Chapter 7
Gait Recognition and Analysis

Shiqi Yu
Chinese Academy of Sciences/The Chinese University of Hong Kong, China

Liang Wang
The University of Melbourne, Australia

ABSTRACT

With the increasing demands of visual surveillance systems, human identification at a distance is an urgent need. Gait is an attractive biometric feature for human identification at a distance, and recently has gained much interest from computer vision researchers. This chapter provides a survey of recent advances in gait recognition. First, an overview on gait recognition framework, feature extraction, and classifiers is given, and then some gait databases and evaluation metrics are introduced. Finally, research challenges and applications are discussed in detail.

INTRODUCTION

In many countries, CCTV cameras are set up almost everywhere. Cameras are used to monitor streets, building entrances, railway stations, airports, malls, national borders, etc. CCTV is helpful to police investigating the crimes and the video data can be used as evidence in courts. But the video data can suffer from bad quality due to low image resolution. Besides, the cameras are running 24 hours each day, and there are so much video data, it is impossible to view all video data by security staffs. Much of the time, even a suspect walks through a CCTV camera, no one will recognize him. Because of the far distance most biometric features such as face, iris, palm print and finger print can not be acquired and used for identification. Gait maybe is the best candidate among biometric features for human identification at a distance.

Gait, the manner of walking, is a newly emergent biometric which offers the possibility to recognize people at a distance. Gait recognition, also called gait-based human identification, is receiving more interest from computer vision researchers because of the increasing demands of visual surveillance. Gait recognition aims to recognize people by the way they walk. Compared with those traditional biometric features gait has many unique advantages

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such as non-contact, non-invasive and perceivable at a distance.

Gait seems to be unique: From a biomechanics viewpoint, each person seems to have a distinctive way of walking because gait pattern is mainly determined by the individual's weight, limb lengths, physical dimensions, habitual posture and so on. Walking is a complex action involving synchronized integrated movements of each body segment, joints and the interaction among them (Winter, 1991). Although these movements follow the same basic pattern for all humans, they seem to vary from one individual to another in certain details such as their relative timing and magnitudes. It is the distinguishable variations in the physical properties of human body structures and the behavioral characteristics of walking actions among different subjects that may provide a unique cue to personal recognition. Many earlier studies (Murray, Drought et al., 1964; Murray, 1967) show that gait can be used to identify different persons.

Gait is non-contact and non-invasive: Most biometric features such as finger print, palm print and iris require physical touch or proximal sensing. Although some biometric systems have shown good reliability today, they still lack the users' acceptance to some extent, e.g., the users are unwilling to touch a finger print scanner and dislike closely watching an iris capture device since they think that doing so may be unclean to their hands or harmful to eyes. However, using gait feature would avoid such problems since it does not need the user's interaction other than walking. Gait can be extracted secretly at a distance which naturally advances the acceptance of the users (Cattin, Zlatnik et al., 2001).

Gait is perceivable at a distance: The gait of an individual can be easily captured at a distance. However, the established biometric features such as face, iris and finger print are limited in such capability. To operate successfully, they usually require sensing the cooperative users at close ranges, e.g., finger prints are obtained by the user's contacting a finger print scanner and faces are taken from near distance in order to produce a resolution high enough for recognition. However at a distance, these biometric features are hardly applicable. Fortunately, gait is still visible in this case. So, from a surveillance perspective, gait is a most attractive modality for recognition at a distance.

Gait is hard to conceal: In applications of biometric recognition, many biometrics can be obscured, altered or hidden. For instance, face may be made up, at low resolution or be hidden with a mask, hands may be even cut off or be obscured, ears are probably invisible due to the occlusion by hair, etc. However, people need to walk. Hence, human gait is usually visible (i.e., the users generally do not disguise or hide their gaits purposely).

Besides human identification, gait can be used in many applications, such as in surveillance video retrieval systems, pedestrian information collection systems and others.

Human identification: For it unique advantages, gait can be used for human identification especially in visual surveillance systems. However, gait can not gain as high recognition rate as iris and finger print. So gait can only be used in a small population. In a large population, gait can be used to find some suspected persons and the security staffs confirm whether they are the persons wanted. Recognition performance can be improved by fusing gait with other biometrics such as face. As gait, face is also perceptible at a distance.

Video retrieval: After a criminal event happens, policemen and security staffs will review a lot of videos to find where the suspects have gone and what the suspects have done. Because there are a lot of cameras mounted everywhere nowadays, there are a lot of videos need to be reviewed. Gait recognition technology can compare each person in videos with suspects and search suspects automatically (Xu and Yan et al., 2007).

Pedestrian information collection: Besides