Research theme title:
Robotic systems for minimally invasive and interventional surgery

Description:
The use of robotic systems in minimally invasive and interventional surgery has significantly increased in recent years due to the benefits they offer such as improved accuracy and dexterity of the performed procedures, and visualization capabilities offered to the surgeon. However, there are still challenges in the development of robotic systems that pose a threat to the quality of care for patients.
Based on these considerations, the main goal of such a research project to study, design, develop, and validate innovative robotic systems that can improve the quality of care in minimally invasive and interventional surgery. More specifically, this challenging objective can be achieved through the following main steps of the work:
1. The first stage will involve the study of existing literature concerning the topic. In particular, the PhD student will conduct a comprehensive review of the current state-of-the-art in robotic systems for minimally invasive and interventional surgery.
2. Building upon the findings retrieved from the literature review, the second stage will involve the design and development of innovative robotic systems, which will improve over existing state of the art. The proposed robotic systems will be capable of performing a wide range of surgical procedures with high accuracy and dexterity.
3. The subsequent part of the work will involve the validation of the robotic systems. First, the performance of the developed robotic system will be evaluated in a simulated environment. The evaluation will include testing the accuracy, dexterity, and speed of the robotic system. Then, the feasibility of implementing the developed robotic system in real-world surgical procedures will be checked with expert surgeons. Advanced visualization tools will be realized to aid the operations of the surgeons. Finally, the robotic system will be considered for tests in real-world applications in collaboration with surgeons to assess its effectiveness in enhancing the quality of care for patients.
4. To provide visibility of the main technical and scientific achievements, the Ph.D. student will submit research results to the following academic venues: international conference, such as MICCAI, IEEE ISBI, IPMI, BMVC (KPI: > 1 per year), high-profile journals, such as IEEE TMI, Elsevier Computers in Biology and Medicine, Elsevier Computer Methods and Programs in Biomedicine, Elsevier Artificial Intelligence in Medicine, Elsevier Journal of Biomedical Informatics (KPI: about 2 for the 3 years). When possible, scientific works will be published via Open Access, or shared in pre-print versions through academic websites. Produced datasets will be shared according to the Findable, Accessible, Interoperable, Reusable (FAIR) principle, by using for example Zenodo and IEEE dataport.

Research activities of the Ph.D. student will produce several contributions alongside the following items.
1. Scientific contribution. In line with the expectations on that topic, at both EU and National (for example, those identified with the definition of PNRR initiatives) levels, the Ph.D. student will develop novel methodologies, tools, and programs for robotic systems applied to minimally invasive and interventional surgery, exceeding the current state of the art.
2. Technological and economic contributions: Obtained results will be presented to national and international stakeholders, thus increasing their interest to invest in hard development activities and obtain a faster time to market.
3. Societal contribution. Scientific, technological, and economic impacts will guarantee an enhancement in the quality of care of patients treated with robotic surgery, thanks to the improved accuracy and dexterity of such systems. Increase in the quality of care will contribute in creating a sustainable, green, and resilient future for our planet.

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