ARAKNES newsletter

Array of Robots Augmenting the KiNematics of Endoluminal Surgery

www.araknes.org

December 2010, Issue no. 1

What is ARAKNES?

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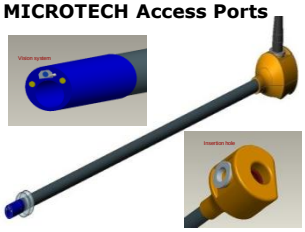
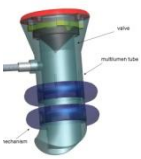
Last six months results

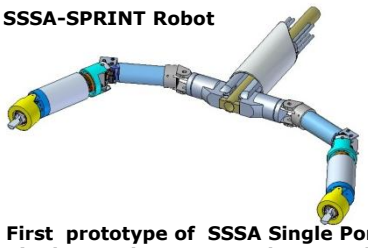
MICROTECH Access Ports



First prototypes of aesophageal (LEFT) and umbilical (RIGHT) access ports have been developed for the ARAKNES robotic platform.



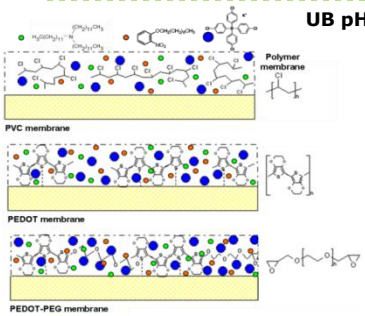
SSSA-SPRINT Robot



First prototype of SSSA Single Port Robot (SPRINT - Single-Port lapaRoscopy bImaNual robot)

The SPRINT is composed by at least two arms of centimetre-scale dimensions. The two arms can be introduced separately through an over-tube and operate in an otherwise non-accessible cavity. The rigid over-tube (with a maximum diameter of 30mm) should be inserted through the navel, then the two robotic arms are inserted one after the other inside the over-tube and finally fixed on the distal part of it.

UB pH sensor

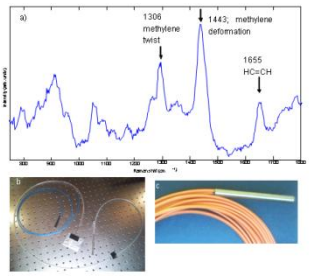


Novel platforms based on the electropolymerisation of poly(3,4-ethylenedioxythiophene) (PEDOT) for pH sensing has been developed in order to improve the stability and the leaching of the commercial poly(vinyl chloride) PVC based ion selective sensors.

Moreover, these novel platforms allow the site selective membrane immobilization in an array format and improve the biocompatibility of the membrane.

Disposable Raman Probe for Robotic Surgery (USTAN)

USTAN Team has developed the first version of a disposable Raman Probe which will allow the ARAKNES robot to perform in vivo Raman spectroscopy during surgery.



a) Raman spectrum of porcine tissue taken with b) Disposable Raman probe designed and built at USTAN. The diameter of probe head is 5 mm and cost: ~ € 400. c) Raman probe designed at USTAN and built by InPhotonics Inc., USA. Diameter of probe head is 7.5 mm and cost € 5800.

It costs about ten times less and has a smaller probe head diameter than any commercially available Raman probe. Its design also offers compatibility with integration into existing surgical endoscopes. To date it has been tested on animal tissues and pharmaceutical tablets and a representative Raman spectrum from porcine tissue is included as figure. Interestingly, the cost is expected be further halved in the next version while retaining performance characteristics.

News

The ARAKNES consortium succeeds in proving highly significant benefit of haptic feedback information for the surgeon. Results published in Surgical Endoscopy.

Since the diminished quality of haptic feedback information from the target tissue is a major reason for the high difficulty level of minimal access surgery, one goal of the ARAKNES project is to tackle this problem through application of sensor-feedback systems based on microtechnologies.
The company novineon Healthcare Technology Partners GmbH from Tuebingen, Germany, partner in the ARAKNES project, has developed a prototype of a laparoscopic grasper providing haptic feedback information to the surgeon. Its novel tactile sensor technology (patent pending) allows this grasper to measure the pressure profile on the forceps jaw on 30 distinct sensor elements. The study results were published in Surgical Endoscopy:

Schostek S, Binser MJ, Rieber F, Ho CN, Schurr MO, Buess GF. Artificial tactile feedback can significantly improve tissue examination through remote palpation. Surg Endosc 2010, 24:2299-2307.

Based on this encouraging results, the ARAKNES consortium further pursues the goal of implementing haptic feedback into their surgical manipulators.

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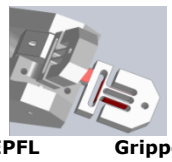
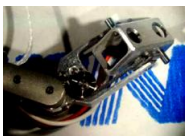


EPFL Gripper Integrating 4 DOF Force Sensing Capabilities

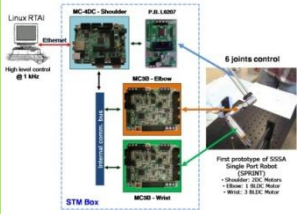


EPFL miniature stereoscopic Pan-tilt camera

EPFL Pneumatic tactile pulse display

EPFL Multifunctional gripper

STM control box

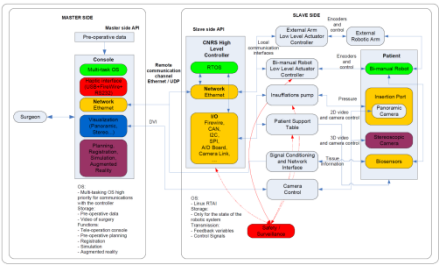


The STMBox is an electronic device which implements the low level control system for the first prototype of SSSA SPRINT Robot. It gives the possibility to control the 6 DoF of the manipulator through an Ethernet connection.

A Linux RTAI Pc was used to execute performance tests, measuring a response time of 584 µs. That is less than the available time of 1 ms.

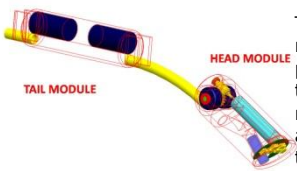
The whole architecture is composed of 3 modules, designed to control one or more joints composing the robotic arm. The modules communicate with each other through a bus, situated inside the arm, in a token architecture. The first module, named Shoulder Module, acts as a bridge between the Ethernet link and the internal communication bus.

CNRS Real-time control architecture for the tethered system



The real-time architecture is devised to be as generic as possible in order to perform minimally invasive bi-manual force reflecting teleoperated surgery with any of the selected approaches: single-port transabdominal access robot, multiple needles transabdominal access robot, or oesophageal access array of micro-robots. In particular, the control system has to be safely architected in order to ensure patient safety.

SSSA Magnetic levitation camera robot



The magnetic levitation camera robot is composed of two main parts (head and tail) linked by a thin elastic flexible joint. The tail module embeds two magnets for anchoring and manual rough translation.

The head module incorporates two motorized donut-shaped magnets and a miniaturized vision system at the tip. The magnetic levitation system can exploit the external magnetic field to induce a smooth bending of the robotic head, guaranteeing a high span tilt motion of the point of view (0°-80°). The device is 105 mm long and 12.7 mm in diameter.

Intuitive Surgical - The design of a new multi-DOF bimanual robotic arm for single port procedures is being developed by Intuitive Surgical

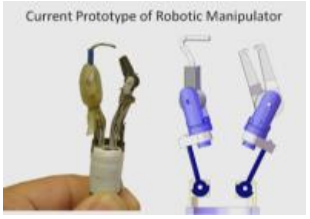
The new multi-DOF robotic micro-manipulators has been presented during the International Conference of Robotics and Automation in Anchorage (U.S.A., May 2010). The robotic system is completely cable actuated by a multi-sheath system.

Source site: http://icra2010.grasp.upenn.edu/

Natural orifice transgastric endoscopic wedge hepatic resection in an experimental model using an intuitively controlled master and slave transluminal endoscopic robot (MASTER)- Surg Endosc (2010) 24:2293–2298

This study explored the feasibility of adapting an intuitively controlled master and slave transluminal endoscopic robot (MASTER) developed to facilitate wedge hepatic resection in NOTES.

This study demonstrated for the first time that the MASTER could effectively mitigate the technical constraints normally encountered in NOTES procedures. With it, the triangulation of surgical tools and the manipulation of tissue became easy, and wedge hepatic resection could be accomplished successfully without the need for assistance using laparoscopic instruments.



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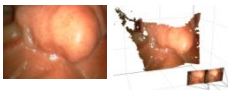
First ICL integrated prototypical ARAKNES console

The console incorporates an autostereoscopic display positioned in between the two supplementary LCD displays on the left and right sides.

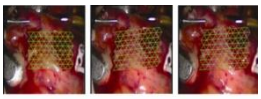
Feasibility study on using the perceptual docking framework for collaborating tasks.

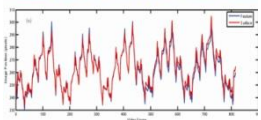
ICL Optical 3D reconstruction of operation field



Stereo-laparoscopic image (Left); semi-dense 3D structure propagated using the zero mean normalized cross correlation (ZNCC) (Right).

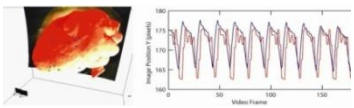
ICL Soft-tissue temporal tracking





Triangulated mesh tracked on observed tissue surface (Top); recovered motion for a feature along the X axis (Bottom).

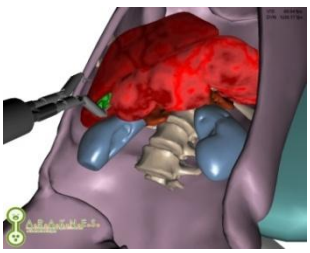
ICL Validation framework for optical method using CT scan model



3D rendition of the phantom model and fiducials on the camera's coordinate system (Left); trajectory motion of a fiducial recovered (proposed method in blue and CT ground truth in red) (Right).

UNIPI Test bed based on realistic physical phantom

Set-up for ARAKNES assessment: assembled mannequin (upper part of image) equipped with silicone organs that replicate the patient anatomy (the bottom part of the image (sx)).
On the right of the figure, the virtual models used to obtain the internal organs).



In order to evaluate robot workspace and collisions between robotic arms and anatomical structures, a robotic plastic mock-up has been moved in the mannequin equipped with the silicon organs (on the left). Moreover, an assistive computer-guidance system (on the right) allows to load the planning of the intervention , and the system indicates to the surgeon the step to follow leaving to the surgeon the responsibility to perform the indicated intervention.

Upcoming Events

2011 SAGES Congress, March 30 - April 2, 2011, San Antonio, TX.
Deadline for submission is **Friday, January 28, 2011.**
Details under, http://www.sages.org/meetings/annual_meeting/2011/

ICRA 2011, 9-13 May Shanghai International Convention Center, Shanghai, Cina.
See details under: http://www.icra2011.org/

Minimally Invasive Robotic Association (MIRA) 6th International Congress, May 11-13, 2011, Athens, Greece.
Deadline for abstract submission is **February 11, 2011**. See details on http://www.mirasurgery.org/

19th EAES Congress, 15-18 June 2011 Torino, Italy.
Abstract submission deadline: **1st of February 2011**
See details under: http://congresses.eaes-eur.org/index.php

Workshop on **New Technologies for Computer/ Robot Assisted Surgery July 11-13, 2011: Graz, Austria.**
Deadline for 500 Word Abstract Submission is **February 15, 2011**

EMBC 2011, August 30 – September 3, 2011, Boston.
Abstract submission deadline: **March 26, 2011**
For details, see http://embc2011.embs.org/

SMIT2011, 13-16 September, 2011, Tel Aviv, Israel.
Details under, http://www.smit2011.org/index.php

5th Summer school in Surgical Robotics , coordinated by
E. Dombre and P. Poignet
LIRMM, CNRS-Université Montpellier 2
Montpellier, September 2011