Robot-Assisted Laryngeal Microsurgery Workshop

June 24, 2012

2012 IEEE International Conference on Biomedical Robotics and Biomechatronics

Location

Università Campus Bio-Medico di Roma
Via Alvaro del Portillo 21
00128 Roma, Italy

Program

8:50	**9:00**	**Welcome**		
9:00	9:20	Medical Robotics: Background, Today, and the Future!	Edward Grant	North Carolina State University, USA
9:20	9:35	Towards cognitive supervision in robot-assisted surgery	Loris Fichera	Istituto Italiano di Tecnologia, Italy
9:35	9:55	Advantages and disadvantages of various types of surgery on vocal folds cancer: a user point of view	Lionel Pazart	University Hospital of Besançon, Fance
9:55	10:10	Micromechanisms for laser phonosurgery: A Review of Actuators and Compliant Parts	Sergio Lescano	FEMTO-ST Institute, France
10:10	10:25	User interfaces in computer-assisted and robot-assisted surgery	Jesus Ortiz	Istituto Italiano di Tecnologia, Italy
10:25	10:40	Break		
10:40	11:00	State of art and future perspectives of laryngeal carcinoma surgery	Giorgio Peretti	Università degli Studi di Genova, Italy
11:00	11:15	On-site Laser Phonomicrosurgery – Challenges for an endoscopic system design with integrated augmented reality	Andreas Schoob and Benjamin Munske	Leibniz Universität Hannover, Germany
11:15	11:30	Bidirectional translational research: an illustration with fluorescence diagnosis	Bruno Wacogne	University Hospital of Besançon, France
11:30	11:45	Toward Tumor Detection and Medical Images Segmentation Techniques	Giulio Dagnino	Istituto Italiano di Tecnologia, Italy
11:45	12:00	Visual servoing in medical robotics	Syed Zill-e-Hussnain	FEMTO-ST Institute, France

Short abstracts

Medical Robotics: Background, Today, and the Future!
Prof. Edward Grant, NCSU and UNC-Chapel Hill, USA

This introduction to medical robotics will discuss the background to the technology, it will review the state-of-the-art as it exists today, and it will predict where the technology will need to go in the future to be more widely applicable.

Towards cognitive supervision in robot-assisted surgery
Loris Fichera, Leonardo S. Mattos and Darwin G. Caldwell, IIT, Italy

From the initial futuristic vision of autonomous surgical robots (ASRs), able to operate even without the supervision of a skilled surgeon, researchers are now moving, due to acceptance, economical and complexity issues, towards the more realistic concept of surgical robots as intelligent tools at the direct command of the surgeon. In this perspective, artificial intelligence (AI) could help in making surgical robots more intelligent than they are today, e.g. giving them the ability to understand what the surgeon is doing, thus, making them more effective in their assistive task. In this paper, we first review some interesting examples of how machine learning (ML), a branch of AI, has been successfully applied to the field of surgical robotics. Finally, we will give an overview of how AI is likely to play an important role in the development of future surgical platforms, where the use of untangible technologies, such as lasers and ultrasound, will require cognitive abilities that go beyond human ones.

Advantages and disadvantages of various types of surgery on vocal folds cancer: a user point of view
Pazart L, Badet, JM, Gaiffe O, Wacogne B, Loriod T, Tavernier L
University Hospital of Besançon, ENT department & Inserm CIT 808, France

The treatment of laryngeal cancer has evolved significantly over the last ten years to maintain maximum functionality of the larynx. The aim of the present communication is to review the short-term advantages and disadvantages of existing types of surgery on vocal folds cancer from a user point of view.

Micromechanisms for laser phonosurgery: A Review of Actuators and Compliants Parts
Sergio Lescano, Micky Rakotondrabe, Nicolas Andreff, FEMTO-ST Institute, France

Recent advances in the area of micromechanisms have increased potential for an early detection and a better treatment against diseases of vocal folds. With microdevices, mechanisms can be designed to guide the laser beam closer to the vocal fold for an accurate treatment. Micromechanisms are designed in accordance to the restrictions of the microworld and requirements of the task, namely limited space, biocompatibility and severe accuracy (micrometric or submicrometric). To do so, the actuators and structures used in these micromechanisms are often smarts materials and compliants structures. The aim of this review is twofold: first, to provide a survey of technological state of the art in each type of actuation principles for microdevices, such as electrostatics, shape-memory alloy, thermal, magnetics and piezoelectrics actuators. Their advantages and drawbacks will be discussed with particular regard to

biocompatibility. Second, a collection of engineering tools for the design of flexure hinges in compliant mechanisms will be provided.

User interfaces in computer-assisted and robot-assisted surgery

Jesus Ortiz, Leonardo S. Mattos and Darwin G. Caldwell, IIT, Italy

This presentation will offer a review of the user interfaces used in computer-assisted and robot-assisted surgery. These techniques can be used during the surgery, diagnosis, planning or training. The interfaces used during the surgery try mostly to replicate the vision and control of the classical tools to reduce the learning time, but they offer more precision, safety and reliability. The interfaces used in diagnostic and planning are more focused in visualization, and the ones used for training place the emphasis in the simulation. We analize the user interface used in the da Vinci surgical robot, that is nowadays the most used one and, for that, the main reference from the practical point of view. We also review research works on user interfaces for surgery and other medical fields (for example, ultrasound diagnosis) and other fields, unrelated to medical applications, but that could be applied also to computer-assisted surgery.

State of art and future perspectives of laryngeal carcinoma surgery

Prof. Giorgio Peretti and Luca Guastini, UNIGE, Italy

The endoscopic treatment by CO2 laser is considered an effective alternative to the traditional therapeutic options (RT, RT + KT and open surgery) by the international scientific community. The laser is deemed as gold standard treatment for the early state carcinomas (Tis, T1-T2) and for selected glottic and supraglottic advanced carcinomas (T3). The goals of the laser surgery have been achieved thanks to the recent technological improvements: the feasibility of ultra-pulsed energy emission and the development of micro-manipulators have permitted the focalization of the laser ray on a surface with a diameter les then 300 micron with a minimal thermal damage. Future perspectives are the need to make an innovative approach not only based on the use of microscope coupled micro-manipulators but on the use of the fiber guide laser controlled by the endoscopic devices: in this way we will be able to link the better resolution of the endoscopic view with the better maneuverability and cut precision of the laser which at the present can only be used through the microscope.

On-site Laser Phonomicrosurgery – Challenges for an endoscopic system design with integrated augmented reality

Andreas Schoob and Benjamin Munske
Institute of Mechatronic Systems, Leibniz Universität Hannover, Germany

Current laser phonomicrosurgeries rely completely on the dexterity of the surgeons. Since the tissue manipulation and laser application requires a direct line of sight between the surgical microscope and the vocal folds, tilting back the patient's head might lead to a postoperative pain, i.e. for an elderly patient. Furthermore, the manual control of the laser is done via a mechanical micromanipulator mostly with a disadvantageous ergonomic setup.

In comparison to that, the µRALP on-site laser phonomicrosurgical approach targets the development of an endoscope containing all required technologies for an intervention in a more convenient position of the patient, without the need of a direct line of sight. Hence, tools currently inserted through a

laryngoscope need to be integrated into the distal tip of the endoscope or be small enough to be passed through a work channel inside the device. A further challenge is the integration of the surgical laser into the endoscope requiring visual servoing based control of the laser spot. Due to the on-site limited control of the endoscope, an augmented reality system can support the surgeon by providing additional information through a live endoscopic video, pre-operative imaging and surgical planning.

During this talk, different types of endoscope kinematics are analyzed w.r.t. enabling high system integration and the appropriate degree of freedom for actuating of the distal tip. Recent approaches for endoscopic augmented reality are reviewed in order to determine their limitations and the expected challenges for on-site laser phonomicrosurgery.

Bidirectional translational research: an illustration with fluorescence diagnosis

Olivier Gaiffe[1], Christian Pieralli[2], Lionel Pazart[1], Bruno Wacogne[1,2]
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Translational research is a rather new and rapidly evolving concept. The general idea is to translate fundamental research results closer to the patient via preclinical and clinical trials. In other words, it consists in taking research from bench to bedside. It naturally requires close collaboration between scientists and end-users. Clinical trials often lead to questions that require further research actions in order to improve the initial proof of concept. Therefore, the concept of bidirectional translational research is emerging: forward from researchers to end-users and then back to research for answering new questions or improving current results. In this conference, we propose to illustrate this idea through examples concerning fluorescence optical diagnosis, and more precisely tools that can be envisaged for vocal fold disease assessment.

Toward Laryngeal Tumors Detection and Medical Images Segmentation Techniques

Giulio Dagnino, Leonardo S. Mattos and Darwin G. Caldwell, IIT, Italy

A brief overview on medical imaging techniques for laryngeal tumor detection and segmentation will be presented in this talk. We will describe the state of the art of imaging methods for laryngeal tumors detection and computer algorithms for their segmentation. Then, state-of-the-art techniques for real-time precise tumor detection will be introduced and, finally, we will discuss related future work.

Visual servoing in medical robotics

Syed Zill-e-Hussnain, Sounkalo Dembele, Nicolas Andreff, FEMTO-ST Institute, France

Laser phonomicrosurgery is a surgical approach based on the use of laser to perform incision of larynx tissue. Micro-robotics gives the opportunity to improve this approach by enabling precise control of laser spot to follow target trajectory on tissue. This work deals with vision based control of laser spot. A review of control approach achieved that includes a description of open loop control, when the 3D position of spot on tissue is not controlled and closed loop when it is controlled.