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Monitoring Health Wellness Using Walking Pattern

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Abstract: ***This paper presents a review on human identification based on gait features, i.e. the walking patterns of people. The aim of this work is to describe algorithm for the segmentation of the foot-switch signal and the classification of the gait cycles. The performance of the algorithm was assessed comparing its results against the manual segmentation and classification performed by a gait analysis expert on the same signal. The widespread technological development in the field of health wellness, provides various domain to take upon the challenges for new development of various applications Architecture proposes collaborative working of real time videos, data aggregation through related application, analysis of collected data and communication gateway for future updates.***

Keywords: Data Analysis, Real Time Videos (Walking Pattern), Gait Recognition

1. Introduction

The definition of gait is related to the style or characteristic involved in a person's walking. It is divided in two main periods considering the sagittal plane, stance and swing, which in turn are composed of subphases as illustrated in Fig. 1.

This paper presents a review on human identification based on gait features, i.e. the walking patterns of people. It introduces the steps involved in this process with a focus on gait feature extraction approaches.

Aforementioned issues need to be differently categorized while analyzing walking pattern and staircase climbing because in both the cases the stance and swing phases of gait cycle are different. Specifically these postures are considered as these are the basic steps while starting the physio training in rehabilitation.

Figure 1 and 2 shows the variation in Gait cycle phases during walking and during step climbing.

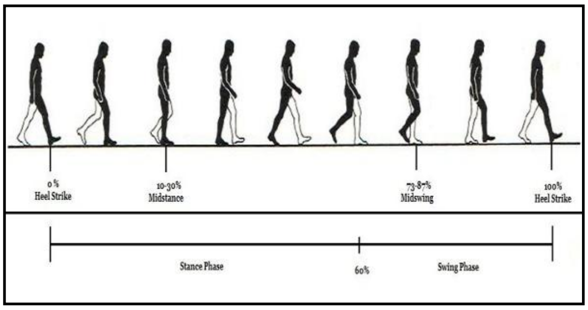

Figure 1: Stance & Swing Phase during Walking

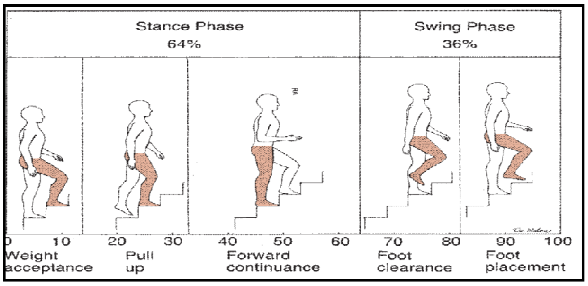

Figure 2: Stance & Swing Phase during step climbing

The basic connectivity, communication and data flow is shown in the Figure3. Block Diagram indicating Data flow Architecture.

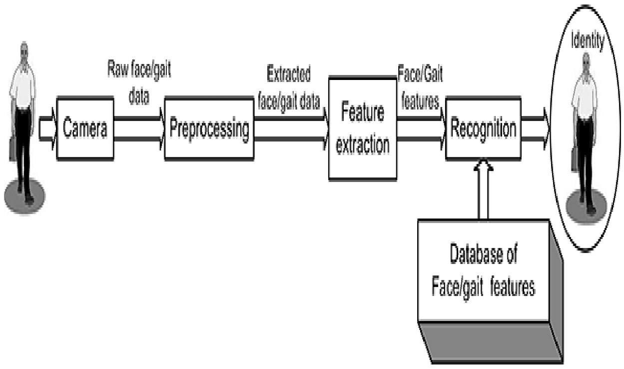

Figure 3: Block Diagram showing Real-Time health monitoring

Gait recognition is a process that is made up of several consecutive stages:

- First, the video of a walking subject has to be captured and the parts of the video that contain the walking sequences are isolated.
- These sequences then need to be preprocessed to extract the walking subject from the static background.
- Features are extracted from the image of the extracted subject and a gait signature is established.

This gait signature can then be recognized using classification techniques to compare the established gait signature with the set of gait signatures from known subjects in the gait database. The major alteration need to be done in the process of identifying step counting, usual 3-axial threshold need to be changed on the basis of type of patient to be monitored. The normalized trained motion detection and the detection of motion in surgery treated person varies on the basis of typical operative/medical treatment they have undergone. Patient monitoring system (PMS) is comprised of data analytical part, feedback system and report generation. Major contributors in PMS are physiotherapist and orthopedic surgeon.

2. Gait Recognition System

1) Gait Acquisition

The First stage in gait recognition is to capture or detect subject gait frames, which is important because the accuracy of the system depends significantly on image samples used for training. The sensing devices have two categories: sensor-based and video based. Sensor devices are floor and wearable sensors [26]. Floor sensors are referred to as a pressure sensor, which generates pressure signals when a person walks on these sensors when placed on the specific floor [27], [28]. Wearable sensors are attached to different body joints, to collect different dynamic features (such as speed, acceleration, and position) and other information which can be used for gait pattern analysis.

The most common application of sensor-based is in clinical research, such as Parkinson's disease diagnosis [24], [25]. Where as video-based gait recognition research refers to capture specific human gait through the visual cameras that can be mounted at any location. These captured gait videos are processed to detect gait pattern information, which can be used for recognition. During the past decade, most research in the area of gait recognition is done using video-based gait dataset [22], [23].

2) Pre-Processing:

Basic background subtraction method includes mean filtering, median method, frame difference method, statistical approach (Gaussian Mixture Model, support vector model), optical flow and many more. The motive of this process is to model human gait silhouette from which spatiotemporal shape and motion characteristics [20], [21] are extracted for recognition.

3) Feature Extraction

After the object of interest has been segmented from the background, features have been extracted that can be used for individual subject recognition. In gait recognition, features are extracted based on Model-based and Model-free (appearance based) representations.

4) Feature Selection

In traditional gait recognition system, extracted features from pre-processed videos sequences are inadequate for classification and performance has been compromised. The reason is that high dimensional features may contain some unnecessary features. So, feature selection(or dimensionality reduction) approach can be applied, which is to choose a subset of variables(features) from the input features which efficiently describe the input variables while reducing effects of noise or extraneous variables and provide excellent prediction or classification results.

5) Classification

The last stage in gait recognition system is to classify the test gait sequences of an individual based on optimized features selected. Classification is divided into two categories: supervised and unsupervised. The kNN(k nearest neighbor) is the most adopted classifier in gait recognition.

3. Theme of Paper

The paper discusses the “Health Wellness”, Model for the restricted group of patients, under the rehabilitation process for their major leg injuries. Considered group to be monitored are assumed to be undergone the major injuries in leg bones: ankle fracture, tibia or fibula fracture knee replacement and badly impacted muscle tone. Intended monitoring activity is simple walk and step climbing in such patients at basic level after major operative or physic treatment.

For a normal human the walking and step climbing pattern is different than the pattern observed after major leg injuries. Few of the categorization parameters are age, sex, types of injury, other medical illness, medical history of patient, expected recovery time, nature of physio therapy suggested etc. for the same statistical classifier could be a better option in analyzing the process.

Comparison with other classification algorithms

In order to check the accuracy of the presented algorithm with respect to other classical classification ones, we have compared our results with the ones obtained with Naïve Bayes, Multilayer Perceptron, Support Vector Machines, Radial Basis Function network and Random Forest algorithms.

Support Vector Machine (SVM) with non-linear kernel, naïve Bayes classifier, Random Forest, Bagging, and AdaBoost have been shown to be powerful supervised learning techniques for sensor-based gait classification. We used Naïve Bayes, SVM, Random Forest, Bagging, and AdaBoost classifiers using a repeated 5-fold cross validation method in our analysis and compared the accuracy of each model across different feature sets and across standardized and non-standardized vectors of feature. Each classifier’s accuracy was calculated using the measures of accuracy, precision, and recall.

4. Conclusion

The proposed Health Wellness theme is intended to cover the specific group of patients under the process of rehabilitation to monitor the typical gait cycle variation within them. Definitely it will open up the wide doors for concept of patient monitoring. The required devices are very general, not burdening the cost to be invested. Module developed for different category of patients will provide close loop communication system without requirement of frequent personal visit. At the initial level suggestions are limited to the change of threshold value for monitoring the walking and step climbing pattern.

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