A Multi-view Method for Gait Recognition Using Static Body Parameters

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Abstract. A multi-view gait recognition method using recovered static body parameters of subjects is presented; we refer to these parameters as *activity-specific biometrics*. Our data consists of 18 subjects walking at both an angled and frontal-parallel view with respect to the camera. When only considering data from a single view, subjects are easily discriminated; however, discrimination decreases when data across views are considered. To compare between views, we use ground truth motion-capture data of a reference subject to find scale factors that can transform data from different views into a common frame ("walking-space"). Instead of reporting percent correct from a limited database, we report our results using an expected confusion metric that allows us to predict how our static body parameters filter identity in a large population: lower confusion yields higher expected discrimination power. We show that using motion-capture data to adjust vision data of different views to a common reference frame, we can get achieve expected confusions rates on the order of 6%.

1 Introduction

Automatic gait recognition is new emerging research field with only a few researched techniques. It has the advantage of being unobtrusive because body-invading equipment is not needed to capture gait information. From a surveillance perspective, gait recognition is an attractive modality because it may be performed at a distance, surreptitiously.

In this paper we present a gait recognition technique that identifies people based on static body parameters recovered during the walking action across multiple views. The hope is that because these parameters are directly related to the three-dimensional structure of the person they will be less sensitive to error introduced by variation in view angle. Also, instead of reporting percent correct (or recognition rates) in a limited database of subjects, we derive an expected confusion metric that allows us to predict how well a given feature vector will filter identity over a large population.

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1.1 Previous Work

Perhaps the first papers in the area of gait recognition comes from the Psychology field. Kozlowski and Cutting [8,4] determined that people could identify other people base solely on gait information. Stevenage, Nixon, and Vince [12] extended the works by exploring the limits of human ability to identify other humans by gait under various viewing conditions.

Automatic gait-recognition techniques can be roughly divided into model-free and model-based approaches. Model-free approaches [7,9,10] only analyze the shape or motion a subject makes as they walk, and the features recovered from the shape and motion are used for recognition. Model-based techniques either model the person [11] or model the walk of the person [3]. In person models, a body model is fit to the person in every frame of the walking sequence, and parameters (i.e. angular velocity, trajectory) are measured on the body model as the model deforms over the walking sequence. In walking models, a model of how the person moves is created, and the parameters of the model are learned for every person.

Because of the recency of the field, most gait recognition approaches only analyze gait from the side view without exploring the variation in gait measurements caused by differing view angles. Also, subject databases used for testing are typically small (often less than ten people); however, even though subject databases are small, results are reported as percent correct. That is, on how many trials could the system correctly recognize the individual by choosing its best match. Such a result gives little insight as to how the technique might scale when the database contains hundreds or thousands or more people.

1.2 Our Approach

Our approach to the study of gait recognition attempts to overcome these deficiencies by taking three fundamentally different steps than previous researchers.

First, we develop a gait-recognition method that recovers static body and stride parameters of subjects as they walk. Our technique does not directly analyze the dynamic gait patterns, but uses the action of walking to extract relative body parameters. This method is an example of what we call *activity-specific biometrics*. That is, we develop a method of extracting some identifying properties of an individual or of an individual's behavior that is only applicable when a person is performing that specific action. Gait is a excellent example of this approach because not only do people walk much of the time making the data accessible, but also many techniques for activity recognition are able to detect when someone is walking. Examples include the motion-history method of Bobick and Davis [5] and even the walker identification method of Nyogi and Adelson [11].

Second, we develop a walking-space adjustment method that allows for the identification of a subject walking at different view angles to the viewing plane of a camera. Our static body parameters are related to the three-dimensional structure of the body so they are less sensitive to variation in view angle. However, because of projection into an image, static body parameters recovered from different views need to be transformed to a common frame.