

## Experiment MOTORE++ D2.2 new Device Prototype release

MOTORE++: A new Rehabilitation Robot for the upper limb: refinement and experimental trials

Version 1 Submission date: 17.09.2015

Date	Name	Changes/Comments
14.10.2015		

## 1 Publishable Summary

The goal is to develop a rehabilitation robot named MOTORE++ aimed to restore upper limb functionality in patients with neurological diseases and to assess his performance. This is a new haptic portable device, the first suitable for home based rehabilitation. Starting from a prototype developed in the last years, the project aims at delivering a small omnidirectional robot moving on *transwheel*, interacting with a patient providing assistance and force feedback during rehabilitation sessions. The software will allow to select among several exercises. Biomechanical studies of the interaction with the robot and on the arm impedance during exercises will be part of the Echord experiment.

During the first six months the device has been completely redesigned in order to achieve better performance and be ready for a CE certification process and an easy maintenance.

## 2 Implementation of the new robot

As mentioned above, during the first six months the robot underwent trough a redesign process in order to endow the robot with:

1) a new motherboard and a new CPU to achieve better performance

2) a SD card and an USB port for data transfer, firmware upgrade and debugging,

3) a Wi Fi module replacing the Bluetooth module for a more stable connection to the PC,

As a consequence a new sump suitable for CE the safety issues related to the CE certification and an easy maintenance of the device.

Further requirements were:

-Increased interaction force (up to 30N)

-Orientation measurement (in order to have a smooth control)

The following pictures show the implementation of the new features in the new devices. The details of components and design can be found in the deliverable D1.1.



Fig.1 the new electronic mother board including the new features and components





Fig.2 the new wi-fi PCB





Fig.3 the new Li-ion swappable battery pack



Fig.4 the new wired optical sensor (developed by Anoto for MOTORE++) and the pattern printed on the working surface.



Fig.4 the new wired optical sensor on board.

As as specified in the requirements the new optical sensor is able to measure the orientation of the robot in the plane as shown by the following picture.





Fig.5 Angle measurement by means of the new wired optical sensor



Fig.6 the new sump.



Fig.7 the new sump (details).

In the technical requirements was also mentioned the improvement of the interaction force. Reconsidering the design, the robot is powerful enough to potentially exert more force than 15N, but a limitation occurs due to the slippage of the wheels on the working surface. In order to overcome the slippage problem we studied solutions to increase the friction:

- Rubber coated *transwheels*
- Soft working surface.

The rubber coated wheels need to be replaced after some while (that's why the sump has been designed with adequate doors.

The soft working surface will increase the contact surface and thus the friction. It has been built making a sandwich of (1) a 4mm rubber sheet, (2) a vinyl Anoto printed pattern, (3) a further coating which protects the print and increases the friction. With this solution we can exert on the patient a force greater than 30N.



Fig.8 Action taken to increase friction (and thus increase the interaction force)



Fig.9 Measurement of the interaction force obtained (by means of the load cell)

The full device has been shown during the 2015 IROS conference at the ECHORD++ booth.



## 3 Deviations & Reasons

The release of the prototype has been delayed (from moth 8 to month 9) due to some supply problems.

In particular the shipment of the Li-ion batteries from USA via air mail requested a long procedures for hazardous goods shipments.

Also the deploy of the optical sensor by Anoto has been problematic. The development and the licensing of prototype took more time than expected to Anoto.