

Experimental Analysis of Gait Parameters Variability Using VideocameraRecords

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***Abstract.** The human gait analysis can provide important data for gait patterns classification of individuals as input for identification of persons according to gait parameters. The set of gait parameters that are relevant for identification purposes is not defined yet. Therefore our recent research target is to distinguish similarities and differences, evaluate the variability of gait parameters of the relevant group of people and conclude the usability for identification purposes. The gait parameters of ten subjects were recorded, calculated and evaluated in our Human motion analysis laboratory at the Technical University of Košice. We use SMART system to capture motion data – dynamic parameters describing trajectories of 25 markers. Their positions, velocities and accelerations provide input for further calculation and linear analysis of human gait as joint angles, rotation angles, step frequency, length and with of step, gait cycle phases.*

Keywords: Human Motion Analysis, SMART System, Gait Parameters, Variability, Identification of People

1. Introduction

The main task of identification of persons is to distinguish person according to the physical appearance, social behaviour, role of interaction in the environment (family, society, friends, work) and identify person according to characteristics, knowledge, occupation and biometrical features (physical, biological, genetic). In the criminology, the identification process can be seen from different point of view and utilize several different methods and algorithms. [1, 2]

Some researchers already showed that gait style and its quantitative description are suitable sources for identification even in the cases when the observation of face, ear, and eye is impossible. In the last years there were made several attempts to identify persons using their motion traces. In order to capture human body motion traces the video capturing systems are applied. It is difficult task to use the video records taken in a real situation in public environment, because usually there is only a less quality record made by a simple camera with low data density. However, cameras improve their parameters, and there are already methods that are able from a simple record of human body movement can provide enough information for identification of individuals. Persons committing crime are often using different camouflage, hidden faces, clothes that can cover body, so the standard methods for identification fail. On the other hand there are laboratory methods with promising results but human motion analysis requires a lot of data, several cameras, special markers for isolating of important points on the human body, and other techniques, to provide reliable results. Video record from the public places is usually in captured in a dynamic, non structures space with possible artefacts caused by other persons and environment.

Identification based on gait analysis has several advantages comparing with other biometric data. It is not invasive, can be remotely captured that is not possible for other biometric features.

Identification of a person is a particular case of a general identification process. It can be classified into [2]:

- external identification (recognition of physical, biological characteristics of person),
- internal identification (perception of the psychological, philosophical and social self-identity).

Gait analysis has many specific individual features for movement identification purposes but on the other hand, there are limitations for use of gait in biometric applications as there are many other factors, which influence the movement patterns and gait styles – intentional change of movement performance, its speed/acceleration, overall behaviour, or external factors like various diseases and injuries influencing posture, short-term and long-term physical and psychical overloading of the body, drugs and medical treatment, changes in body dimensions, walking surface, environment conditions and many others. Also the conditions of imaging can have influence on the gait pattern – calibration, light, shadows, background, and colour of clothing. Some methods will be suited for usage in the laboratory conditions, some of them, on contrary, in the common terrain and environment (streets, public places, corridors, financial institutions, etc.).

2. Subject and Methods

Natural variability in human gait patterns is the precondition for differentiations between individuals when we expect to identify the only one individual between numbers of persons inside of an evaluated group. Therefore we started with an analysis of the gait parameters of a selected homogenous group of subjects. Ten subjects were recorded, calculated and evaluated to analyse variability of obtained data for identification purposes of subjects. In our Human motion analysis laboratory at the Technical University of Košice we use SMART system to record 3D data of moving subjects (6 infrared cameras, 50Hz).

Measurements offer values of dynamic parameters and their time characteristics - trajectories of selected points attached on human body according to the marker set for the whole gait cycle. A model consists of 25 reflex markers placed on head, spine, torso, pelvis, upper and lower extremities. The data available immediately after 3D motion reconstruction are markers positions, velocities and accelerations in time. They provide input for further calculation and linear data analysis of human gait as joint angles, rotation angles, step frequency, length and width of step, gait cycle phases. The subjects were walking during trials in two different speeds - standard walking speed and moderately faster speed. We used 3 types of situations – for each speed we captured gait in tight clothes, in indoor clothes and outdoor outfit with coat and shoes.

Literature analysis shows that there are 2 basic approaches in the gait analysis – identification methods oriented on modelling and recognition of human movement and methods focused on the human body silhouette dynamic changes describing by integrated values [3].

3. Results

The identification process is based on the interpersonal and intrapersonal comparison and individual variance determination. We gathered data from 25 markers because after

evaluation of the data variability we will be looking for significant gait parameters that could help us to distinguish between subjects with the highest probability.

In order to detect significant differences the simple ANOVA test will be used. The best parameters with significant differences between subjects can be used for identification procedure. Parameters with very low score shall prove poor contribution for identification purposes and we plan to release them from the further research.

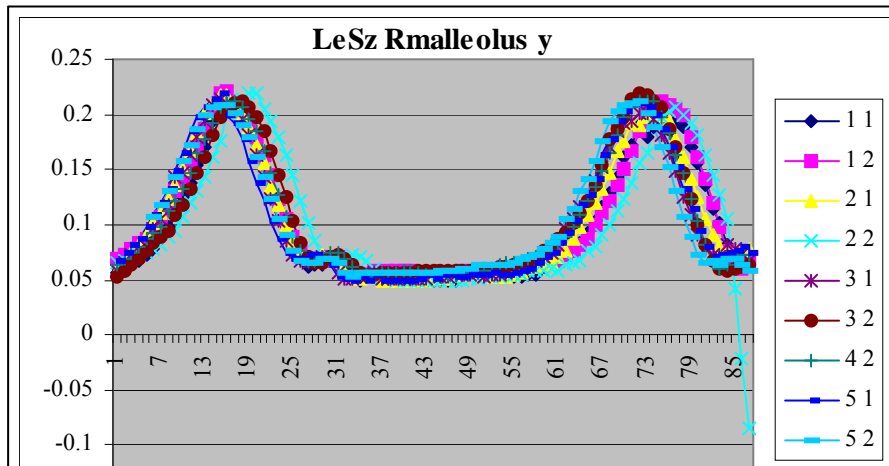
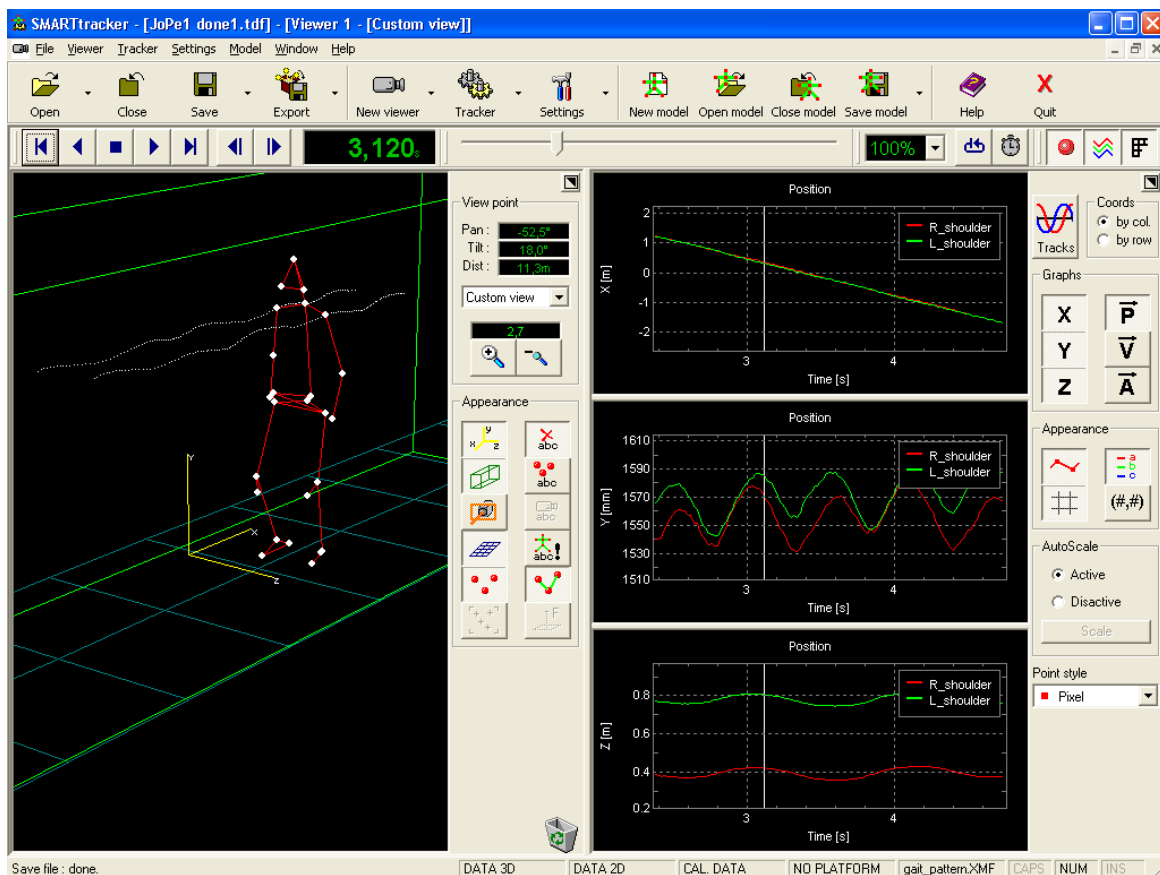


Fig. 1 Variability of the lateral ankle marker position in time

Variability (Fig. 1) of all position data of 25 markers are currently being evaluated.

We use SMART tools for data evaluating in combination with MATLAB and Excell (Fig.2).



4. Discussion

We are currently in the early stage of our research of identification procedures of individuals based on the dynamic stereotype patterns of the human gait.

Variability of gait linear gait parameters is well known fact. We work on proving that fact on the selected group of probants.

The further step will be the factorial analysis of gait parameters looking for a minimal set of significant parameters that are critical for an efficient analysis of an individuals gait record and proving a person identity.

5. Conclusions

Early results of the research obtained ten years ago in different research centres confirmed that gait has a large potential for identification and verification tasks. Only further intensive research in the area of newly developed and applied methods using computational technologies and engineering approach will confirm whether gait will be equally effective, powerful and sufficient biometric alternative to other biometric methods used nowadays.

Gait biometry is associated to high expectations, especially in relation to physical safety and potential use of the already introduced technical resources for safety purposes. There is an option to use already installed industrial cameras, monitoring systems upgraded for automatic evaluation of human identity (real-time systems or retrospectively to identify person from the archive, databases) based on the face and gait recognition. The interest is strongly supported and motivated by security systems due to growing incidences and terror attacks.

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