

Research theme title:

Autonomous systems for guided endoscopic navigation and theranostics

Description:

Endoscopy is a widely used diagnostic and therapeutic procedure in medical practice. It involves inserting a flexible or rigid tube with a camera and other instruments into the body to visualize and manipulate internal organs or tissues. Thanks to the development of the theranostics field, fusion between therapy and medical imaging is possible, solving the problem of undesired variations in biodistribution and therapeutic efficacy of drugs. However, endoscopic procedures can be challenging, especially in complex anatomical locations, requiring high levels of expertise and experience. Furthermore, endoscopic procedures have limitations in terms of the ability to access certain areas of the body and to perform therapeutic interventions.

Based on these considerations, the aim of this research project is to study, design, develop and validate innovative autonomous systems for guided endoscopic navigation and theranostics to improve the accuracy, safety, and efficacy of such procedures in clinical practice.

This challenging objective can be achieved by the means of the methodology detailed in the following steps:

1. Perform a literature search of state-of-the-art approaches concerning autonomous systems for guided endoscopic navigation and theranostics. Realizing a comprehensive literature review will be the first task of the Ph.D. student.
2. Design and develop an autonomous navigation system for endoscopic procedures. The navigation system will use advanced imaging and sensing technologies, such as magnetic resonance imaging, computed tomography, and ultrasound, to create 3D reconstructions of the internal anatomy of the patient, so that the endoscope can be guided to the target location.
3. Design and develop an autonomous intelligent system for diagnosis and therapy delivering during endoscopic procedures. The proposed system will integrate data acquired from real-time imaging systems and sensors to enable accurate and efficient diagnosis and treatment. It will also incorporate robotic and miniaturized instruments to perform therapeutic interventions, such as tissue biopsy, ablation, and drug delivery.
4. Validation of the realized autonomous systems in preclinical and clinical studies, demonstrating their potential to improve endoscopic procedures and quality of care for patients.
5. 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 innovative methodologies, tools, and programs in the context of autonomous systems for guided endoscopic navigation and theranostics, surpassing 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 endoscopy and theranostics, thanks to the novel methodologies and tools proposed throughout the research work. Increase in the quality of care will contribute in creating a sustainable, green, and resilient future for our planet.

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Hosting University

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Type of scholarship:

DM 118/2023 – Project on PNRR (Italy's Recovery and Resilience Plan)