Proceedings of the Sixth International Conference on Machine Learning and Cybernetics, Hong Kong, 19-22 August 2007

A TONGUE-PRINT IMAGE DATABASE FOR RECOGNITION

ZHI LIU[1], JING-QI YAN[1], DAVID ZHANG[2], QUN-LIN TANG[3]

[1]Institute of Image Processing and Pattern Recognition, Shanghai Jiao Tong University, Shanghai China
[2]Biometrics Research Centre, Department of Computing, Hong Kong Polytechnic University, Kowloon, Hong Kong
[3]The Graduate School of Harbin Institute of Technology, Shenzhen, China
E-MAIL: liu.zhi@126.com

Abstract:

The tongue is a unique organ in that it can be stuck out of mouth for inspection, in this act offering a proof of life, and yet it is otherwise well protected in the mouth and is difficult to forge. The tongue also presents both geometric shape information and physiological texture information which are potentially useful in identity verification applications. Furthermore, the act of physically reaching or thrusting out is a convincing proof for the liveness. Despite these obvious advantages, little work has hitherto been done on tongue features. A primary factor for preventing such research is the lack of an available 3D tongue image database. In this paper, we present a newly developed 3D tongue image database, which includes both tongue geometric shape and surface textures of 134 subjects. This is the first attempt at making a 3D tongue image database available for the research community, with the ultimate goal of fostering the research on tongue biometrics. The new database can be a valuable resource for algorithm assessment, comparison and evaluation.

Keywords:

Tongue-prints; Database; Biometrics; Verification

1. Introduction

Reliable automatic identity recognition of persons has long been an attractive goal, with biometrics, such as fingerprints, palmprints and iris images already being widely used. Biometrics have a number of advantages over security measures which use tokens, such as physical keys and those which are knowledge-based and use, for example, passwords. Biometrics features cannot easily stolen, lost, guessed, forgotten, or duplicated [1],[2]. The list of physiological and behavioral characteristics that have so far been developed and implemented is long and includes the face, iris, fingerprint, palmprint, hand shape, voice, signature and gait. However, these traditional biometrics have an inherent limitation in that they are easily forged. In other words, they are ineffective in combating identity fraud. This has been the great challenge for biometrics technologies. Actually, the tightened security required the noninvasive biometrics that are anti-counterfeiting and can provide living person verification. Accordingly, it is very necessary to find some new biometrics to fill the requirements.

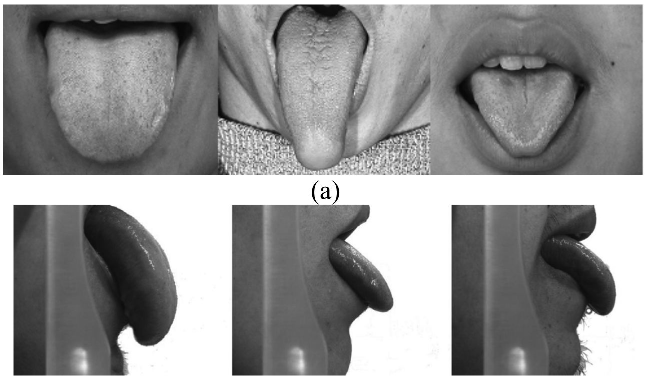

Figure 1. Some samples with different shape from frontal and profile view. (a) different shapes from the frontal view (b) different shapes from the profile view.

Figure 2. Some samples with different textures

The tongue may offer a solution to this difficulty, having as it does many properties that make it suitable for use in identity recognition. To begin with, the tongue is unique to each person in its shape (see Figure 1) and in its surface textures (see Figure 2). Second, the tongue is the only internal organ that can quite normally and easily be exposed for inspection. This is useful because it is the exposed portion of the tongue that carries a great deal of

1-4244-0973-X/07/$25.00 ©2007 IEEE

information with visual difference, i.e. the shape and texture, we call these "tongue-print". Third, according to our long period of observation, the individual tongue shape is constant and the physiological textures are invariant. Fourth, as human tongue is contained in the mouth, it is isolated and protected from the external environment, unlike the fingers, for example. Finally, the process of tongue inspection is also a reliable proof of life.

To the best of our knowledge, little investigation has been conducted on analyzing tongue as a biometrics, even though it is believed to be a suitable number for the biometrics family. In the following sections, we propose to describe a new tongue-prints image database for recognition.

2. Creation of 3D tongue database

The development of our database was designed to sample the frontal and profile views of the tongue, which can propose the whole information of tongue. The database of tongue images was created in two stages, i.e. enrolment and update. Enrollment is necessary when no tongue shape template is currently stored in the database for a particular individual. Update is required when the passing of time, illness, or some other factors resulting in variation in the previously enrolled tongue. Thus, the updating stage will show its advantage during the long term image collection period.

2.1. Capturing tongue images

The 3D tongue image data is captured with the imaging system (3DTC system, Figure 3).

Each subject is instructed to sit in front of the 3D tongue image capture system. They are requested to stick out his\her tongue downwards.

Furthermore, the sampling procedure requires subjects to stick out their tongues in a standard way: the tongue should be flat to enable the tongue to be measured accurately and tongue must not be bent overly, as this will influence the measure. The subject finds the correct pose with assistance from the capture software and a laser location device.

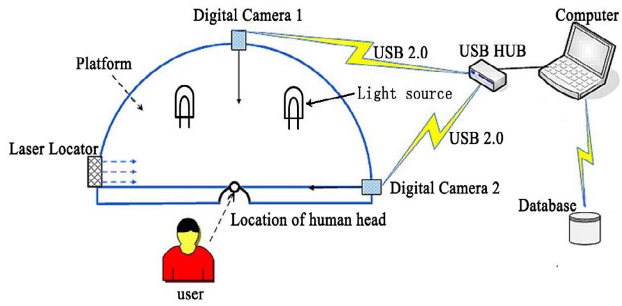

Figure 3. Tongue-print imaging system setup

2.2. Composition of participants and introduction of image

There were 134 subjects who participated in the collection, including undergraduates, graduates and faculty from HIT and SJTU. The resulting database consists of about 66.4% male and 33.6% female subjects with a variety of ethnic/racial ancestries, including yellow, black, and white. Table 1 shows the composition of the tongue shape database.

The images were collected in five separate sessions uniformly distributed over a period of five months. Each time we collected forty images of the tongue of an individual, twenty front views and twenty profile views. Thus, this tongue-print image database contains 26800 images of 134 people differing in age, sex, and nationality. Some example images are shown in Figure 4.

Figure 4. Some tongue-print images from the database

In order to make the database useful for assessing and comparing algorithms recognition techniques, we provide high-resolution tongue images, which include both tongue textures and tongue shape, as the raw data in the database. The tongue images captured by our device are 1280*1024 pixels in JPEG format. Since the raw image data contain the unprocessed images around human tongue, these can be used for evaluate the algorithms not only on recognition but also on tongue detection. Samples were mostly from adults, whose tongue shapes are more stable than those of children.

Table 1. Composition of the tongue-print image database

	Sex		Age		
	male	female	20-29	30-39	40-49
Number of samples	89	45	81	32	21
Percentage (%)	66.4	33.6	60.4	23.9	15.7

3. Data management

Figure 5 shows the data structure for archival. By query, the data is searchable by ID. Therefore, in total, the 26800 raw image data of the database, which include 13400 frontal view images and 13400 profile view images, can be managed efficiently. We label the samples in our database from 0001 to 0134. In addition to the geometric data and texture data, a set of associated descriptors is also generated as an optional data set.

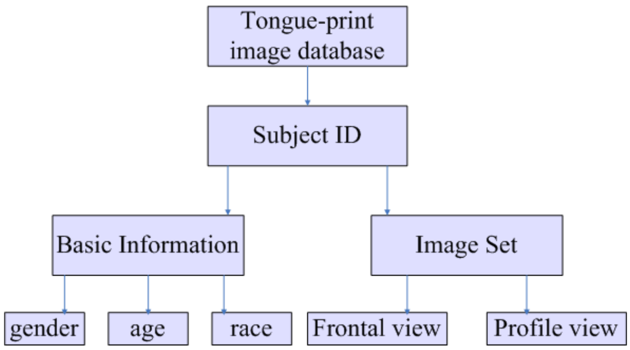

Figure 5. Data structure of the database

4. Validation and evaluation of the database

The quality of the tongue-print image database is evaluated through the validation experiments. The validation study addresses the question of whether the samples of the database can be used to for verification and whether they can represent the general feature extraction. To do so, we conducted an analysis and test against our tongue-print image database.

4.1. Experiment 1

To investigate to what degree the shape of tongue varies, we used the 5 set of samples of the same subject from 5 different times during five months. The cropped tongue contour is labeled by a set of markers. The contour detection method can refer to [3][4]. For each marker set, we take the first set of samples that we recorded as the reference object and compare other sets of samples with it. As our point of comparison, we sum the distance between the corresponding marker points of the two comparing contours. If this sum exceeds a certain threshold, the shape is regarded as strongly variant. If all the sample tests results in the marker set with the same ID number are below the threshold, the shape is regarded as constant. Table 3 shows a comparison of the tongue shape variation of the person with ID=0006. The tongue contour is considered to be constant over the entire five months sample period (the person is required be sampled 5 times during the 5 months) since all the error data is below the 50 pixel threshold.

Table 2.Tongue shape variance during the 5 months (the average error in pixels**)**

The order	**The number of marker points**				
	7	9	11	13	15
1	-	-	-	-	-
2	29	27	22	25	23
3	26	23	20	19	18
4	28	22	24	21	20
5	24	24	25	23	21

4.2. Experiment 2

We also investigated tongue shape stability, defining an unacceptable variation occurrence rate (UVOR) to be computed as follows:

$$UVOR = \frac{occurance\ \ of\ \ strong\ \ shape\ \ variation}{the\ \ total\ \ number\ \ of\ \ the\ \ subjects} \times 100\%$$

The UVOR data based on our tongue database is shown in Table 3.

We can see from Table 2 and Table 3 that the tongue contours are disturbed, but the disturbances are so limited that they can be ignored if we constrain the pose of tongue when it stick out of the mouth. Several factors may produce this variation, for example, disease or tongue movement, but in general we can see that the shape of the human tongue is acceptably constant for use in verification.

Table 3. Unacceptable variation occurrence rate (UVOR) of tongue shape

	The sequence				
	1	2	3	4	5
times	-	3	5	4	4
UVOR (%)	-	2.2	3.7	3.0	3.0

5. Development of Database in Future

Human tongue is a special organ, and treating it as a biometric is novel. Thus, our future work will focus on the following aspects:

(1) We will enlarge this database so that it contains more samples of human tongue.

(2) Since human tongue is non-rigid when it moves, we expect to collect the video of tongue to extract some rules of its movements.

6. Conclusions

Although so many biometrics databases have been developed [5-7], to our best knowledge, there is no tongue-print image database for tongue verification yet. In this study, we developed a new 3D tongue-print image database for the scientific research community. This is the first attempt to foster the research on tongue recognition.

Acknowledgements

The work was supported in part by the National Natural Science Foundation of China (NSFC No. 60402020), the National 863 Program of China (Grant No. 2006AA01Z119), and the HK government (A Unified Framework for the Dynamic Fusion of Human Body Information (G-YD86)).

References

[1] A. Jain, R. Bolle, and S. Pankanti, Biometrics: Personal Identification in Networked Society, Kluwer Academic, Boston, 1998.

[2] D. Zhang, Automated Biometrics—Technologies and Systems, Kluwer Academic, Boston, 2000.

[3] Wangmeng Zuo, Kuanquan Wang, Zhang, D., Hongshi Zhang, Combination of polar edge detection and active contour model for automated tongue segmentation, Proceedings of Third International Conference of Image and Graphics, pp.270 -273, Dec. 2004.

[4] Liu Zhi, Jing-qi Yan, Tao Zhou, Qun-lin Tang, Tongue Shape Detection Based on B-Spline, ICMLC2006, Vol. 6, pp. 3829-3832, Aug. 2006.

[5] A. O'Toole, J. Harms, et al. A video database of moving faces and people. IEEE Trans. PAMI, 27(5), 2005.

[6] T. Sim, S. Baker,M. Bsat, The CMU pose, illumination and expression database, IEEE Trans. PAMI, 25(12), 2003.

[7] P. Phillips, H. Moon, P. Rauss, et al., The FERET evaluation methodology for face recognition algorithm, IEEE Trans. PAMI, 22 (10), 2000.