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Reviewing an Authentication Technique Based on Gait Recognition

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Abstract: Gait recognition based authentication is one of the prominent biometrics which is usually used to secretly recognize people. It recognizes a person according to a sequence of received images. Gait is physiological characteristic of mankind. Gait analysis enables us to authenticate a person from a long distance using low resolution video. The information and properties regarding one person's gait are extracted which makes authentication possible.

Keywords: Biometric, Gait Recognition, Machine Vision, Ground Sensors, Wearable Sensors

1. Introduction

Using biometric to authenticate people is greatly beneficial as extracted characteristics are difficult to be counterfeited; they cannot be shared and they cannot be forgotten. The gait for each person is a unique characteristic by which people can be authenticated. Gait is a sophisticated biometric.

Gait is referred to type of walking or how the body is displaced on foots. Each person's gait is unique. Walking is a complicated activity including movement of all body organs and their interactions. Therefore, the differences between movements and body structure of different people might be exploited as specific characteristics for authentication. It was firstly proved by Johanson in 1970. He stated that similar people can be recognized based on their gait. It was possible through analyzing video sequences taken from people's gait while they were carrying a light on a specific part of their body. It is hard for people to conceal their gait as they need to walk normally to enter any place. Gait recognition is relatively simple in normal conditions; however, a slight change in these conditions may result in awful consequences.

2. Efficacious Factors

Changes in clothes may affect type of people's movements. Moreover, lightening differences may adversely influence our system performance. Another important factor is pace which is constant and unique for each person. Person's gait is another factor which is determined according to other factors such as weight, length of hands and legs, kind of shoes and person's pose. These factors affect characteristics which are empirically used to recognize gait including pace, length of steps and angles of different parts of hands and legs. View angle is a paramount factor. In the past the person had to walk just through the path where the database video images were recorded. Nowadays, several cameras are located in different angles to record people's video from different views.

3. Advantages, Applications and Techniques

The primary and the most crucial advantage of gait recognition is that it can be applied even from long distances. Additionally, there is no need for person's cooperation as well as impossibility to conceal it from observers and surveillance systems are other superiorities. This method is mostly used in security paths and airports. This authentication system, in fact, is a part of secret systems. Thus, it is employed in surveillance systems, authentication systems and smart Environments. Gait recognition techniques can be divided into three groups:

- Machine vision
- Ground sensors
- Wearable sensors

3.1. Machine Vision

In this category people's image is taken using a camcorder from long distance. Afterwards, gait patterns are extracted and processed. These patterns include long steps, static parameters of body (such as stature), distance between head and pelvis, the maximum distance between pelvis and legs and distance between legs. For example in robbery cases where the thief uses a mask to cover his face and uses a glove to avoid leaving fingerprints, there would be no information available about face and finger prints; Nevertheless, gait recognition might be exploited based on videos recorded by security cameras.

3.2. Ground Sensors

A set of sensors are installed on the ground and when a person walks on them they are able to measure his/her gait. Characteristics which can be measured by these sensors include heel strike, length of each step, pace and so on. These sensors usually are located in front of building entries. They are advantageous as they can simply collect information.

3.3. Wearable Sensors

Some these sensors are wearable and they record and collect body movements. These sensors measure acceleration of walking. These sensors may be installed on people's belt, around their thigh or around their shin. These sensors might be even put in people's pocket. These sensors were proposed to be utilized in cellphones and portable electronic gadgets for support, protection and authentication purposes.

4. Challenges

Although the performances of all three biometric gait recognition approaches are encouraging, there are several factors that may negatively influence the accuracy of such approaches. We can group the factors that influence a biometric gait system into two classes (not necessarily disjoint):

4.1. External Factors

Such factors mostly impose challenges to the recognition approach (or algorithm). For example, viewing angles (e.g. frontal view, side view), lighting conditions (e.g. day/night), outdoor/indoor environments (e.g. sunny, rainy days), clothes (e.g. skirts in MV-based category), walking surface conditions (e.g. hard/soft, dry/wet grass/concrete, level/stairs, etc.), shoe types (e.g. mountain boots, sandals), object carrying (e.g. backpack, briefcase) and so on.

4.2. Internal Factors

Such factors cause changes of the natural gait due to sickness (e.g. foot injury, lower limb disorder, Parkinson disease etc.) or other physiological changes in body due to aging, drunkenness, pregnancy, gaining or losing weight and so on.

One of the public gait data set that was published by Sarkar et al. [3] includes five factors that may influence gait recognition. These factors include change in viewing angle, in shoe type, in walking surface, carrying or not carrying briefcase, and the elapsed time between samples being compared.

For example, when the difference between the template and the test samples was in shoe type (A vs B), view (right camera vs. left camera), briefcase (carrying vs. not carrying) and surface (grass vs concrete), the recognition rates were 78%, 73%, 61% and 32%, respectively [3].Some of the external factors may have various effects on different gait recognition approaches. For example, while carrying an object may influence the dynamics of gait both in WS-based and MV-based categories, it may also create additional difficulties in MV-based category during human silhouette extraction. The effect of carrying backpack from WS-based perspective is studied in [4]. When carrying backpack the EER increased from 7.3% to 9.3% and recognition rate dropped from 86.3% to 86.2% [4].

5. Methods

Basically, gait analysis can be divided into two major categories, namely model-based approach and model-free approach.

5.1. Model-Based Approach

Model-based approach generally models the human body structure or motion and extracts the features to match them to the model components. It incorporates knowledge of the human shape and dynamics of human gait into an extraction process. The gait dynamics are extracted directly by determining joint positions from model components, rather than inferring dynamics from other measures (such as movement of other objects). Thus, the effect of background noise can be eliminated. Research examples of this approach are static body parameters, thigh joint trajectories, dual oscillator, articulated model, 2D stick figure and elliptic Fourier descriptors.

The advantages of this approach are the ability to derive dynamic gait features directly from model parameters. It is free from background noise as well as the effect of different subject's apparel or camera shooting viewpoint. However, it creates many parameters from extracted gait features and hence resulting in a complex model. Due to that reason, the computational time, date storage and cost are extremely high due to its complex searching and matching procedures.

5.2. Model-Free Approach

Model-free approach generally differentiates the whole motion pattern of the human body by a concise representation such as silhouette without considering the underlying structure. Normally, its parameters are obtained from the static gait features like centroid, width and height of the silhouette. Research examples of this approach are self-similarity Eigen gait, key frames analysis, spatial-temporal distribution characterization, kinematic features, unwrapped silhouette,

higher order correlation, video oscillations and gait sequences.

The advantages of this approach are speedy processing, low computational cost and small data storage. However, the performance of this approach is highly affected by the background noise and the changes of the subject's apparel.

6. Discussion, Conclusion and Future Work

Person's gait is as unique as his/ her fingerprint. It can be exploited to authenticate people. In gait recognition systems, person's gait is recognized in accordance with saved sequences. This recognition can be performed secretly. This scheme is a biometric technology which might be used for surveillance purposes without people's cooperation. Controlling systems in environments such as banks, military zones and airports need to rapidly detect threads. So this method is a proper technique to achieve this purpose.

Researchers are trying to produce a biometric shoe which helps people's recognition. These shoes can authenticate people by analyzing gait.

As a matter of fact these shoes have an application similar to fingerprints. Scientists in Pedobiometric lab of Carnegie Mellon University are studying a kind of shoe which is able to authenticate the person. These shoes consist of sensors which measure the pressure on the bottom of shoe.

They analyze person's gait via information collected by these sensors. Information received from these sensors is processed by a microcomputer and is compared with saved patterns of person's gait. If the information matches the patterns, sensors are disabled but if the person's gait is not familiar for microcomputers they will activate the alarm. Marious Savids, the director of lab research group, has said that this technology is able to authenticate a person through merely three steps. He stated that this technology has been tested and has achieved 99% precision.

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