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Edoardo Sinibaldi

Italian Institute of Technology, Italy

Biorobotics and modeling for the central nervous system

Central nervous system pathologies are one of the world's leading causes of disability. Despite the availability of advanced interventional techniques, many surgical tasks are still very challenging because of complex anatomical constraints. Moreover, in many cases, therapy control is hampered by the lack of a thorough, quantitative understating of the related underlying physical phenomena. Both aspects motivate the development of novel approaches, including the introduction of robotic platforms and tools, and modeling frameworks. On the robotics side, we will illustrate a platform that encompasses, in particular, a lightweight robot fostering synergistic robot–surgeon integration. We demonstrated its potential for mitigating some risk factors in neurosurgery by addressing a model ventriculostomy, in collaboration with neurosurgeons. At the tool level, we will illustrate a novel design approach that permits to achieve flexible scopes to be deployed over a given trajectory (the whole shaft, not only the tip), thus avoiding undesired/harmful contacts. On the modeling side, we will address the numerical investigation of intrathecal drug delivery (ITDD) in the cervical subarachnoid space. The growing interest in ITDD is mainly motivated by its potential for bypassing the shielding effect of the blood-brain barrier to macromolecules. However, ITDD is affected by several parameters, many of which are little understood. We will show some recent results (obtained in collaboration with the University of Oslo and the University of Idaho) regarding the effects of catheter placement on ITDD, also encompassing drug transport to the cord.

Biography

Edoardo Sinibaldi obtained his MSc in Aerospace Engineering in 2002 from University of Pisa, PhD in Mathematics for Technology and Industry in 2006 from Scuola Normale Superiore, Pisa and pursued his Post-doc at The Biorobotics Institute, Scuola Superiore Sant'Anna, Pontedera. He is with the Italian Institute of Technology since 2009, formerly as Senior Post-doc, then as Researcher. His current research interests include biorobotics, in particular medical robotics, and modeling for biomedical applications. He serves as Reviewer for nearly 20 journals. He has published one book, three book chapters, more than 40 peer-reviewed papers and two patents. He also demonstrated the first flexible probe able to physically build its track while being deployed.

edoardo.sinibaldi@iit.it

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