

# BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

## Robotics in medicine

<b>Funded By</b>	Ministero dell'Università e della Ricerca - MUR [P.iva/CF:96446770586]
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<b>Context of the research activity</b>	Bridging biomedical research and robotics to improve the delivery of surgical treatments

Nowadays, robotic technologies are increasingly spreading in several scenarios: from the daily living to clinical areas. Biorobotics is an active research discipline, smoothly bridging different knowledges. Biorobotics is progressively entering the medical practice, assisting clinicians and orthopedic surgeons in delivering the most effective treatment, from minimally invasive surgeries, to the development of laparoscopic devices and rehabilitation orthoses. Of lesser concern, however, is the possibility of using biorobotics to evaluate the performance and the usability of medical and surgical instruments, which permeate clinical activity in every context, from homecare to hospitals. From this perspective, the research of novel testing solutions, coupled to a better understanding of physiological systems through experimental investigations, could lead to the development of more effective systems and devices in medicine, and thus contribute to achieving the third, sustainable development goal of promoting Good Health and Well-being. And guiding manufacturers in the Regulatory process is determinant of any successful, biomedical research. With the entry into force of the new Medical Devices Regulation (MDR), in fact, the evaluation of the performance and the usability of medical devices, essential for device marketing, has assumed fundamental importance. Blending the strong potential of collaborative robots with the tools of motion analysis, the focus of this research is to develop a multipurpose testbench able to detect, analyze and then mimic surgeons activities with surgical instruments. The development of this research activity requires highly multidisciplinary expertise, needing to combine the analysis of biomechanical and electrophysiological data at the basis of human movement with the mechanics of biological tissues and medical devices, along with a knowhow in robotics and motion analysis.

## Objectives

The National Recovery and Resilience Plan (PNRR) indicates 6 missions as structural “thematic” areas of intervention. This research activity addresses two of them, “Healthcare” and “Education and research”, aiming not only at promoting research devoted to the improvement of safety of medical devices for citizens, but also at strengthening technology transfer mechanisms from University to SMEs. In this scenario, the coexistence of the PolitoBIOMed Lab Interdepartmental Centre and the Research Infrastructure PASTISs play a central role in providing: i) new technologies for health and life science; ii) development of new approaches for advanced medical device CE marking; iii) close relationship with biomedical companies in the Piedmont area. Moreover, this research activity is part of the SNSI, with particular reference to the development of new medical devices that ensure sustainable delivery of ventilatory therapy even in the extreme conditions that occurred during the pandemic. The research activity is therefore consistent, in particular, with: the “Area di specializzazione regionale” 5.3.10 Salute; the “Area tematica nazionale” 5.4.3 Salute, alimentazione, qualità della vita; the “Traiettorie tecnologia di sviluppo a priorità nazionale” 5.5.3 Salute, alimentazione, qualità della vita e la linea legata a Traiettorie tecnologiche di sviluppo a priorità nazionale. The activity proposed in here also complies well with the PNR standards and requirements, aiming at the development of sustainable technological solutions, with a high quality/cost ratio (Affordable Health & Care), and a rapid transfer to the industry with a view to a “Quick Transfer of Knowledge for citizens”. Within the “SALUTE” research area, in particular, it is placed in the areas of intervention 5.1.4 Tecnologie per la salute, Articolazione 4. “Robotica per la salute e sicurezza”.

The PhD student will rely on the competences and the facilities of both the PolitoBIOMed Lab Interdepartmental Centre and the IR PASTISs. As concerns experimental activities, a state-of-the-art Cobot with the highest payload on the market will be available, together with an advanced system for Motion Analysis integrated into Virtual Reality environments. The technologies available for addressing the specific objectives outlined below are in the forefront of biomedical research.

This PhD programme will focus on the research applied for the development of a multipurpose testbench for surgical tools performance and usability assessment, and will benefit from a 6 month period at The Research Centre for Biomedical Engineering (CREB) of Universitat Politècnica de Catalunya (UPC).

Experimental and computational methodologies will be exploited hand in hand to tackle the following research goals: 1) Implementation of sensing and acquisition protocols for the recording of surgeon activities on reliable phantoms; 2) Development of software and hardware systems for human machine interface, enabling the modelling and prediction of movements and forces experienced by surgeons; 3) Study of the regulatory aspects (Medical Device Regulation 2017/745 and specific Standards) addressed to provide a guideline to properly design the testing workbench for usability assessment purposes. 4) Development of data processing algorithms for the extraction of surgical tools performance limits, of value to design input for device optimization.

The final aim of the research will be to engineer a protocol of objective assessment, the replace the currently subjective evaluation of kinematic and kinetic demands associated with the most effective, surgical interventions. Addressing this goal warrants touching on all the aspects involved in the Research and Development activities, from the definition of input designs to the actual implementation of the test bench.

We are looking for talented and motivated candidates, preferably with

**Skills and competencies for the development of the activity**

skills/experience in: Motion analysis, Experimental data acquisition, Image and data processing, Mechatronics and Control, Mechanics of human tissues, Computer programming.

We desire a candidate with strong aptitude for teamworking and problem solving, open and able to work in multidisciplinary teams and having good communication skills. We require a good proficiency level in both Written and Spoken English.