Exo-SAM: Robot-assisted therapy for stroke patients

Nuria Juliana Novoa Rodríguez A01333330
José Armando Zavala Rebollar A01262271
Gerardo Daniel Barbosa Celis A01166500

Consultants:

Eng. Javier Alberto de la Tejera de la Peña
Dr. Martín Rogelio Bustamante Bello

Professor:
Gabriela M. Ruiz Soto

Tecnológico de Monterrey

Campus Ciudad de México

Escuela de Ingeniería y Ciencias

Mayo, 2019

Background

According to World Stroke Organization 80 million people in the world have had a stroke, 50 million stroke survivors live with some form of permanent disability. The most common disability is paralysis which amongst other things affects their motor control, such as walking and balance, leading to gait problems.

World Stroke Organization

Objectives

General objective

- Create a database and classify it with machine learning about walking, standing and sitting

Specific objectives

- Create a database based on the Vicon system Nexus software.

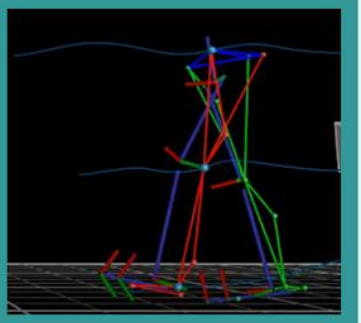
-Develop a data reading and processing algorithm with Machine Learning

- Obtain a data classification of all states (walking, standing, sitting)

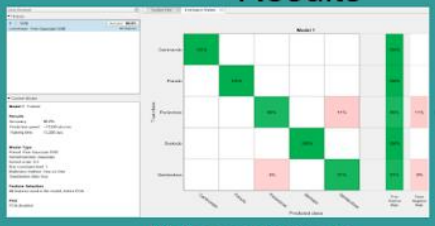
Developing

The lower limb exoskeleton consists of a mechanical system attached to the patient's hips, legs and feet, as well as a kinetic analysis of gait (KAG) system, which uses inertial sensors, gyroscopes and accelerometers in order to measure the hip and knee angles of the user.

The flexion angles of the right hip, right knee, left hip and left knee are the characteristics the algorithm needs in order to predict the activity of the user. With the use of motors, incorporated to mechanical system.



Results



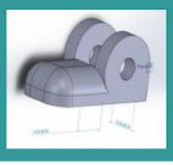
Confusion Matrix

Motor control code

98.6% accuracy, a metric used for evaluating classifiers

In order to test our classifier and prototype we created a protocol where a subject was standing for 5 seconds, then sitting for 5 seconds and finally standing again for 5 seconds. The resulting angles where copied to a database, without being labeled, and then tested.

The trained model was able to successfully predict the activity of the test subject, according to the test protocol, with a 100% accuracy.



Future work

Validate KAG system with the data obteined from Nexus

Incorporate the KAG system into the exoskeleton.

Incorporate the mechanical system with the prediction algorithm.

Conclusions

A lower limb exoskeleton can be used for therapy to control the rehabilitation assistance by an exoskeleton. The data can be obtained from sensors. Given the amount of data, classifying the signals is difficult. A machine learning algorithm can be used to identify patterns in data and classify them. The data to train the algorithm was obtained by creating a database with the hip and knee angles of 20 test subjects. Using a nonlinear SVM fine Gaussian model, and 5-fold cross-validation, a human activity recognition machine learning algorithm for controlling an exoskeleton used in robot-assisted therapy for stroke patients.