

PhD Course in Bioengineering - Final Thesis Defense



PhD Candidate: WALTER BACCINELLI
Advisor: Prof. Carlo Albino Frigo
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29.06.2021
h. 10:30
@ Microsoft Teams

Thesis: DESIGN AND DEVELOPMENT OF AN RF-BASED SYSTEM FOR THE REHABILITATION OF THE UPPER LIMB

COMMITTEE MEMBERS

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SCHEDULE OF THE DAY

| | |
|---------------|----------------------------------|
| 10:30 - 10:45 | Committee Meeting |
| 10:45 - 11:45 | Thesis presentation - Discussion |
| 11:45 - 12:00 | Committee meeting |
| 12:00 | Award Ceremony |

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PhD student: WALTER BACCINELLI – XXXII Cycle

Thesis title: DESIGN AND DEVELOPMENT OF AN RF-BASED SYSTEM FOR THE REHABILITATION OF THE UPPER LIMB

Advisor: Prof. Carlo Albino Frigo – Deib - Politecnico di Milano
Ing. Maria Bulgheroni – Ab. Abacus srl

Abstract:

INTRODUCTION

Acquired disabilities are nowadays one of the major challenges the healthcare systems have to face. As the aging of the population increases the number of persons with disability, the need of resources and effective tools to take care of impaired patients continuously grow. One of the leading causes of acquired disability worldwide is represented by stroke, and one of the most impacting consequences affecting stroke survivors is the impairment of the upper limb. The recovery of upper limb functionalities can be maximized through rehabilitation therapy, consisting of repeated functional exercises. In particular, occupational therapy has been shown to positively impact on the recovery of functionalities. While several technological solutions have been implemented supporting the rehabilitation process in clinics, the current need of healthcare costs reduction calls for new solutions to support the patients in the continuity of the rehabilitation process also at home, to be used autonomously by the patients, with a minimal intervention from the clinicians.

REHABME SYSTEM

To face the current healthcare needs in the field of post-stroke rehabilitation of the upper limb, a new system, RehabMe, has been designed and developed. The system guides the patients in the execution of functional exercises, which are built as sequences of reaching and grasping tasks to be executed with custom everyday objects. The exercises creation process and the monitoring of motor performance, together with the guidance during the execution, represent the three core functionalities provided by the system.

The RFID technology has been identified as a suitable way to implement the system. Indeed, the development of the system required a deep analysis of the potentialities and the limits of the RFID technology, and their mapping to the clinical requirements identified. The analysis of the range of typologies of RFID systems and their characteristics has led to the design of a technical solution based on passive UHF RFID systems.

PROTOTYPE DEVELOPMENT

The system design and implementation required an accurate analysis of the hardware components, the characterization of the system as a whole from the electronics (e.g., power consumption, communication interfaces, circuit protection, etc.) and the ergonomics point of view. This process required several development, testing, and refinement steps, from the choice of the system components to their integration and refinement. The process resulted in a final robust hardware device based on flexible electronics, with a shape and dimensions designed to be easily wearable on the forearm without discomfort, able to wirelessly communicate with clients, with enough energy to be used for the rehabilitation session without needing the intervention of the user.