.1 and it is observed that on taking some threshold value it is decided for match and not match.

Table 4.3. NCC value of Right /Left Hand, NM (no match), M(match) range [0,1]

Palm No.jpg	**Type**	**NCC values for left palm**	**Decision based on NCC (Th=0.9)**	**NCC values for right palm**	**Decision based on NCC (Th=0.9)**
palm0001	L	1	M	0.8776	NM
palm0002	L	0.924316286	M	0.83537232	NM
palm0003	L	0.908045649	M	0.893865815	NM
palm0004	L	0.911274144	M	0.8916082	NM
palm0005	L	0.922325198	M	0.872080946	NM
palm0006	L	0.905877726	M	0.89605427	NM
palm0007	L	0.901073111	M	0.894218908	NM
palm0008	L	0.876557038	NM	0.870822589	NM
palm0009	R	0.860061145	NM	1	M
palm0010	R	0.858743713	NM	0.998018839	M
palm0011	R	0.83510893	NM	0.935007229	M
palm0012	R	0.840590762	NM	0.971519321	M
palm0013	R	0.888537342	NM	0.929232254	M
palm0014	R	0.89001467	NM	0.931723599	M
palm0015	R	0.887452513	NM	0.934980282	M
palm0016	R	0.834901091	NM	0.930568405	M
palm0017	L	0.916501824	M	0.897225417	NM
palm0018	L	0.898084337	NM	0.882776414	NM
palm0019	L	0.904247812	M	0.862085519	NM
palm0020	L	0.875981741	NM	0.867090231	NM
palm0021	L	0.861540544	NM	0.864350786	NM
palm0022	L	0.882046809	NM	0.858687178	NM
palm0023	L	0.876204649	NM	0.848362653	NM

palm0024	R	0.807131267	NM	0.914954649	M
palm0025	R	0.791954271	NM	0.906271612	M
palm0026	R	0.882320735	NM	0.841548278	NM
palm0027	R	0.801373396	NM	0.905876433	M
palm0028	R	0.818123168	NM	0.890212266	NM
palm0029	R	0.798173497	NM	0.892508208	NM

A two-dimensional plot of the false positive rate FPR (defined as the ratio of the total number of incorrect matches to the total number of matches) versus the false negative rate FNR (defined as the ratio of the total number of incorrect non-matches to the total number of non-matches) is known as a ROC curve. Every part of a palmprint matching system is necessary for FPR and FNR. FPR and FNR have a [0,1] range. The optimal point on a ROC curve is (FPR, FNR) = (0,0). In Figure 4.1 shows the ROC curve of FPR and FNR of NCC values corresponding to the given dataset.

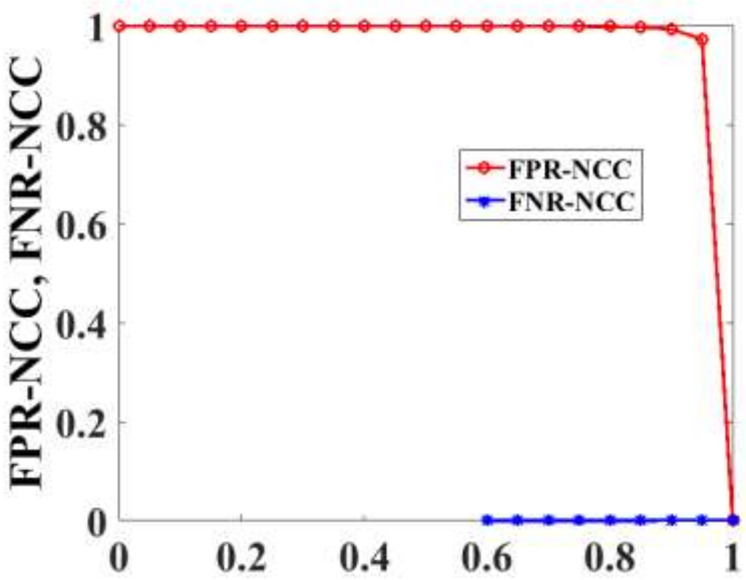

Figure 4.4. ROC Curve for NCC range [0,1]

5. CONCLUSIONS

This study presents an investigation of palmprint matching based on NCC similarity measurement. The primary goal of this work was to determine the palmprint matching accuracy. On several palmprint images, experiments have been conducted. NCC and similarity measurements are used to evaluate the effectiveness of their matching. To determining accuracy, we have calculated FPR and FNR using various threshold values. The findings show that NCC delivers the least value at the 0.760 threshold, whereas NCC gives the least value at the threshold value of 1.

6. REFERENCES

[1] N. Duta, A. K. Jain, K. V. Mardia, ‘Matching of palmprints’, Pattern Recognition Letters 23 (2002) 477-485.

[2] G. S. Badrinath, P. Gupta, ‘Stockwell transform based palm-print recognition’, Applied Soft Computing 11 (2011) 4267-4281.

[3] D. Brown, K. Bradshaw, ‘Deep Palmprint Recognition with Alignment and Augmentation of Limited Training Samples’, SN Computer Science (2022) 3:11.

[4] A. Kong, D. Zhang, M. Kamel, ‘A survey of palmprint recognition’, Pattern Recognition, vol.42(7), pp.1408–1418, 2009.

[5] P. H. H. Yeomans, B. V. K. V. Kumar, M. Savvides, ‘Palmprint classification using multiple advanced correlation filters and palm-specific segmentation’, IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, VOL. 2, NO. 3, SEPTEMBER 2007.

[6] D. Zhang, W. Zuo, F. Yue, ‘A comparative study of palmprint recognition algorithms’, ACM Comput. Surv. 44, 1, Article 2 (January 2012), 37 pages. http://doi.acm.org/10.1145/2071389.2071391

[7] J. You, W. Li, D. Zhang, ‘Hierarchical palmprint identification via multiple feature extraction’, Pattern Recognition 35 (2002) 847–859.

[8] D. M. Sai, T. L. Chien, ‘Fast normalized cross correlation for defect detection’, Pattern Recognition Letters, Vol. 24, pp. 2625-2631, 2003

[9] J. Chen, Y. S. Moon, M. F. Wong, G. Su, ‘Palmprint authentication using a symbolic representation of images’, Image and Vision Computing 28 (2010) 343–351.

[10] D. Zhang, A. W. K. Kong, J. You, M. Wong, ‘Online palmprint identification’, IEEE Trans. Pattern Anal. Mach. Intell., vol. 25, no. 9, pp. 1041–1050, Sep. 2003.

[11] A. Kumar, ‘Incorporating Cohort Information for Reliable Palmprint Authentication’, Sixth Indian Conference on Computer Vision, Graphics & Image Processing.

[12] X. Bao, Z. Guo, ‘Extracting Region of Interest for Palmprint by Convolutional Neural Networks’, 978-1-4673-8910-5/16/$31.00 ©2016 IEEE.

[13] J. Svoboda, J. Masci, M. M. Bronstein, ‘Palmprint recognition via discriminative index learning’, 2016 23rd International Conference on Pattern Recognition (ICPR) Cancún Center, Cancún, México, December 4-8, 2016.

[14] L. Di. Stefano, S. Mattoccia, M. Mola, ‘An Efficient Algorithm for Exhaustive Template Matching based on Normalized Cross Correlation’, IAPR Int. Conf. on Image Analysis and Processing (ICIP 2003), September 17-19, Mantova, Italy, pp. 322-327, 2003.

[15] Kong, A. W. K., Zhang, D.: Feature-Level Fusion for Effective Palmprint Authentication, ICBA 2004, LNCS 3072, pp. 761-767, 2004. © Springer-Verlag Berlin Heidelberg 2004.

[16] G. Lawton, Biometrics: a new era in security, Computer, vol. 31, no. 8, pp. 16-18, 1998.

[17] "CASIA Palmprint Database, http://biometrics.idealtest.org/"