Roto.BiT^{3D}

The Roto.BiT^{3D} consists of a moving base connected to three fixed linear electrical actuators by three corresponding fixed length floating arms by means of spherical joints.

The aims of the Dynamic Posturography (DP) are to study and analyze the control capability of subjects in more complex conditions than the simple maintenance of the upright unperturbed posture. The DP involves the use of experimentally induced perturbations; specific assessment methods are applied to measure both the independent and the collaborative nature of the visual, vestibular, and proprioceptive sensory inputs.

RotoBit^{3D}

Founded by: Italian Ministry of Health
Principal Investigator: Paolo CAPPA
Aim: Design a 3DOF Robotic Platform for Dynamical Posturography.

Mechanical Design

A moving base with a diameter of 80 cm is connected to a stationary frame by a spherical joint and three actuators in order to obtain a pure 3-DOF rotational motion around a fixed point. Thus, any arbitrary rotation in terms of roll, pitch, and yaw angles can be obtained by synchronizing the displacements of the three linear actuators. The workspace limits are defined by the dimensions of the members of the kinematic chain and the range of motion of the spherical joints. The kinematic scheme used for the design of the platform, thanks to the presence of the central support, allows a noticeable reduction in the motor power usage in comparison with other parallel robots. The motors are rigidly connected to the fixed frame, such that their inertial contribution to the robot dynamic is not dependent on the platform attitude. Three rollway wheels are mounted under the base to permit the mobility of the RotoBiT^{3D}.

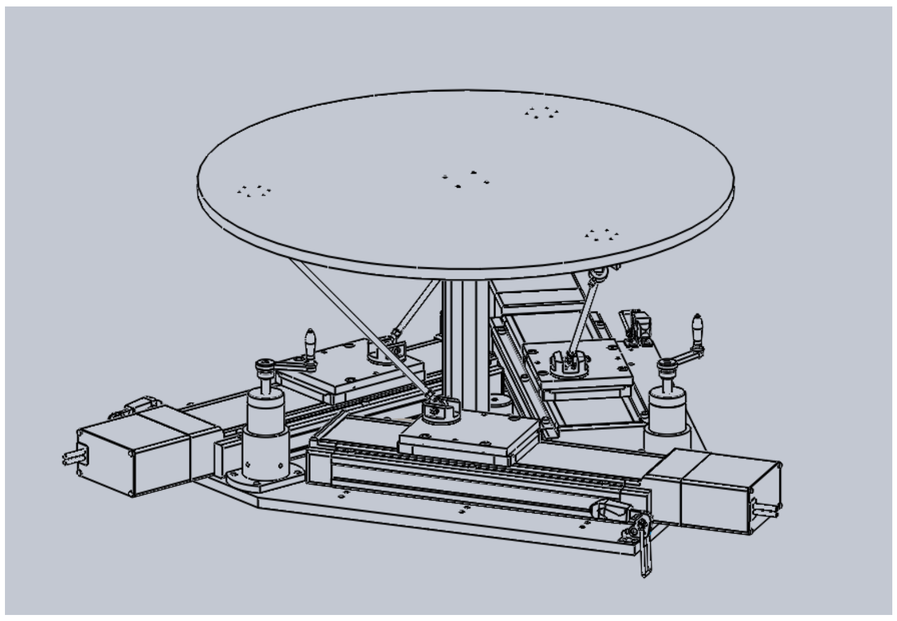

Fig.1 Roto.BiT^{3D} mechanical design and positioning

Equipment

The robot is instrumented with a pressure matrix that allows to evaluate the main posturographic parameters and three uni-axial load cells. Moreover, the movement of subject that performs the rehabilitative exercise can be acquired using both Inertial Measurement System and/or an Optoelectronic System.

Controller design and test protocol

The robot can be controlled in three different ways.

- **Position mode:** the robotic device imposes a preset trajectory (i.e., sine wave, step, etc.) independently from the subject behavior. In this case the main task of the subject is to maintain the balance.
- **Impedance mode:** stiffness and dumping parameters of the platform are subject-scaled (based on her/his weight and height) and consequently the movement of the base is determined from the subject's postural adjustements to mantain the upright posture.
- **Assistive mode:** an assistive parameter can be selected in order to change the assistance level of the platform. Subject is asked to follow a target trajectory rendered on the screen (Fig.4) and he can be helped with several levels of the assistive parameter.

Performance evaluation

The main parameters used to evaluate the subject performances during the computerized dynamic posturography trials are the confidence ellipse area, statokinesigram and stabilogram that allow to evaluate the amplitude of the trajectory of the center of pressure (CoP) in the horizontal plane during the exercises.

These parameters are used to evaluate differences between healthy subjects and patients as well as the variation of the performances of the patient during a rehabilitation treatment.

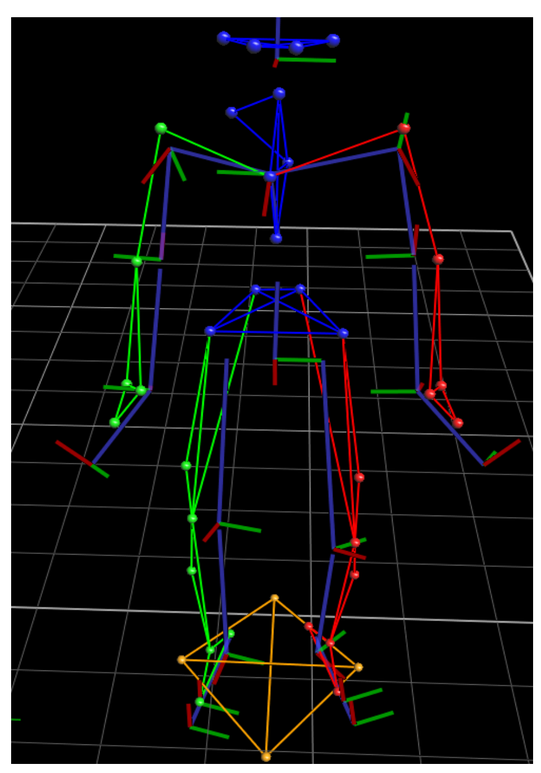

Fig. 2 Full body Vicon model

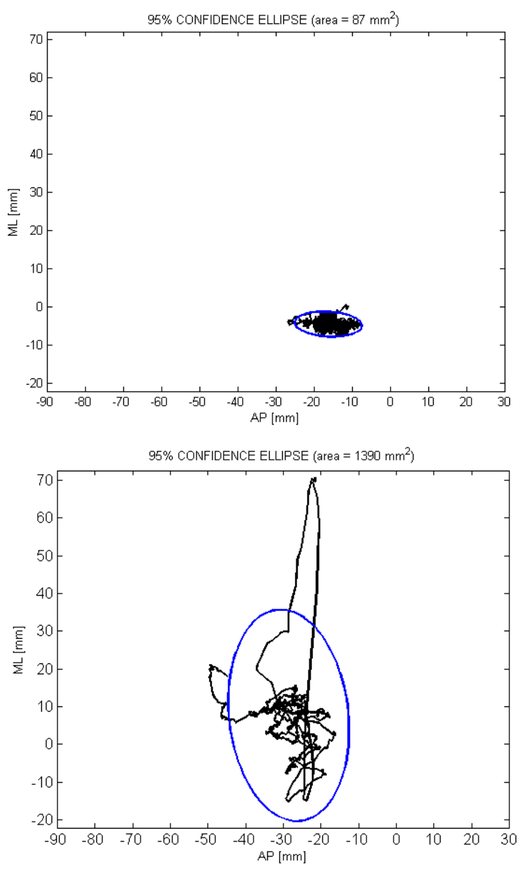

Fig. 4 Example of 95% confidence ellipse (I. healthy subject; II pathological subject)

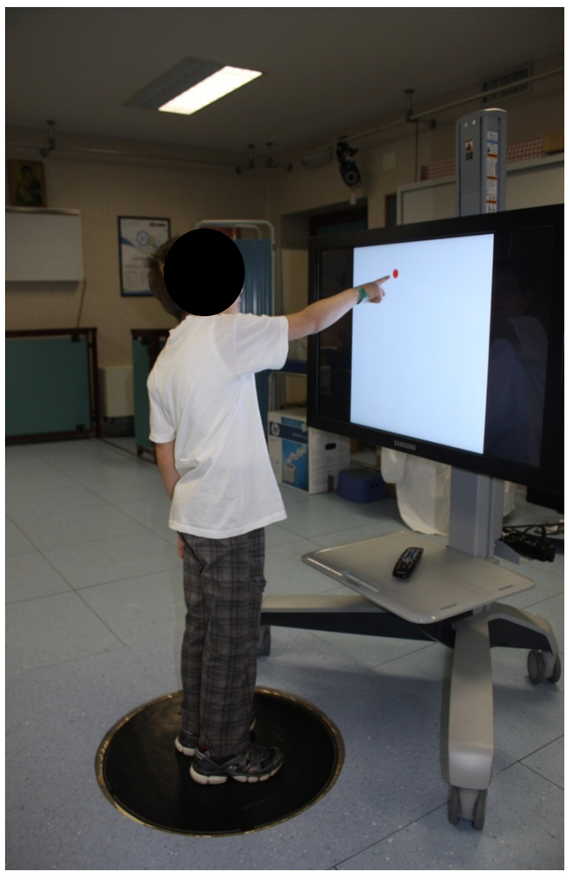

Fig.5 Interactive rehabilitation

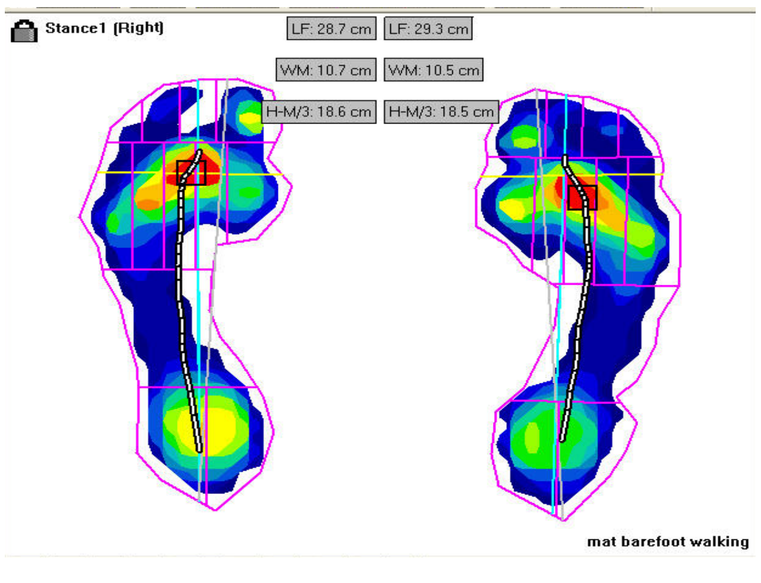

Fig. 3 Pressure Matrix output