Palmprint Recognition with Three Dimensional Features

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Abstract

In this paper, some 3D features are developed for authentication in the existing 3D palmprint database. The features are stable in samples of a single person over time and distinguishable among samples of different people.

An identification process based on the features is also proposed.

Experiments on 8,000 samples in the database prove that the system works.

Acknowledgements

To my parents.

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Chapter 1

Introduction

Palmprint has been increasingly recognized as unique and stable biometric characteristics for personal authentication. In the past decade, various methods based on two dimensional (2-D) palmprint have been studied in depth. The 2-D recognition techniques have proved to achieve high accuracy [4].

In recent years, three dimensional (3-D) palmprint recognition devices emerge and are quite promising because of the additional depth information gathered.

Although the devices has been out for more than two years, most previous matching algorithms treat 3-D information as a supplement to 2-D texture images and used joint matching techniques to increase accuracy [5, 7, 13, 12, 11]. Authentication with only the 3-D information has not been thoroughly studied. The amount of useful information carried by the 3-D data is still under investigation.

There are two major challenges:

1. 3-D devices, compared to 2-D ones, are lower in resolution.
2. The depth values are susceptible to movements of human hands and are therefore less stable than 2-D texture information of palmprints.

David et al. explore a 3-D palmprint recognition approach by exploiting the 3-D structural information of the palm surface [13, 12]. The structured light imaging is used to acquire the 3-D palmprint data, from which several types of unique features, including mean curvature image, Gaussian curvature image, and surface type, are extracted. A fast feature matching and score-level fusion strategy is proposed for palmprint matching and classification. Wei et al. propose an efficient joint 2D and 3D palmprint matching scheme [7]. The principal line features and palm shape features are extracted and used to accurately align the palmprint, and a couple of matching rules are defined to efficiently use the 2D and 3D features for recognition. The experiments show that the proposed scheme can greatly improve the performance of palmprint verification. Wei et al. also present an efficient scheme for 3-D palmprint recognition [5]. They extract both line and orientation features after calculating and enhancing the mean-curvature image of the 3-D palmprint data. The two types of features are then fused at either score level or feature level for the final 3-D palmprint recognition.

Existing work has been done to utilize the 3-D information for palmprint classification and sorting. The global features proposed for that purpose are fast in matching speed but low in accuracy compared to 2-D techniques.

The major contribution of this paper is a set of features that can increase the recognition performance of palmprint verification.

Chapter 2

Related Work

This work is based on a number of previous research efforts.

Different approaches are available for 3D imaging including laser scanning [1], viewpoint reconstruction [3] and structured light scanning [2]. Structured light scanning, compared to other approaches, is fast and accurate. For palmprint recognition, speed is an important factor. The verification or identification result must be given in a short time. Otherwise the system is barely suitable for real-world applications.

Projecting a narrow band of light onto a three-dimensionally shaped surface produces a line of illumination that appears distorted from other perspectives than that of the projector, and can be used for an exact geometric reconstruction of the surface shape (light section).

A faster and more versatile method is the projection of patterns consisting of many stripes at once, or of arbitrary fringes, as this allows for the acquisition of a multitude of samples simultaneously. Seen from different viewpoints, the pattern appears geometrically distorted due to the surface shape of the object.

Although many other variants of structured light projection are possible, patterns of parallel stripes are widely used. Figure 2.2 shows the geometrical deformation of

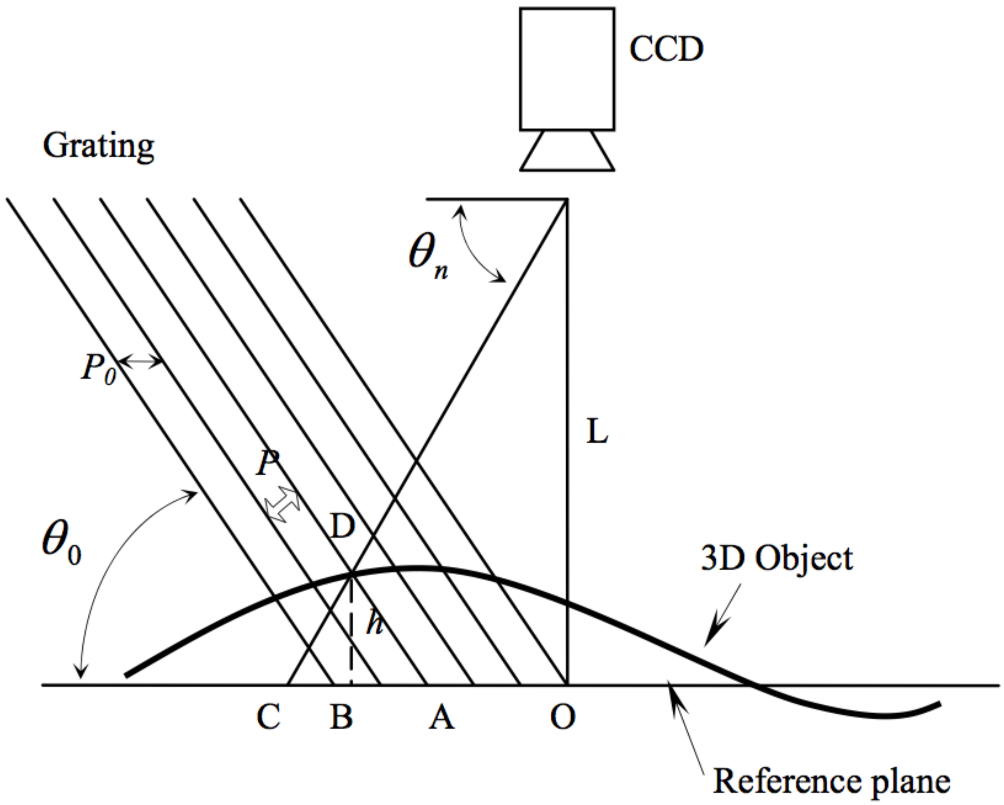

Figure 2.1: The principle of structured-light imaging[6]

a strip pattern projected onto a palm. The displacement of the stripes allows for an exact retrieval of the 3D coordinates of any details on the palm's surface.

David et. al designed a 3D palmprint capturing device [12]. The system proposed has a resolution of 768x576. Figure 2.3 shows a sample acquired.

Some general features were extracted for recognition including 3D Mean Curvature Image, 3D Gauss Curvature Image and 3D Surface Type [12, 6].

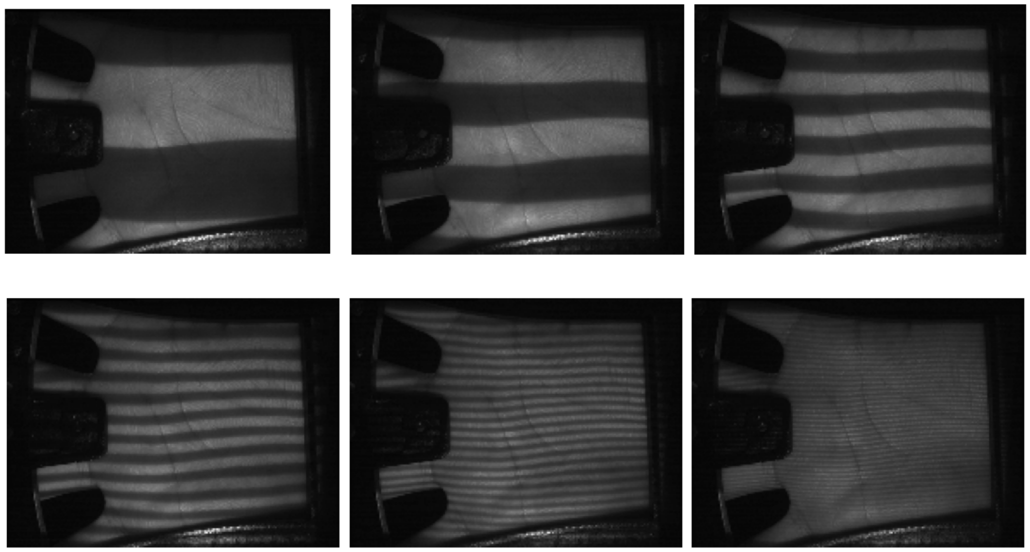

Figure 2.2: Sample patterns of the stripes on the palm [6]

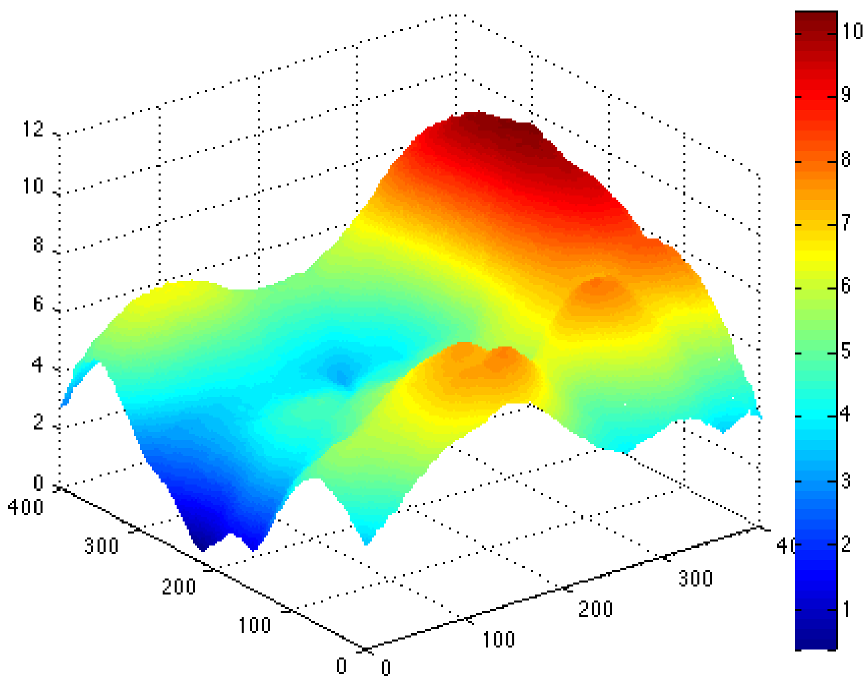

Figure 2.3: A 3-D palmprint sample

Chapter 3

Methodology

The idea is to extract one or more features from the 3-D information as classifiers. Together with existing classifiers found in existing work in related fields [9, 10, 8], the new features will be combined to achieve a high performance classifier for personal authentication using Support Vector Machine (SVM).

The sample data has already been collected. There are 8,000 samples from 400 different palms with both hands. Samples of a palm are collected in two separate sessions with an average interval of one month.

Experiments will be done using Matlab.

1. Extract features from each palmprint sample.

2. A subset of samples will be chosen as test set.

3. Train an authentication model based on the rest of samples.

4. Verify the samples in the test set with the trained model against their true identities.

5. Discuss the performance of the model.

3.1 Region of Interest Extraction

3.2 Feature Calculation

3.3 Feature Matching

Chapter 4

Experimental Results

4.1 Feature Distribution

4.2 Identificaiton Performance

4.3 Verification Performance

Chapter 5

Conclusions

5.1 Future Work

Bibliography

[1] F Blais, M Rioux, and JA Beraldin. *Practical considerations for a design of a high precision 3-D laser scanner system*. SPIE Proceedings, 1988.

[2] M Halioua and H Liu. *Automated phase-measuring profilometry of 3D diffuse objects*. Appl. Opt, 1984.

[3] Richard Hartley. Multiple view geometry in computer vision, 2000.

[4] Adams Kong, David Zhang, and Mohamed Kamel. A survey of palmprint recognition. *Pattern Recognition*, 42(7):1408–1418, July 2009.

[5] W. Li, D Zhang, L. Zhang, G. Lu, and J. Yan. 3-D palmprint recognition with joint line and orientation features. *Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on*, (99):1–6, 2011.

[6] Wei Li, Lei Zhang, and D Zhang. Three dimensional palmprint recognition. In *Systems, Man and Cybernetics, 2009. SMC 2009. IEEE International Conference on*, pages 4847–4852, 2009.

[7] Wei Li, Lei Zhang, D Zhang, Guangming Lu, and Jingqi Yan. Efficient joint 2D and 3D palmprint matching with alignment refinement. In *Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on*, pages 795–801, 2010.

[8] Chafik Samir, Anuj Srivastava, and Mohamed Daoudi. Three-dimensional face recognition using shapes of facial curves. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 28(11):1858–U1, 2006.

[9] C. Xu, Y. Wang, T. Tan, and L. Quan. Automatic 3D face recognition combining global geometric features with local shape variation information. *Automatic face and gesture recognition, 2004. Proceedings. Sixth IEEE international conference on*, pages 308–313, 2004.

[10] Ping Yan and K.W Bowyer. Biometric Recognition Using 3D Ear Shape. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, 29(8):1297–1308, 2007.

[11] D Zhang, V. Kanhangad, N. Luo, and A. Kumar. Robust palmprint verification using 2D and 3D features. *Pattern Recognition*, 43(1):358–368, 2010.

[12] D Zhang, Guangming Lu, Wei Li, Lei Zhang, and Nan Luo. Three Dimensional Palmprint Recognition using Structured Light Imaging. In *Biometrics: Theory, Applications and Systems, 2008. BTAS 2008. 2nd IEEE International Conference on*, pages 1–6, 2008.

[13] D Zhang, Guangming Lu, Wei Li, Lei Zhang, and Nan Luo. Palmprint Recognition Using 3-D Information. *Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on*, 39(5):505–519, 2009.