Framework of Human Identification using Multi-Modal Biometrics

Min-Gu Kim[1], Hae-Min Moon[2] and Sung Bum Pan[3,*]

[1] *Dept. of Control and Instrumentation Engineering, Chosun University*
375 Seosuk-dong, Dong-gu, Gwangju, Korea
[2] *Dept. of Information and Communication Engineering, Chosun University*
375 Seosuk-dong, Dong-gu, Gwangju, Korea
[3] *Dept. of Control, Instrumentation and Robot Engineering, Chosun University*
375 Seosuk-dong, Dong-gu, Gwangju, Korea
happy9433@gmail.com, bombilove@gmail.com, sbpan@chosun.ac.kr

Abstract

Biometrics has been used to verify intrusion and identification of intruder in video surveillance system. Biometrics was divided into traditional biometrics and soft biometrics. Traditional biometrics is a method using information on face, iris, and fingerprint. Soft biometrics is a method using information on gender, ethnicity, and height. Recently, many researchers have been researched human identification using soft biometrics in long distance environment. In this paper, we analyze a human identification with applying traditional biometrics or soft biometrics suitable for video surveillance system. Also, we propose a framework to solve problems such as lighting, occlusion, and shadow.

Keywords: *video surveillance, human identification, biometrics, soft biometrics.*

1. Introduction

With the increase of international terrorism and violent crime, the interest for identification technique applicable to video surveillance system has been increased. Especially, after September 11 terrorist attacks occurred in United States in 2001, the interest in biometrics for identification has been increased to enhance security. Biometrics is largely divided into traditional biometrics using information on face and fingerprints, and soft biometrics using information on gender, ethnicity, height, tattoo, and signature [1]. Recently, multi-modal biometrics is researched to verify the identity in various environments that are not controlled while achieving high recognition performance using traditional biometrics and soft biometrics together. Traditional biometrics has advantages of excellent accuracy and high universality. However, it is difficult to extract the feature of face as the distance between camera and target is far, and in case of fingerprint, it has the disadvantage of requiring cooperation with the user. On the other hand, soft biometrics has narrow accuracy compared to traditional biometrics but it can be used in various environments and can verify the identity without cooperation with the user. However, since soft biometrics has low distinctiveness and permanence, it is not enough to recognize the individual if it is used by a single biometrics.

In this paper, we analyze biometrics for identification in video surveillance system and propose framework to solve problems such as lighting, occlusion and shadow. This paper is composed of section 2 which describes the method for identification using biometrics suitable for video surveillance system, and section 3 which proposes applicable framework to

* Corresponding author

human identification in long-distance environment. At last, the future research direction and conclusion is discussed in section 4.

2. Biometrics

2.1. Traditional Biometrics

The biggest reason why biometrics receives attention is because of security and convenience. Especially, face and fingerprints are researched the longest among biometric information and are used in various fields because it has higher recognition rate than other biometric information. Thus, identification research is proceeding by applying biometric information such as face and fingerprint to video surveillance system which requires a high level of supplementation. Identification technique using face is the most excellent in terms of convenience of the user because it can be recognized naturally without contact. But it is sensitive to the facial expression of the user or changes in lighting, and it also has a weakness in the change of face over the years. As the distance between camera and the user increases, it is also difficult to extract the face feature needed for identification.

2.2. Human Identification using Discrete Soft Biometrics

The traditional biometrics explained earlier has high accuracy and universality. However, the identity can be verified with active cooperation with the user and in the controllable environment. So, soft biometrics is researched to allow identification without various environments applicable to video surveillance system and cooperation with the user. The discrete soft biometrics is to verify the identity using gender, ethnicity, iris, etc. Wayman suggested the method of filtering database that large-scale biometric information was stored using soft biometric information such as gender and age [2]. Filtering limits the number of target candidates in the database according to the feature of the user. This method improves the speed of biometric system and the efficiency of search.

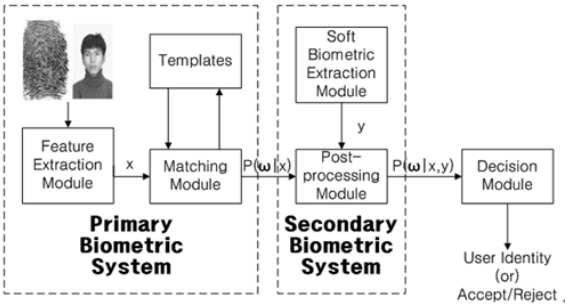


Figure 1. Example of Discrete Soft Biometric Traits

But, it appeared that the elements like age, gender, ethnicity and occupation can affect performance of biometric system [3]. Therefore, the technique that verifies the identification by assigning other weighted values to each of biometric information in multi-modal biometric system is being researched recently.

Jain proposed the multi-modal biometric system that verifies the identity using Bayes Theorem [4]. However, if multi-modal biometric information is used, each of biometric information can have different results in identification. Thus, as shown in Formula 1, different weighted values were assigned in each of biometric information. w_i represents the number of test subjects in the database, and x represents the value of traditional biometric traits such as face and fingerprint. And y represents the value of soft

biometric traits that can be used additionally. Less weighted value was assigned to soft biometric information compared to high accuracy biometric information. The total of weighted values assigned to each of biometric information is 1, and a0 » a1 and i=1,2,…m.

$$g_i(x,y) = a_0 \log P(\omega_i \mid x) + a_1 \log p(y_1 \mid \omega_1) + ... + a_k \log p(y_k \mid \omega_1) + a_{k+1} \log P(y_{k+1} \mid \omega_1) + ... + a_m \log P(y_m \mid \omega_i) \quad (1)$$

Hossain used the face and gait information together to verify the gender [5]. Traditionally, the gender was verified only using face information but the performance of gender recognition was improved by using face and gait information together. Figure 2 is the simple flow for gender recognition.

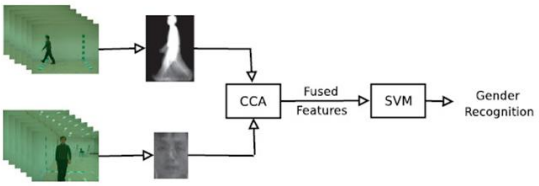


Figure 2. Gender Recognition using face-gait

First, gait image and face image of the subject extracted are obtained using background subtraction technique. Gait cycle is determined depending on the change in the number of pixels in the lower part of silhouettes. After this, the gender is verified according to the correlation between two image information obtained using Canonical Correlation Analysis(CCA) and the database. Lastly, after going through the main identification step primarily using face information and gait information obtained from remote camera, the recognition performance level was improved using in conjunction with soft biometric information obtained from the short distance camera.

2.3. Human Identification using Continuous Soft Biometrics

Biometric information for identification is an important technique in the surveillance system. For this, a variety of biometrics suitable for environment of surveillance system has been researched.

For example, in case of height the specificity is low but it is not oppressive and it obtains relatively accurate height from long distance as well as short distance. To extract the height, the method using projective geometry is being researched [6]. When vanishing line and vertical vanishing point on the standard plane and the standard height in the image are given, the height of the person can be calculated. The clothing color is one of the information to verify the identity of a subject. First, the quantization technique is used to distinguish clothing color. The octree-based color quantization technique can configure the similar palette to the pixel value obtained from image because its memory utilization is low if an appropriate octree depth is specified, the velocity of quantization is also fast and it configures the dynamic tree for input image [7].

3. Framework Applicable to long-distance Human Identification

Biometric information used for identification in existing video surveillance system includes face and fingerprint. However, the problems such as lighting, occlusion and shadow occurred frequently in remote video surveillance system cause the decrease of recognition

rate. So we propose the framework suitable for long-distance human identification as shown in Fig. 3. The experimental environment of proposed framework is assumed to be inside the building.

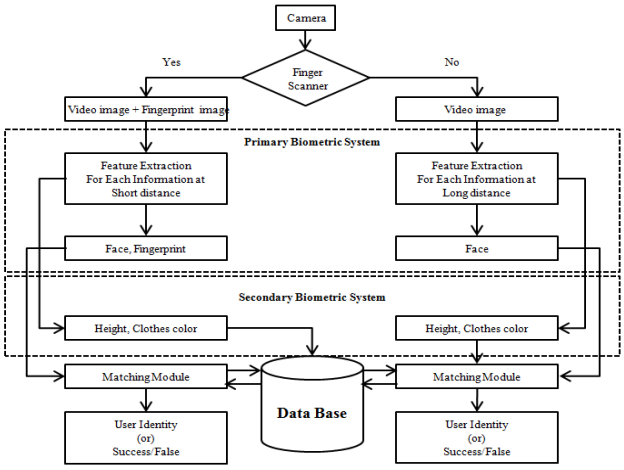


Figure 3. Proposed long-distance human identification framework

Generally, for buildings requiring high level of security such as companies, libraries or broadcasting station, it has limited recognition performance with only single biometric system. Thus, video surveillance camera and fingerprint sensor are equipped at the entrance of the building for identification. If inside the building, the identity of the subject in long distance should be verified only with face information obtained from video surveillance camera. However, due to this reason when the problem such as lighting, shadow or occlusion occurs, it is difficult to obtain accurate face information. The proposed framework obtains information on face, fingerprint, height and clothing color needed for identification from video surveillance camera and fingerprint sensor in short distance to determine the access of the subject at the entrance of the building. At this time information on height and clothing color obtained from video surveillance camera is stored in the database and it is used for additional biometric information along with information on face and fingerprint for identification. If the user is determined as unauthorized, the entry of the user will be controlled.

If a subject is working inside the building where no fingerprint sensor is installed, the fingerprint information can't be obtained because the fingerprint sensor is not used not like the environment of building entrance. So information on face, height and clothing color is obtained only by video surveillance camera. However, if the face information needed for identification couldn't be obtained when the distance between camera and subject is too far or the problem such as lighting, shadow, or occlusion is occurred, the problem can be solved using information on height and clothing color stored in the database at the entrance of the building and information on height and clothing color obtained from the inside. If the subject is entered the building again after moving outside of the building, the information on height and clothing color can be changed. In this case, the identity can be verified by storing the new information on subject's height and clothing color in the database.

Therefore, the human identification system using proposed framework is expected to improve the recognition performance by using various biometric information even though the feature extraction is difficult due to the environmental factors such as lighting, shadow and occlusion.

4. Conclusions

The research using biometric information for identification has been actively proceeded in video surveillance system. However, the traditional biometrics has the problem of decreased recognition rate because it needs cooperation with the user and low resolution image. Thus, the multi-modal biometrics is researched using in conjunction with soft biometrics recently to verify the identity in non-oppressive and various environments. The multi-modal biometrics using different biometrics is suitable for specific environment like video surveillance system compared to single biometrics and increases the recognition rate by maximizing the advantages of each biometric information.

In this paper, the identification technique using biometrics suitable for video surveillance system was analyzed. However, no human identification system that satisfies various environments with the current technique is existed. Therefore, proposed framework limited the experimental environment to the inside of the building, but in the future we plan to complement the problems that can occur in various environments.

Acknowledgements

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MEST) (No. 2009-0086148). This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2010-0005091).

References

[1] A. K. Jain, S. C. Dass and K. Nandakumar (Eds.), "Can Soft Biometric Traits Assist User Recognition?", Proceedings of the International Society for Optical and Photonics, **(2004)** April 12; Orlando, USA.

[2] J. L. Wayman (Ed.), "Large-scale Civilian Biometric Systems - Issues and Feasibility", Proceedings of Card Tech /Secur Tech ID, **(1997)**.

[3] E. Newham (Ed.), "The Biometrics Report. SJB Services", **(1995)**.

[4] A. K. Jain, S.C. Dass and K. Nandakumar (Eds.), "Soft Biometric Traits for Personal Recognition Systems", Proceedings of the International Conference on Biometric Authentication, **(2004)** July; Hongkong.

[5] S. M. E. Hossain and G. Chetty (Eds.), "Next generation identity verification based on face-gait biometric", Proceedings of the International Conference on Biomedical Engineering and Technology, **(2011)** Kuala Lumpur, Malaysia.

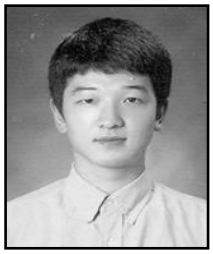
[6] A. Criminisi, A. Zisserman, L. Vangool, S. Bramble and D. Compton (Eds.), "A New Approach to Obtain Height Measurements form Video", Proceedings of the International Society of Optical Engineering, **(1998)**.

[7] M. Gervautz and W. Purgathofer (Eds.), "Simple Method for Color Quantization: Octree Quantization", Proceedings of New Trends in Computer Graphics, **(1990)**.

[8] U. S. Park and A. K. Jain (Eds.), "Face Matching and Retrieval using Soft Biometrics", IEEE Transactions on Information Forensics and Security. 5, 3 **(2010)**.

Authors

Min-Gu Kim received the B.S. degree in control, instrumentation, and robot engineering in 2011 from Chosun University, Gwangju, Korea. He is currently working toward the M.S. degree. His research interests include security, privacy of video surveillance and video compression.



Hae-Min Moon received the B.S. degree in control, instrumentation, and robot engineering in 2009 and information and communication engineering in 2010 from Chosun University, Gwangju, Korea. He is currently working toward the Ph.D. degree. His research interests include security, privacy of video surveillance and video compression.

Sung Bum Pan received the B.S., M.S., and Ph.D. degrees in Electronics Engineering from Sogang University, Korea, in 1991, 1995, and 1999, respectively. He was a team leader at Biometric Technology Research Team of ETRI from 1999 to 2005. He is now professor at Chosun University. His current research interests are biometrics, security, and VLSI architectures for real-time image processing.