

Chapter 21

Recognition of Human Silhouette Based on Global Features

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ABSTRACT

The aim of this paper is people recognition based on their gait. The authors propose a computer vision approach applied to video sequences extracting global features of human motion. From the skeleton, the authors extract the information about human joints. From the silhouette and the authors get the boundary features of the human body. The binary and gray-level-images contain different aspects about the human motion. This work proposes to recover the global information of the human body based on four segmented image models and applies a fusion model to improve classification. The authors consider frames as elements of distinct classes of video sequences and the sequences themselves as classes in a database. The classification rates obtained separately from four image sequences are then merged together by a fusion technique. The results were then compared with other techniques for gait recognition.

INTRODUCTION

Gait analysis is the systematic study of animal locomotion, more specific as a study of human motion. It is a cyclical pattern of corporal movements that are indefinitely repeated every cycle. Gait analysis techniques allow for the assessment of gait disorders and the effects of corrective Or-

thopedic surgery. Many different disciplines use motion analysis systems to capture movement and posture of the human body. Basic scientists seek a better understanding of the mechanisms that are used to translate muscular contractions about articulating joints into functional accomplishment, e.g. walking. Increasingly, researchers endeavor to better appreciate the relationship between the human motor control system and gait dynam-

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ics. Basic changes in gait pattern serve as early indicators of disease such as Parkinson's disease, multiple sclerosis and hydrocephalus. For a long time, gait analysis was restricted to the medical field, but now is spreading to other applications, such as for biometric recognition. Recent research has proven that human beings have special and distinct ways of walking (Sarkar et al., 2005; Havasi, Zoltan, & Szirányi, 2007; Boulgouris & Zhiwei, 2007). Given this premise, a human being's gait can be understood as an important biometric characteristic. The objective of this work is to establish a methodology that can recognize a person from the way he/she walks.

Considering that there are differences in the way each person walks and that these differences can be significant in terms of identifying an individual, the proposal of this work is based on the observation that in a video sequence with only one person walking, the movement of this person, even in images with a complex background, generates valuable data among the highly correlated frames.

The main contribution of this work is the proposition and fusion of four distinct models of human silhouette representation: Silhouette-Gray (SGW), Silhouette-Binary (SBW), Silhouette-Edge (SEW) and Silhouette-Skeleton (SSW). The SGW model captures motion based on grey level variations; the SBW model captures motion based on binary information; the SEW model captures motion based on edge information and the SSW model captures motion based on skeleton movement. The classification rates obtained separately from these four different models are then merged using a new proposed fusion technique.

RELATED WORK ON GAIT RECOGNITION

Traditional techniques for gait recognition are divided into two main groups: Methodologies based on Silhouette (Niyogi & Adelson, 1994; Hong, Lee, & Kim, 2007; Kale, Cuntor, Yegnanarayana,

Rajagopalan, & Chellappa, 2003; Lee & Grimson, 2002) and methodologies based on Model (Bobick & Davis, 2001; BenAbdelkaer, Cutler, & Davis, 2002; Yang, Wu, & Peng, 2006; Liu & Zheng, 2007). In the approach based on silhouette, the shape and its derived attributes are the most important characteristics. Taking this into account, measurements are used to recognize a person in terms of the shape and/or movement.

The aim of the approach based on the Model is to interpret movement of the trunk and/or legs. In contrast to the approach based on silhouettes, generally the model-based methodology focuses on the dynamics of the movement, omitting the body shape. There are techniques to join the two models, thus providing a mixed methodology (Nizami et al., 2008; Wang, Tan, Ning, & Hu, 2003; Chellappa, RoyChowdhury, & Sundaresan, 2003).

One of the first techniques for automatic gait recognition, based on the silhouette analysis, was proposed by Niyogi and Adelson (1994) where the gait signature was obtained from the spatial patterns of individual movement. Hong et al. (2007) have proposed a new representation for human gait called the Mass Vector approach. A Mass Vector is defined as the number of pixels with non-zero values in a column of a matrix of binary silhouettes. This type of vector is inspired by the concepts of Kale et al. (2003). The proposed methods by Yang et al. (2006), difference motion slices that contain moving objects are extracted. With the difference motion slices, it's possible to get difference gait images, in which both static appearance shape information and dynamic information of habitual motion of the body can be expressed. The experiments have been conducted on the NLPR database (www.cbsr.ia.ac.cn).

In the method known as Gait History Image (GHI) (Liu & Zheng, 2007), static and dynamic characteristics of the gait, as well as spatial and temporal variations can be represented. In the work proposed by Nizami (2008) is presented a multi-view gait recognition algorithm for identification at a distance. The work makes use of two gait

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