Remote Target Recognition and Tracking Based On Biometric Characteristics

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Abstract. Biometric characteristics recognition (BCR) is a method of individual identification using inherent human vital signs or behavioral characteristics. This work aims at realizing remote BCR and target’s tracking system. First, we solve target’s identification through remote facial BCR. Then we achieve target’s vital signs recognition by non-contact breath and heartbeat detection. At last, we employ cross-validation of biometric characteristics recognition and vital signs identification technology method, and realize target’s tracking and locating.

Introduction

As the only physiological property or behavioral pattern (such as human face, fingerprint, voiceprint, iris, gait, etc.) which can be measured or verified, biometric characteristic (BC) has a strong distinctiveness. It is ‘portable’ and is a widely applied in counterterrorism, identification friend or foe, security systems and other military or public security area. Research and experience indicate that the universality and uniqueness of biometric characteristics can be met in most cases, but the stability and unduplicatedness might be different due to the characteristics of various biometric characteristics. Limited by performance of sensor and algorithm, the remote recognition precision of BCR system will decrease. We may also lose target if the relative position between BCR system and target changes or relative velocity is too fast.

Acquiring the target’s information is significant to remote recognition and target tracking. Being one of the target’s key information, BC has 4 characteristic elements: 1) unique; 2) nonperishable; 3) difficult to steal; 4) can be gathered conveniently and efficiently. It mainly includes, fingerprint, voiceprint, iris, palmprint, human face, DNA and so on. Among these BCs, fingerprint is one of the most classical BCR technologies. It mainly includes feature extraction, fingerprint classification, comparing and matching \cite{1-4}. Voiceprint recognition technology is a kind of behavior recognition technology, which mainly includes voice signal segmentation, feature extraction and speaker recognition \cite{5}. Iris recognition is divided into 4 parts: image acquisition hardware, image processing module, iris encoding technology and identification module. Daugman, Wilds and Boles \cite{6} have studied iris recognition which is a relatively new but incomplete technology, and provided a feasible solution to the marketization of this technique. As an emerging BCR technology, palmprint recognition technology has a high recognition rate \cite{7}. It doesn’t need expensive acquisition equipment and is easily acceptable for users, thus palmprint received much attention in decades. DNA (desoxyribo-nucleic acid) is the carrier of hereditary information. Its uniqueness and permanency throughout one’s whole life make DNA recognition the most authoritative and accurate method.
Although extracting DNA template is simple and convenient, DNA recognition is lack of flexibility, convenience or economics which are required as identification function. Facial feature recognition is an emerging BCR technology. So far, 5 primary methods are techniques based on facial geometric features [8], eigen face [9], neural network, localized characteristics analysis [10] and elastic matching.

Vital signs are also important information of human target. 1996, Lawrence Livermore National Laboratory in USA developed a particular UWB (ultra wide band) radar-micropower impulse radar. They carried out CT scans (minimum spacing is 2cm) to monitor respiration and heartbeat signal using range gate technology which extremely restrained the disturbance of external environment to respiration and heartbeat signal. With a high gain antenna, the detection distance can reach 100m at the farthest. A computer imaging workgroup of Swiss realized non-contact measurement of vital parameter signal using pulse microwave radar system. However, it only has a close ranging distance and is strict with human target. Furthermore, the system cannot detect the heartbeat signal accurately if the tested target breathes freely. Interiorly, the 4th Military Medical University is the earliest to conduct correlational research in the earliest using continuous wave biological radar, and they achieved the detection of creatures’ sort, amount and distance. 2007, the research group led by Professor Wang Jianqi used UWB system radar of mono-antenna bowtie antenna. Penetrating 2m thick brick-concrete structure, they successfully detected the respiration signal of human with normal lying posture and achieved considerable effect in the search and rescue activity of WenChuan earthquake in 2008.

Domestic and international scholar have already carried deep studies in recognition and tracking of biometric characteristics and vital signs, yet they are all confined to single detection of biometric characteristics or vital signs. However, usage of biometric characteristics and vital signs in the meantime has not been described. Aiming at scenario requirement of remote target recognition, this article illustrates a method of identifying and tracking targets by choosing an appropriate biometric characteristics and using vital sign in combination simultaneously. We solve the problem of losing target and realize a robust remote recognition and target tracking system in complex environment.

Remote Target Identification and Tracking Based on Biometric Characteristics

As a good information source of remote recognition, biometric characteristic is unique for individuals. It is noteworthy that system will lose target frequently in complex environment, while vital signs can supplement extra information. We select facial feature with breath, heartbeat and other vital signs and then employ cross-validation of biometric characteristics recognition and vital signs identification technology to locate and track targets dynamically and accurately. The overall technical route is shown in Fig.1.

![Figure 1. Overall technical route.](image-url)

We intend to adopt remote facial recognition technology in order to verify target’s identity primarily; then employ non-contact breath and heartbeat sensation technology to confirm target’s vital signs; finally carry out a cross-validation experiment between biometric characteristics and vital signs, and realize a stable remote recognition and target tracking system.
Remote Facial Biometric Characteristic Recognition Technology

Target’s facial features can be reliably captured through HD camera. Subsequently, outer face detection is carried out, which we preliminary test face region according to complexion and divide face into different skin color areas. Then we verify and locate the target with facial geometric feature, which we call inner face detection. Finally, we compare the facial geometric feature with images in database to identify the target. Main technical solution is shown in Fig.2.

![Diagram](image)

**Figure 2. Technical route of facial features recognition.**

Facial recognition uses the eigen face technology, extracts useful information to identify the identity of the target. Eigen face is an effective facial recognition description method, which is derived from the principal component analysis (PCA). This method converts the local regions into a random vector using the K-L base. The Eigen Face is the larger one and of the similar shape to the face. We can use a linear combination of these bases to describe the target’s face to accomplish the task of face recognition. The target’s face is mapped into the eigen face space to acquire the feature vector. Then, we feed this feature vector into the support vector machine (SVM) of nonlinear kernel and get the recognition result.
Remote Breath and Heartbeat Vital Signs Sensation Technology

With vibration imaging technology and PSD (position sensitive detector) sensor, non-contact breath and heartbeat sensation system can measure micro displacement caused by breathe or heart beat, and achieve a breakthrough of non-contact breath and heartbeat measuring technology. Technical solution is shown in Fig.3. The structured light after modulate reflects, and then received by photodetector array. Data processing unit processes the received light signal by Fourier transform and get target’s vibrant information as output from which we can acquire heart rate, breath, body movement and other vital signs information.

Summary

Aiming at the problem of losing targets easily while tracking facial features, we synthesize target’s signals of breath and heartbeat; carry out cross-validation between biometric characteristics and vital signs; integrate and build a novel recognition characteristic; and realize accurate recognition and continuous dynamic target’s tracking.

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References

[1] Mansfield, T., Roethenbaugh, G.: Glossary of Biometric Terms. J. Association for Biometrics & International Computer Security Association. (1998).

[2] Jain, A.K., Hong, L., Pankanti, S.: An identity-authentication system using fingerprints. J. Proceedings of the IEEE. 85(9), 1365-1388 (1997).

[3] Upendra, K., Singh, S., Kumar, V.: Online fingerprint verification. J. Journal of medical engineering & technology. 31(1), 36-45 (2007).

[4] Ratha, N.K., Karu, K., Chen, S.: A real-time matching system for large fingerprint databases. J. IEEE Transactions on Pattern Analysis and Machine Intelligence. 18(8), 799-813 (1996).

[5] Zhu, H., Guo, D.: Principles and Key Technologies of Voiceprint Recognition System. J. Network & computer security. 9, 006 (2007).
[6] Daugman, J., Wildes, R., Boles, W.: Statistical decision theory of Iris. J. IEEE, (2004).

[7] Kong, A., Zhang, D., Kamel, M.: A survey of palmprint recognition. J. Pattern Recognition. 42(7), 1408-1418 (2009).

[8] Brunelli, R., Poggio, and T.: Face recognition: Features versus templates. J. IEEE transactions on pattern analysis and machine intelligence. 15(10), 1042-1052 (1993).

[9] Sandhu, P.S., Kaur, I., Verma, A.: Face Recognition Using Eigen face Coefficients and Principal Component Analysis. J. International Journal of Electrical and Electronics Engineering. 3(8), 498-502 (2009).

[10] Zhou J., Lu C.Y., Zhang C.S.: A Survey of Automatic Human Face Recognition. J. Acta Electronica Sinica. 28(4), 102-106 (2008).