INSTRUMENTED SHOES FOR MEDICAL DIAGNOSYS AND REHABILITATION

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Introduction

Human gait pattern analysis has an increasing importance in rehabilitation medicine, sports and other areas. Therefore, understanding gait patterns enables medical staff to follow recovery processes of patients and adjust their treatments, as well as it permits to evaluate the efficiency of athletes' gait in order to improve their performances.
The aim of this work is to infer about the recovery degree of patients with gait disorders. This can be done through the study of the ground reaction forces (GRF) and the trajectory of the centre of pressure (CoP), during human gait.

State of the Art

Currently, there are many systems that measure some parameters that characterize human gait, like the vertical component of the GRF, which is used to map the plantar pressure and to compute the CoP's location. Most present solutions use force plates and insoles with pressure or force sensors. However, force plates restrict the number of steps that can be done and sometimes insoles don´t adjust very well to the footwear.

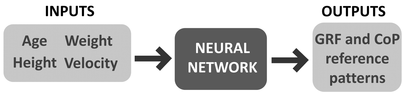
Materials and Methods

The present work uses a pair of low cost instrumented shoes, which measures the three components of the GRF. Each shoe contains sixteen thin force sensors in its sole. The sensors are connected to a microprocessor and a transmission board which sends data to a computer, or other electronic device, via a wireless protocol.

The instrumented shoes were tested in persons with and without physical disorders to build a GRF database. Unhealthy tested people were subjected to ligamentoplasty tow years ago, because of the rupture of their knee's anterior cruciate ligament. Tested persons had different ages, weights and heights, and walked at five different velocities (slow, very slow, normal, fast and very fast).
In order to generate reference gait patterns for healthy people with different physical characteristics, were trained different fitting neural networks. The inputs were biometric parameters and the walking velocity, and the outputs were the time curves of the three components of the GRF and CoP's trajectory.

Schematic representation and real instrumented shoe's sole.

Input and output variables of the neural network:



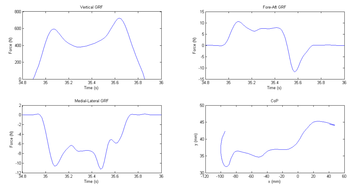
Schematic representation of the neural network system for reference pattern generation.

Statistical methods analysis and computacional intelligence methods will be used in order to compare reference GRF and CoP curves of unhealthy people with the ones of healthy people. Ultimately will be found a gait index to conclude about patient's recovery and the disease's severity.

Results

The results obtained testing the instrumented shoes with healthy people, showed GRF and CoP curves consistent with those in the literature.

Preliminary results show that it is possible to quantify differences in gait patterns of unhealthy people.



Representation of the three components of the GRF and the CoP's location, for one step done by an healthy person.

Conclusion

The presented system can be an important gait disorder diagnostic tool as it objectively quantify gait disorders, something that is harder to get with the present subjective analysis. These shoes can be successfully used for assisted age living.

Patent

Calçado Instrumentado para Análise da Marcha (Instrumented Shoes for Gait Analysis) – Patent number 108143 at the Portuguese Institute of Industrial Property (INPI).

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