A novel mechatronic baby gym for promoting infants motor development

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Abstract—Stroke and other neurological conditions affect the population of infants in relevant percentages. Preterm infants are the group at highest risk for neurological damage. Currently, these infants have rehabilitation sessions few times a week in rehabilitation centres, but according to basic neuroscience it would be necessary to provide them with an early, intensive and multiaxial intervention. The aim of this work is to develop an innovative training platform for promoting early intervention and motor development analysis.

I. INTRODUCTION

It has been estimated that around 10% of the children and young people in the world suffer from relevant neurological abnormalities. Cerebral Palsy (CP) is the most common cause of motor disability in early childhood, rated between 2 and 3 per 1000 live births. This rate increases to 40-100 per 1000 live births among babies born very early or with very low birth weight, who therefore represent the population with highest rate of neurological disorders [1].

The young human brain is highly plastic, thus it is now increasingly appreciated that the corticospinal system, after early injury, is capable of a substantial reorganisation likely to underlie the partial recovery of function. Functional and anatomical evidence demonstrate that neural plasticity can be reinforced and shaped by training activities [2].

The aim of this work is to develop an innovative system to promote intervention in the first year of life and to reinforce therapy. The new platform, based on the concept of common baby gym, and equipped with a variety of sensors, can be administrated at home by caregivers.

II. MATERIALS AND METHODS

The objective of the platform is to stimulate infant’s grasping forces, gaze and postural control while measuring their response. The device is mainly composed of a mechanical wood structure, like a box, with a sensorized base and four walls. On the basis of detailed clinical specifications, we designed the platform with the following main components:

- A box with interactive walls and sensorized mat
- Four sensorized toys
- A sensorized belt
- An arched gym
- Three wearable sensors
- A laptop computer running custom applications

Each feedback wall contains three points of interest to attract the infant with lights of different colours, lighting buttons and speakers. A kit of four toys has been designed and developed on the basis of infant hand dimensions [3] and our previous experience [4], [5]. The shapes have been carefully chosen to have a clear affordance and encourage different manipulation approaches on the basis of the type of grasping that we want to detect and monitor:

- MICKEY: cylinder equipped with a pressure sensor and lights, with two small petals each embedding a force sensor and a light;
- U-TOY: horseshoe composed of two cylinders with pressure sensors and lights;
- LARGE RING: ring with pressure sensors and lights inside;
- SMALL RING: ring with thin cross-section diameter.

We designed two bracelets and a chest strap with embedded wireless Inertial Measurement Units. Such wearable sensors, together with mat’s pressure map, allow a satisfying reconstruction of infant’s position and movements.

Software running on the laptop provides for data analysis, remote training session design by clinicians and data upload to the clinical centre’s server.

III. RESULTS

The platform presented in the study allows to stimulate and measure infants’ movements inside the gym. The developed platform is currently under validation in real domestic environments with preterm infants. The first tests have underlined a good reliability of the system, which fits well into the domestic environment and is generally well accepted by parents and children.

REFERENCES