Guest Editorial
CRAS - Joining Efforts, Progressing Faster

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I. INTRODUCTION

THE IEEE Transactions on Medical Robotics and Bionics (T-MRB) is a multi-disciplinary journal aimed at publishing peer-review and medical application results, reporting significant theoretical findings and application case studies in the areas of medical robotics and bionics.

In particular, one of the six Journal Areas addressed in T-MRB is Surgical Robotics. Robotic systems are effectively altering clinical practice and patient expectations. With roughly 10,000 systems installed worldwide and 3 decades of developments, evidences of the effectiveness of surgical robotics are accumulating. Nevertheless, ample room for improvements remain. Advances in materials, machining, sensors, actuation solutions and control algorithms could lead to new form factors. Minimal invasive treatment of deeply seated organs increasingly comes into reach. Breakthroughs in Artificial Intelligence open up new ways to steer instruments or to represent the surgical field to the clinicians, providing more detail of the patient’s anatomy and better cues or guides to interact with it. Long-awaited techniques such as augmented reality, 3D reconstruction, motion compensation, virtual guidance, haptic feedback, etc., are progressing closer towards the market and physicians now need to be trained on these fast-growing technologies.

CRAS – the Conference on New Technologies for Computer and Robot Assisted Surgery – strives to strengthen the collaboration and knowledge exchange between research groups active in this field and by doing so shorten the development cycle and enhance the effectiveness of robotic solutions. This is an ambition that CRAS shares with The IEEE Transactions on Medical Robotics and Bionics. For CRAS 2020, the 10th and jubilee edition of CRAS, we chose to pair up with T-MRB to more broadly disseminate the best appreciated papers that were presented at CRAS 2020.

You will find a selection of 5 papers within this November 2021 Issue (Volume 3 Issue 3) of T-MRB. All highest-ranked conference contributions were invited to elaborate their work to a full, regular T-MRB paper. Each paper underwent a full review cycle by at least 2, but mostly 3 or more, independent reviewers. Only the best reviewers, expert in the respective fields were invited. The review process was overseen by the associate editors, authors of this Guest Editorial. Heavily involved in the organization of the CRAS conference since 2011, as founders, or contributors and now as guest editors of this edition, we have had the pleasure to overlook the most important developments in this field. Similar to Industry 4.0, where data forms the base for accelerated automation of traditional manufacturing and industrial processes, we see recently an increased emphasis on new sensing schemes, data and AI also in surgical robotics. Not only do these bring opportunities for increasing the level of automation in surgery, the increased data also offers a more in depth understanding of the performance that is being displayed. The gestures that now become measurable offer better insights on how to guide surgeons, endoscopists or interventions to raise their skill levels. It is when surgical robots become smarter and when clinical experts get more proficient in operating them, that we will see the true value of surgical robots appear, in a true collaboration. Through joining efforts now, CRAS and T-MRB aim to progress faster towards this common goal.

II. SPECIAL SECTION CONTENT

This Special Section includes the 5 papers, which are an extended journal version of the best articles presented to the CRAS 2020 conference.

The paper “Data Stream Stabilization for Optical Coherence Tomography Volumetric Scanning” by G. Liao et al. introduces algorithms to improve the quality of Optical Coherence Tomography sensing, a first and recent upcoming technology that, when integrated in a surgical robotic system, provides the capability to scan robot surroundings from within the human body. This improved awareness could lead to smarter, more effective surgical or robotic actions.

The paper “Vision-guided Autonomous Robotic Electrical Bio-Impedance Scanning System for Abnormal Tissue Detection” by V. Penza and co-authors explores the potential to employ impedance sensing to detect and localize subsurface tumors. This is a second application where small integrated sensors offer real-time information that exceeds human’s perceptual ability and that could be either conveyed to the operator, allowing wiser decisions and actions, or sent to a robot to direct more precise automatic actions.
That robotic technology is in fact capable to deliver such elevated precision levels is exactly what is showcased in the next paper, the work “A Focus Control System based on Varifocal Mirror for CO2 fiber-coupled laser surgery” by Geraldes et al. In this work the authors present a hydraulically actuated microfabricated varifocal mirror. The new actuation system is shown to be able to achieve superior precision levels compared to fixed focus or bare fiber systems. The authors suggest linking the mirror’s control system to distance sensing so that the focus can be adjusted automatically offering the right amount of energy at the right time and the right location.

Setting up a system that support such automatic actions by Falezza et al. in their paper “Modelling of Surgical Procedures using Statecharts for Semi-Autonomous Robotic Surgery”. The proposed methodology relies on the merging of a bottom-up approach, based on data-driven techniques, with a top-down approach based on knowledge representation techniques. Within their work Falezza shows how surgical tasks can be decomposed different granularity levels. Adding a method that continuously monitors the task evolution, makes it possible to introduce robust decision making for autonomous robot control.

Finally, S. Tognarelli and co-authors analyze the problems of training and simulation in the paper titled “Development and validation of a high-fidelity neonatal pneumothorax simulator”. Training of medical procedures which are life-saving and have to be performed in emergency situations is a major challenge in medicine. The developed pneumothorax simulator was able to restore the haptic feedback for operators and has been tested both by in presence sessions and remote session, thus offering interesting opportunities also during the COVID pandemics.

**III. CONCLUSION**

This Special Section shows how innovative sensing, actuation and modeling are going to shed new lights on the intra-operative reality, providing improved understanding to guide surgeons or robots better or better methods to train them all-in-all rendering their gestures and interventions more effective. With CRAS 2022 planned from 23 to 25 February, that will take place in Naples, Italy, we take the liberty to extend our call to join efforts and invite all interested parties to consider submitting relevant CRAS works. Also, in this future edition authors of the best works will be invited to publish (after peer-review) an extended version in a future upcoming T-MRB special edition. So, that we can progress faster and establish a stronger impact in the surgical field.

**ACKNOWLEDGMENT**

In closing, we would like to extend our appreciation to all reviewers who played a crucial role in the peer-review process for the manuscripts submitted to this issue for their timely and professional comments.

Most importantly, thanks to all the authors who submitted their manuscripts for consideration of publication.

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