Cross Models for Twin Recognition

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ABSTRACT

Nowadays, Biometrics has become a popular tool in personal identification as it can use physiological or behavioral characteristics to identify individuals. Recent advances in information technology has increased the accuracy of biometric to another level, there is still a slew of problems existed, such as complex environment, aging and unique problems. Among many classes of identifications, recognizing twins is one of the most difficult tasks as they resemble each other. This affects the use of biometrics in general cases and raises potential risks of biometrics in access control. In this paper, the authors manage to distinguish twins using four different models, namely, face recognition, ear recognition, voice recognition and lip movement recognition. Their results show that voice recognition has the best performance in twin recognition with 100% accuracy. This is much higher than that of face recognition and ear recognition (with 58% and 53% respectively); and lip movement recognition that yields 76% accuracy.

KEYWORDS

Cross Models, Ear Recognition, Face Recognition, F-measure, Lip Movement Recognition, Precision, Recall, Speaker Recognition, Twin Recognition

BACKGROUND

Biometrics has been broadly employed in many access control systems, digital security, and forensics. This is the technology that automatically recognizes a person by using the physiological or behavioral characteristics (Jain et al., 2004). These characteristics such as face, ear, fingerprint, iris, voice, and deoxyribonucleic acid (DNA), are collected by the instruments such as digital camera and voice recorder. The collected data are labelled, trained, and applied to identify individual among others. There is a myriad of biometrics which have been applied to our day-to-day life such as face recognition, DNA analysis, fingerprint identification, signature verification (Qi & Hunt 1994) and speaker recognition, etc.

Biometric has certain advantages that make it popular in recent years. Unlike passwords, biometrics is much difficult to be shared and guessed (Jain, 2007). For an example, passwords combined with numbers or alphabetical letters normally contain personal information such as birth date or name. Complicated ones are hard to be remembered and easy to forget. On the other hand, it is tough to replicate the biometrics information of a person, and biometrics does not need to be remembered.

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Nowadays, face recognition is one of the most commonly used biometrics (Turk & Pentland, 1991), however, it may not be employed in twin recognition directly. The obvious problem of twin recognition is uniqueness of the faces (Gauthier & Logothetis, 2000). Twin recognition using face recognition is one of the most difficult tasks (Mahalingam & Ricanek, 2013) which has greatly challenged the conventional face recognition. Recently, many researchers have paid their special attention to this problem and have obtained notable achievements.

Research of Biswas et al. (Biswas, Bowyer & Flynn, 2011) shows that human visual system can work much better than computational machines in twin recognition. The research outcomes find that human is good at acquiring facial marks such as moles and scars to effectively identify twins. In addition, if human beings can spend more time to carefully examine the difference, the performance will become much more reliable. Klare, Paulino and Jain (2011) identify twins with human facial features such as eigenfaces as the level 1, Local Binary Patterns (LBP) as the level 2 and facial marks as level 3. The mouth shapes are relatively helpful to separate twin in typical data sets; especial the focus is on the age changing of twins (Le, Luu, Seshadri & Savvides, 2012). Therefore, they have employed facial aging features in twin identification. In another literature, Vijayan et al. (2001) utilize a 3D model to recognize twins. Albeit a spate of good recognition has been achieved, it is still far from solving the problem finally, e.g. closing the gap to human visual system.

Figure 1(a) are photos of identical twins taken when they were two months old. It is really hard to distinguish them from these photos. Figure 1(b) was the time when they were between two and ten years old. The two photos shown in Figure 1(c) were acquired when the twins were between 15 and 23 years old. In these three groups of photos, twin A is at the left side and twin B is at the right side. The twins look very similar in all the photos indeed.

**RELATED WORK**

There are a number of methods in face recognition of twins. Dimensionality-reduction approach is the primary mission in these algorithms. The methods usually take the entire face for consideration (Delac, Grgic & Grgic, 2005). Principal Component Analysis (PCA) which adopts the feature eigenface is one of the effective algorithms in face recognition (Gottumukkal & Asari, 2004; Moghaddam & Pentland, 1997). PCA greatly reduces the computational complexity by diminishing dimension of features.

Recently, twin recognition in association with human earmark technology has become a new class of relatively stable biometrics. Human ear recognition as a biometric does not have significant changes over time and this makes it an effective biometric (Kurniawan, Shafry, & Rahim, 2012). Compared to other pattern recognition methods, ear recognition has its unique pros and cons which is seldom affected by human emotions and aging problem (Kurniawan, Shafry, & Rahim, 2012). Methods of ear recognition have been split into twofold: statistical-based method and geometric-based method.

Statistical-based methods analyze a human ear by using statistical tools. The ear image is treated as a matrix, then the method such as PCA is taken to deal with the features and reduce the redundancy of the data. PCA is a statistical-based method which was developed to extract features from images (Chang, Bowyer, Sarkar & Victor, 2003). The related work also analyzes performance with the changes of human aging, illumination and pose. In addition, features of human faces and ears are extracted by using PCA. The recognition rates are 71.6% for ear recognition and 70.5% for face recognition, respectively.
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