SUMMER SCHOOL OF SURGICAL ROBOTICS 2007,MONTPELLIER

Design of a robotic system for ultrasound guided biopsy

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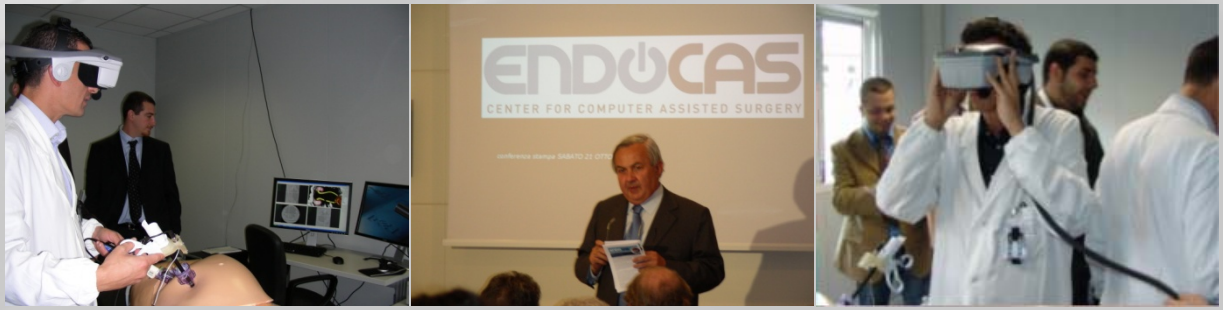
Endocas Center

Centre of excellence in computer assisted surgery

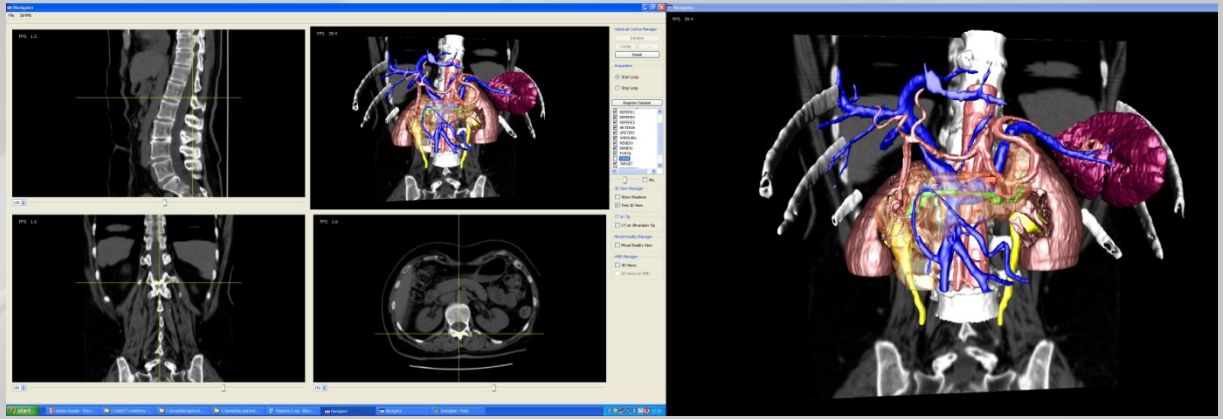


- The medical partners of the Centre of Excellence are a group of surgeons of University of Pisa that practice research in the field of computer assisted surgery (CAS) in addition to clinical activities

- The technological partners of the Centre are the bioengineering groups of Scuola Superiore Sant'Anna (CRIM Lab and ARTS Lab) and a group of computer scientist of CNR (Visual Computing Group) specialized in computer graphics.

Main activities

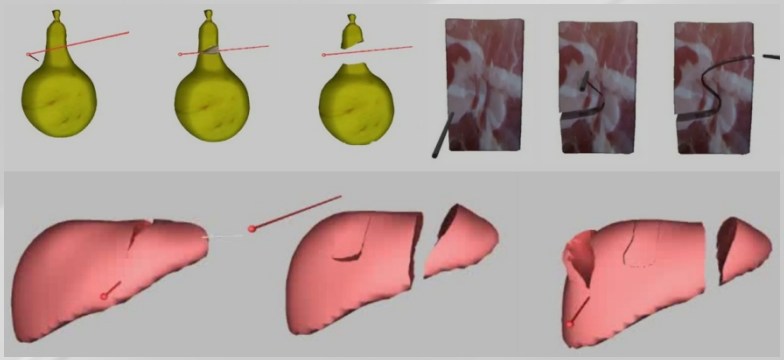
- Surgical Navigators - first prototipe for laparoscopic MIS tested in OR

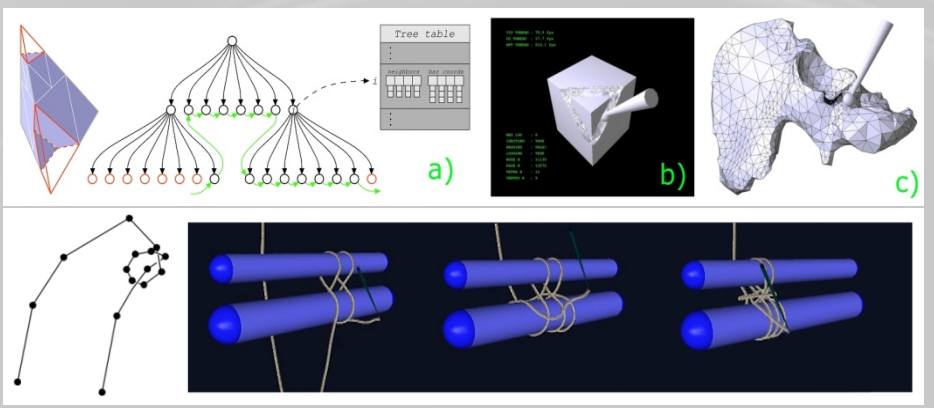


- Robotic and Mechatronic instrumentation - hand-held instrument for laparosopic surgery, laser dissector(cutting and coagulation)

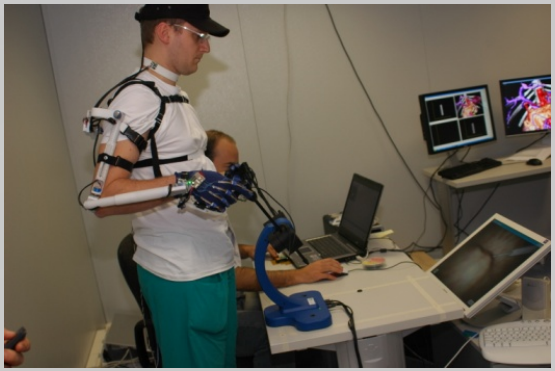
Main activities

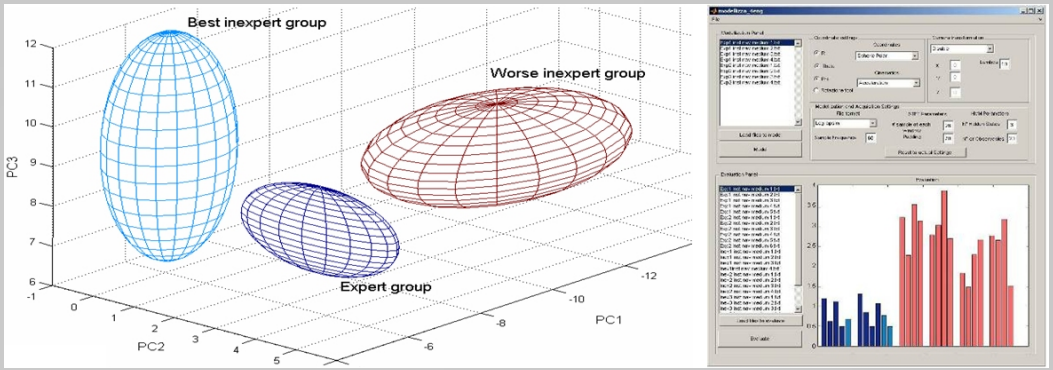
- Simulation and deformable models - cutting of soft tissues, real time texture syntesis of soft tissues, bone erosion, execution of a surgical knot





- Analysis of surgical gesture - evaluation of surgeons' performances using machine learning and biomechanical approaches





outline

- State of the art
- Actual needs
- Possible solutions
- Work in progress
- Future work

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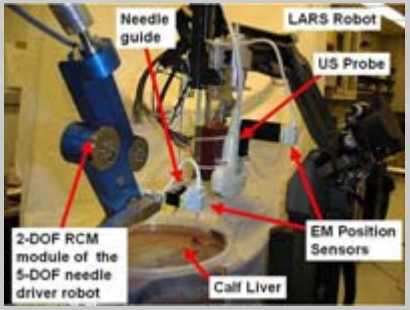
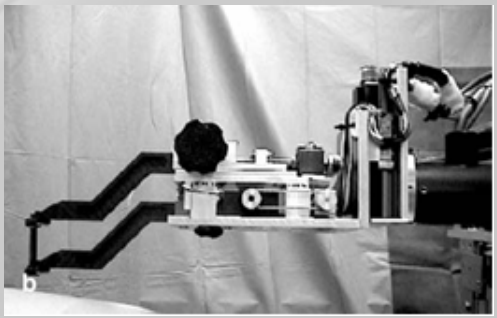
State of the art

Robot Architecture

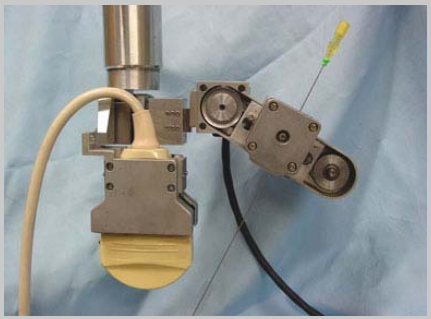
Paky Robot - John Hopkins University



A Dual-Armed Robotic System for Intraoperative Ultrasound Guided Hepatic Ablative Therapy
Boctor,Fitchinger,Taylor-ICRA 04



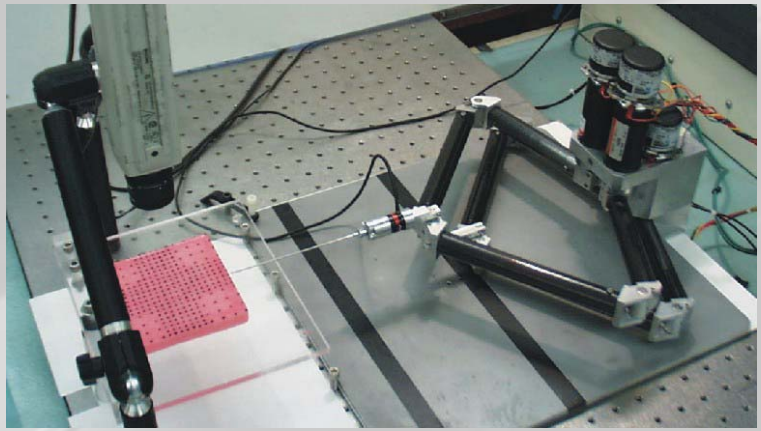
Robot-assisted biopsy using ultrasound guidance - Kettenbach
Kronreif, Fürst - B-Rob I



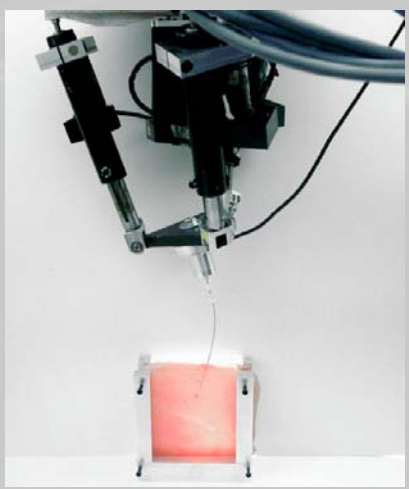
An ultrasound-driven needle-insertion robot for percutaneous cholecystostomy
Hong, Dohi-04

State of the art

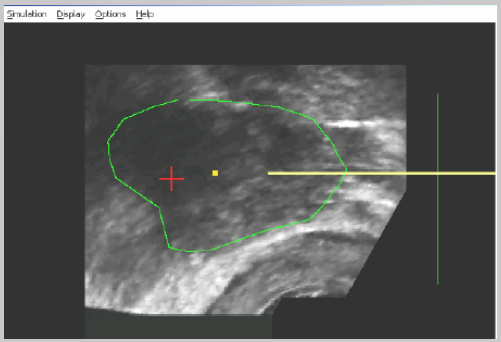
Needle Insertion Modelling



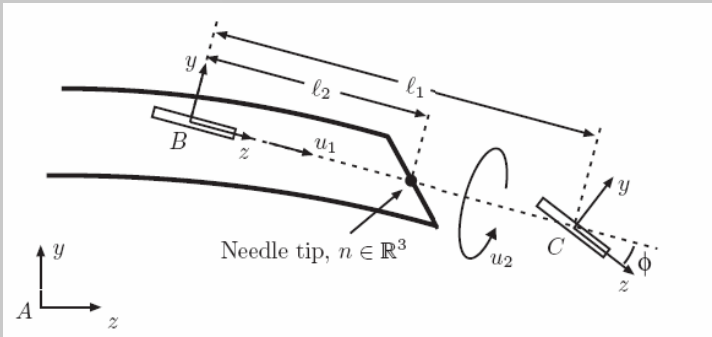
DiMaio,Salcudean - MICCAI 02



Glozman,Shoham-MICCAI 04



Alterovitz – IROS 03



Webster, Cowan - ICRA 07

needs

- precise placement of the needle
- control of surgeons' wrong movements
  necessity of avoiding tremors of various nature
- localization of the whole system
- analysis of the interaction between needle and soft tissues

possible solutions

- Find trajectory of the needle in order to insert it in the right point - study of the kinematics of the needle insertion

- Design of a robotic system suited for percutaneous interventions - light, simple to use ,very precise and accurate, sinergic with the physician; this system will allow the operator to select the target point directly on the echo-graphic image, afterwards the robotic arm will place the biopsy needle along the optimal trajectory and at last the agent will insert the needle and take the sample of the tissue.

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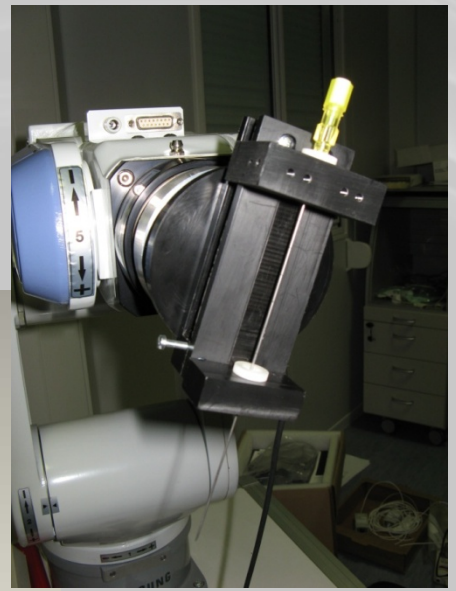
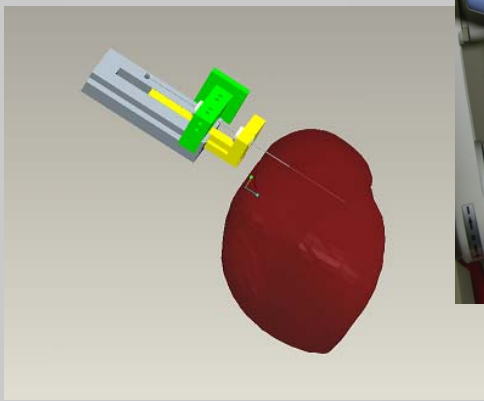
work in progress

- Realization of an end-effector for an industrial robot -

  1 d.o.f. mechanical slide for the needle, sensorized with a 6 d.o.f. force sensor



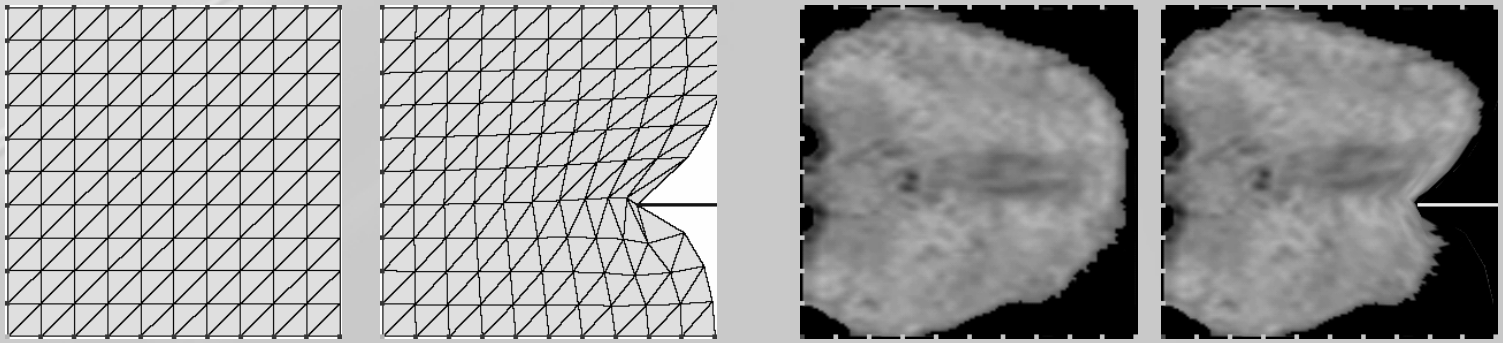


- Sensorization - 8 infra-red LEDs for the ultrasound probe,4 for the mechanical slide for the raising of the position

- Robot Positioning - alignment of the needle along the direction between the target point inside the body selected on the US image and the entry point on the skin of the patient selected by the clinician

future work

- Analysis of the interaction of the needle with the soft tissues (liver) - using ultrasound images and data from force sensor in order to extract mechanical properties of the tissues



reference mesh deformed mesh reference image deformed image (Alterovitz)

- Design of the whole architecture for the robot - choice of the more suitable one for this purposes on the basis of the study of forces, velocities and direction involved in percutaneous procedures

Thank you !