RESEARCH CENTER FOR INDUSTRIAL ROBOTS SIMULATION AND TESTING

CESTER

Prof. Dr.-Ing. Doina PISLA

29 April 2013

CESTER is the research center developed through the Academic Exchange Program between Romania and Germany and the long lasting cooperation (since 1992) between Prof. Juergen Hesselbach and Prof. Nicolae Plitea.

Founded in 2001 with financial support of:

▸ the German Academic Exchange Office (DAAD);

▸ Institute of Machine Tools and Production Technology (IWF), Technical University of Braunschweig Germany;

▸ Alexander von Humboldt Foundation (AvH);

▸ The Technical University of Cluj-Napoca.

UNIVERSITATEA TEHNICĂ
DIN CLUJ-NAPOCA

CERTIFICAT
DE ACREDITARE INTERNĂ

În baza aprobării Senatului Universității Tehnice din Cluj-Napoca din 22 iulie 2010, ca urmare a îndeplinirii standardelor de performanță științifică ale universității, se acreditează pentru funcționare:

Centrul de Cercetare pentru Simulare și Testare Roboți Industriali

Director centru de cercetare:

Prof.univ.dr.ing. Doina Liana Pîslă

Perioada de valabilitate a certificatului: 25.11.2010 – 24.11.2015

Rector,
Prof.univ.dr.ing. Radu Munteanu

Prorector Cercetare și Relații Internaționale,
Prof.univ.dr.ing. Aurel Vlaicu

Director DMCDI,
Prof.univ.dr.ing. Stelian Brad

25.11.2010
Cluj-Napoca

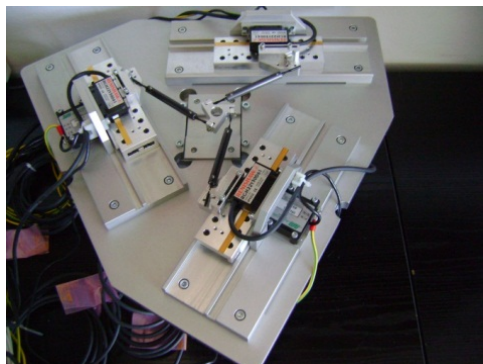**Development of robotic structures**

The CESTER team addresses the problem of developing robotic structures with parallel architecture that responds best to the given application requirements. In a well-defined time sequence is carried out: structural synthesis, kinematic and dynamic modeling, design, control algorithms and actuators. In recent years, research has mainly addressed medical robotics for minimally invasive procedures.

Simulation of complex systems

In an evolving economic framework, efficiency is crucial, the addresses issues focused on optimizing all stages of development of the product life cycle proposing integrated solutions for scientific innovation and adaptive management around the concept of PLM (Product Lifecycle Management).

Modeling and simulation of mechatronic systems with applications in aerodynamics and fluid flow or fluid modeling and simulation

Advanced research on the static and dynamic behavior of fluids in application like renewable energy, high-speed fluid flow and modeling of human fluids, design and optimization of high power mechatronic systems.
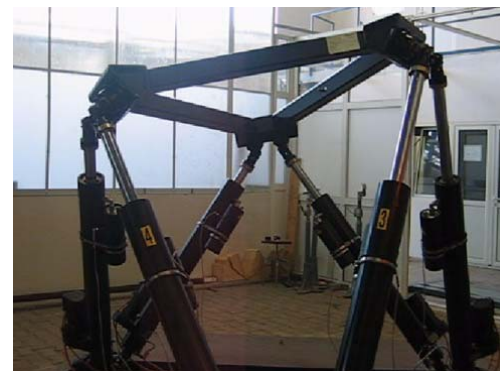
Parallel Robot Laboratory
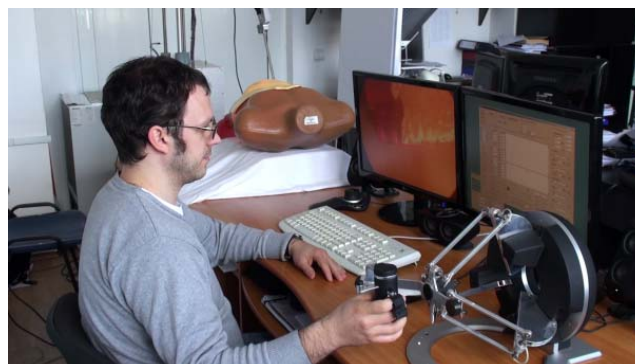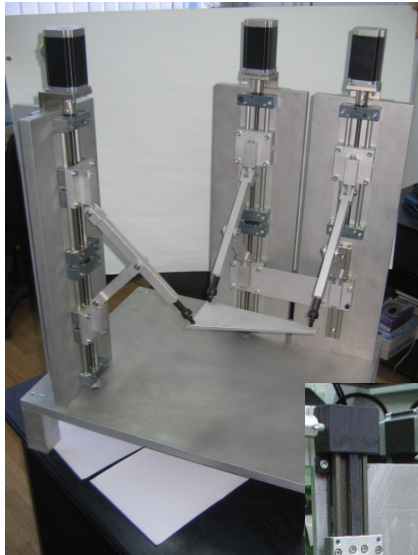

Simulation Laboratory

Mechatronics Systems in Aerodynamics and Fluid Flow Laboratory

Dynamic System Simulation Laboratory

The Parallel Robots Laboratory

There are several robotic structures developed at an experimental degree, some of them in international partnership with the Technical University of Braunschweig, Germany:

❑ the **HEXA** parallel robot - a robot with six degrees of freedom

❑ the **PARMIS** parallel robot – a robot with three degrees of freedom - the first structure developed in Romania for conducting minimally invasive laparoscopic interventions;

❑ the **ROPAR4** robot – a reconfigurable parallel robot with four degrees of freedom;

❑ the **PENTBOB** robot – a reconfigurable parallel robot with five degrees of freedom;

❑ the **MICABO** micro-robot – a planar micro-robot with three degrees of mobility and positioning accuracy 1 micron.

Simulation Laboratory

Hardware and software equipment, which stand behind the development of research projects, carried out in recent years:

- ❑ the **3D virtual simulator** equipped with haptic devices;
- ❑ the **PARASURG-5M** parallel robot for active driving in minimally invasive surgery instruments;
- ❑ the **Omega 7** haptic device (with 7 degrees of freedom and 4 active axes) designed for receiving tactile feedback in minimally invasive surgery;
- ❑ **PARASURG-9M** robotic system, used as an active arm with enhanced dexterity in minimally invasive surgery, consisting the robotic arm PARASURG-5M and the instrument PARASIM.
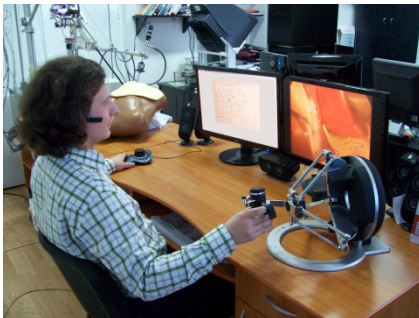
The CESTER Research Center has developed a fundamental strategy along its existence, continued in the next 5 years too, based on three main pillars:

1. **Attracting research funds** from multiple sources (national and international);

2. **Involvement and training of young researchers** in top domains;

3. **Adhesion to priority research** topics at national and European level.

Mathematical modeling and experimental researches for the development of a modular parallel robot for minimally invasive surgery

Project type: International - Alexander von Humboldt Foundation no. 3.4 Fokoop – DEU/1010959 (2006-2011)

Description: The project was focused on developing a parallel robot for minimally invasive surgery. It was intended to minimize the space occupied in the patient vicinity, to create an as wide as possible working field for the doctor, and to provide a simple intuitive and efficient voice command system.

Multidisciplinary development of surgical robots based on parallel structures - PARMIS

Project type: Partnership, PN-II no. 11016/2007 (2007 - 2010), Web site: http://www.parmis.utcluj.ro/

Description: The PARMIS project intended to develop a complex parallel surgical robotic system and to exploit the competences from different fields in order to develop innovative solutions with outstanding performances and advanced control systems based in the concept and characteristics of parallel robots in order to offer efficient solutions for applications in the field of minimally invasive surgery.

Innovative development of an innovative virtual system for e-learning in hepatic surgery - HEPSIM

Project type: Partnership, PN-II no. 92080/2008 (2008-2011) Web site: http://www.granturi.umfcluj.ro/hepsim/

Description: The HEPSIM project aimed to develop a system for simulating virtual liver surgery interventions with the double function of pre-planning of interventions in sensitive areas (proximal functional elements) and the training of young surgeons. To maximize the efficiency of the system, real patients were included whose internal structure was reconstructed and placed in a computer simulation.

Creative Alliance in Research and Education focused on Medical and Service Robotics: CARE-robotics
Project type: International, Scopes IP Grant, no. IZ74Z0_137361/1 (2011-2014)
Web site: http://www.pupin.rs/RnDProfile/project-care.html
Description: CARE-Robotics proposes to increase the capacity and capability of partner organizations (TUCN-Romania, IMP-Serbia, EPFL-Switzerland) to access research funds, focusing on medical robotics and services. An important part of this project is to attract and encourage young researchers towards academic careers.

Development of innovative kinematic and dynamic models for parallel robots in surgical applications, PROINS
Project type: Bilateral reasearch project Romania-Austria, No: 544/31.05.2012 (2012-2013)
Description: PROINS intends to develop new advanced methods to investigate investigated the kinematic and dynamic behaviour of two types of parallel robots potential designed for surgery

Robotic assisted brachytherapy, an innovative approach of inoperable cancers – CHANCE
Project type: Partnerships, PN-II no. 173/2012 (2012 - 2015) Web site: www.cester.utcluj.ro/CHANCE.html
Description: The CHANCE project consortium proposes an innovative minimal invasive approach in brachytherapy interventions, offering viable solutions for the treatment of cancer patients considered inoperable or when their general status do not allow an aggressive treatment.
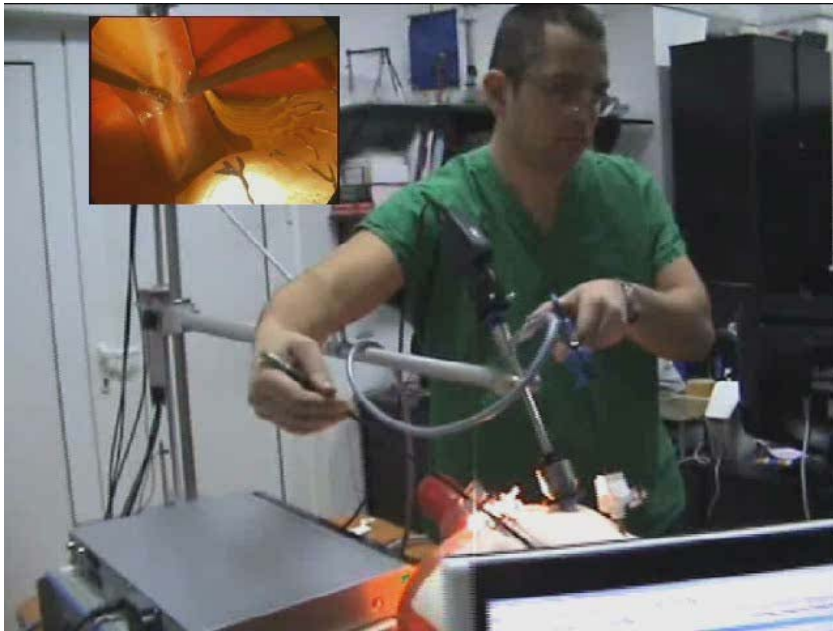
PARAMIS performed in 2009 the first cholecistectomy presented at European Congres for Surgical Endoscopy E.A.E.S. 2009, Prague, The Czech Republic

PARAMIS
(Plitea, 2007; Vaida, 2009, Pisla, 2008;)

3-DOF parallel robot, which has been developed in Romania, used for laparoscope camera positioning.

-the control input allows the user to give commands in a large area for the positioning of the laparoscope using different interfaces:

➤ joystick
➤ microphone
➤ keyboard & mouse
➤ haptic device

PARASURG-5M hybrid parallel robot
(Pisla, 2010; Gherman, 2011)

- a robotic arm used to guide either a laparoscope or an active surgical instrument
- introduced for the first time the concept of voice feedback

PARASURG 5M
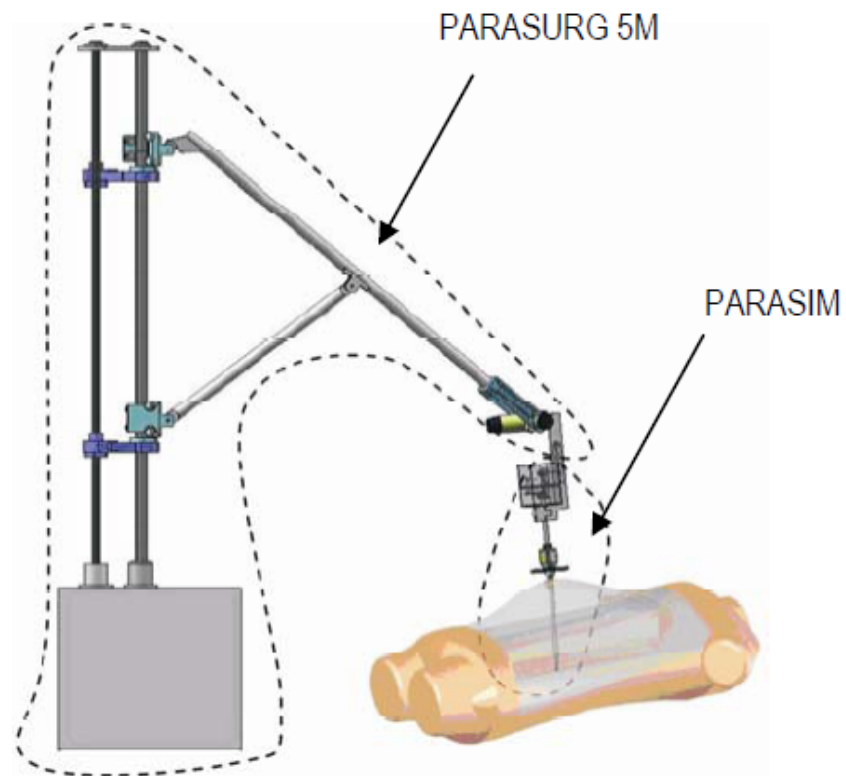
PARASIM

Surgical robot PARASURG-9M
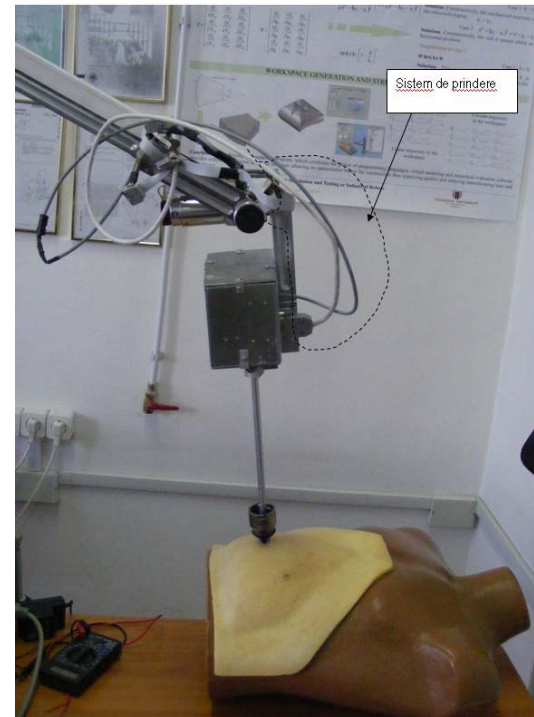
**Active surgical robotic arm
PARASURG-5M + PARASIM**
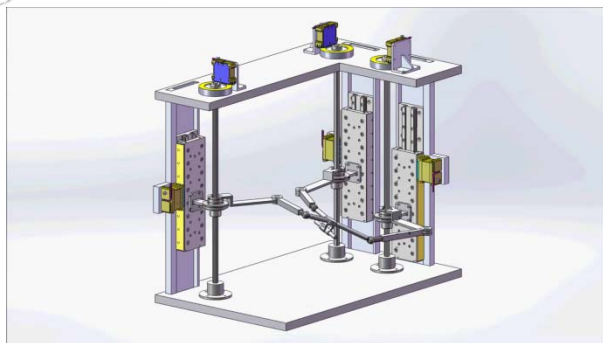(Suciu et al, 2011)
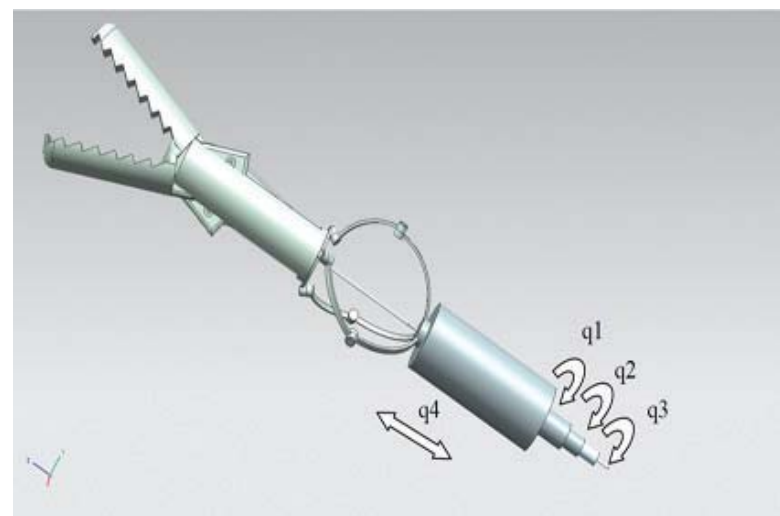
Active instrument PARASIM
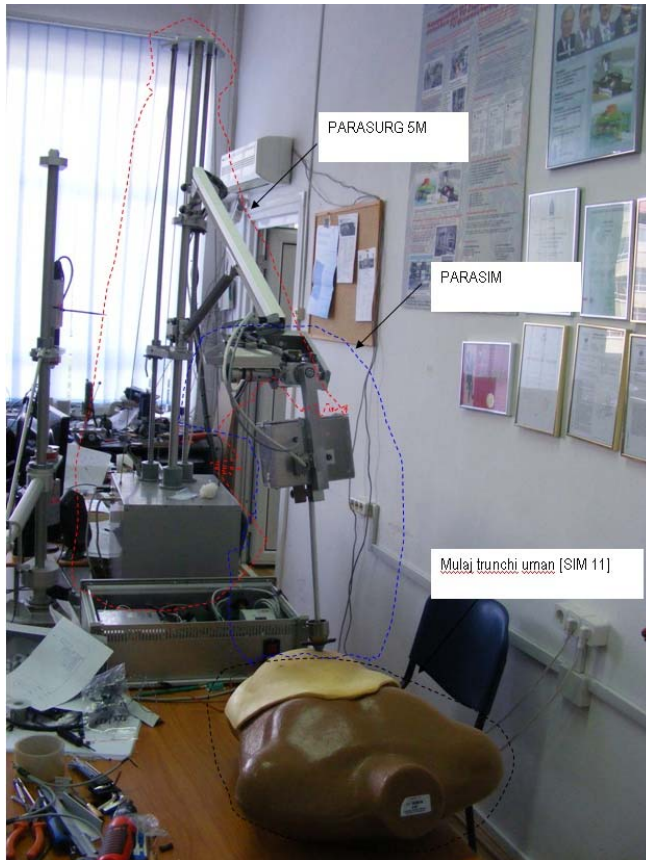
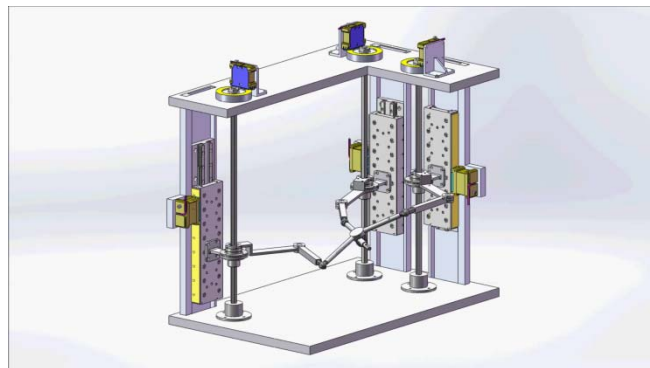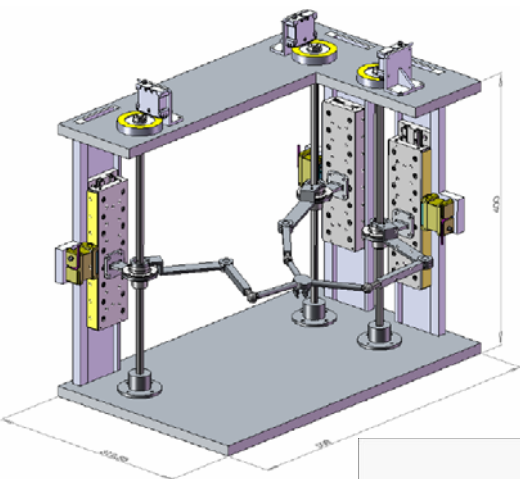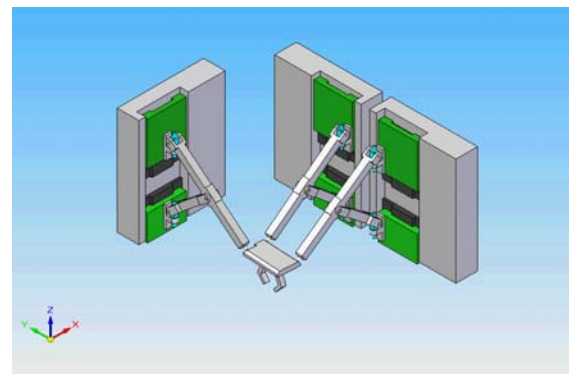## The experimental model of PARASURG-9M

Connection between PARASURG 5M and PARASIM
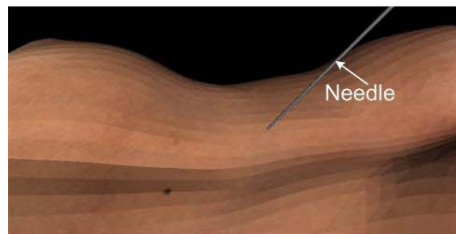
Reconfigurable parallel structures

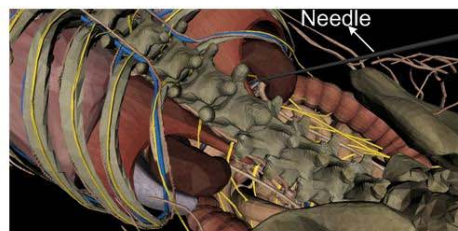RECROB – 6 DOF high precision reconfigurable robot

MICABO H – Original configuration with 6 DOF

Development of a parallel robot for brachytherapy (2012-2015)

Insertion of branhyterapy needle

Needle avoiding the vital organs

Needle in the final position

Pre-planning of a brachytherapy needle trajectory

High Accuracy Parallel Robot for Brachytherapy (Patent pending, 2013)

Based on its team competences, **CESTER research center** is interested to cooperate with Technical University of Braunschweig in:

- ❏ **Robotics** (mechanism synthesis, medical applications, high precision structures),
- ❏ **Product lifecycle management – PLM** (competitive design, management of production systems),
- ❏ **Space Service Robotics –SSR** (fluid flow modeling, high power drives, renewable energy, modeling and simulation).

Through the **Authorized Training Center Siemens PLM**, CESTER is able to offers advanced CAD training in Solid Edge and Siemens NX as well as basic courses in control systems with the B&R Automation Platform.

- **Erasmus Academic Bilateral agreement** between Technical University of Braunschweig and Technical University of Cluj-Napoca (2009-2014) – Summer 2013 - two Romanian students will perform placement at IWF, TU Braunschweig, July-October 2013

- **Joint international Workshops**: The International Exploratory Workshop on Medical and Service Robots (Chair: Doina Pisla, Co-Chair Annika Raatz and Marco Ceccarelli), July, 2012

- **Joint publications** the last one beeing in the Springer book „New Trends in Medical and Service Robots", 2013

- **Proposals of FP7 projects:** the last one being as partners in the field of development of robotic systems for rehabilitation and physiontherapy purposes, January, 2013

- **Technical Visit to Brauschweig:** 6-8 May 2013, meeting with Prof. Klaus Dröder and Dr. Annika Raatz to establish new ways of cooperation within joint research and insitutional projects

Thank you very much
for your attention!