CESTER

RESEARCH CENTER FOR INDUSTRIAL ROBOTS SIMULATION AND TESTING

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Research Center for Industrial Robots Simulation and Testing

CESTER

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 şi 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 şi Relații Internaționale,
Prof.univ.dr.ing. Aurel Vlaicu

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

25.11.2010
Cluj-Napoca

Areas of Expertise

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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.

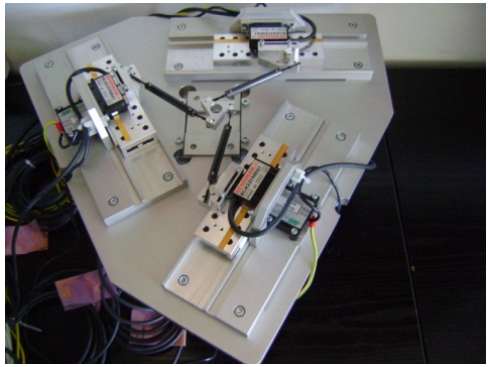
Simulation of complex systems

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

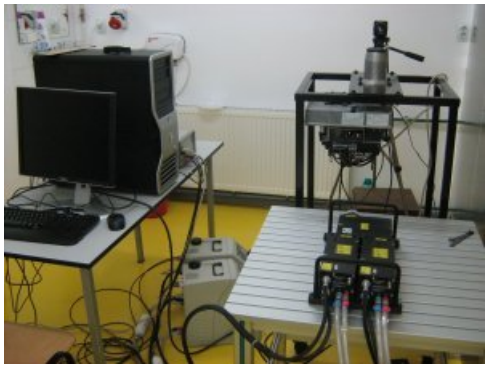
Advanced research on the static and dynamic behavior of fluids in application like renewable energy, high-speed fluid flow and modeling of human fluids, design and optimization of high power mechatronic systems.

Laboratories



Parallel Robot Laboratory

Simulation Laboratory

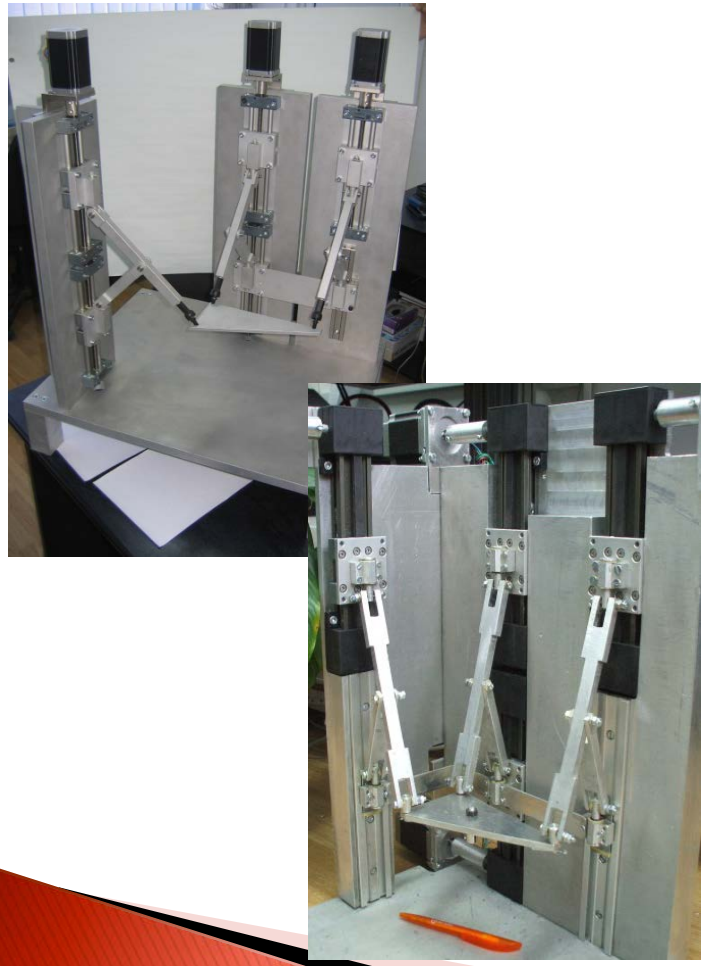


Mechatronics Systems in Aerodynamics and Fluid Flow Laboratory

Dynamic System Simulation Laboratory

Laboratories

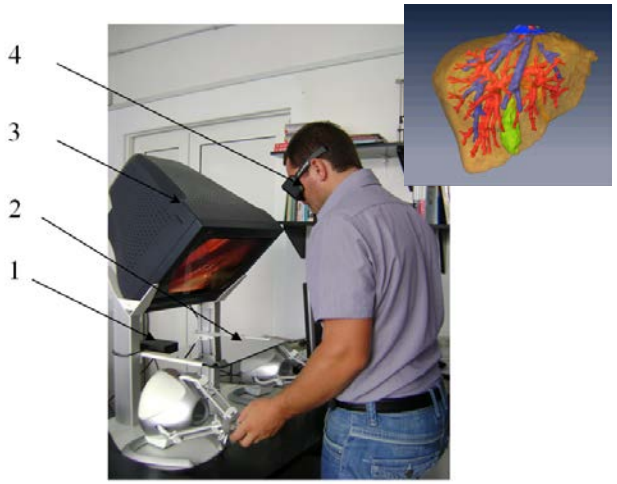
The Parallel Robots Laboratory



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.

Laboratories



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.

Team and key skills

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Dynamic Systems Simulation Laboratory

The Dynamic Systems Simulation Laboratory has dedicated equipment for modeling of industrial processes and a strong software platform:

- a **flexible manufacturing cell** with two machine tools and a handling robot;
- a **hexapod type platform** (Gough) designed for highly dynamic flight simulators;
- **multiple vision systems** and equipment for **acoustic-visual dynamic simulation**.
- The **software package** from **Siemens PLM** (NX, Solid Edge, Tehnomatix, Teamcenter) which provides its users with the most advanced system design, simulation, optimization, manufacturing and testing, covering all steps of the development cycle of a product.

Team and key skills

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Laboratory for Modeling and Testing of Mechatronic Systems with Applications in Aerodynamics and Fluid Flow

Within this lab there are several Fluid Mechanics specific equipment:

- a **stand for** testing and monitoring of low and medium power **hydraulic pumps**;
- **a stand** for monitoring and simulation of **flow phenomena** (flow, pressure, variable density);
- a **thermal phenomena simulation stand**, a stand for simulation of mixed of gas-liquid fluids;
- a **stand for testing wind turbines**;
- a **wind tunnel** for behavioral study of structures with complex profiles;
- **a PIV** (particle image velocimetry) **system** and a **dSpace system** for simulating command systems. The used software package is Fluent, a program simulating fluid flow in various structures and environmental conditions.

Research Strategy

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.

Representative projects of the last 5 years

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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.

Representative projects of the last 5 years

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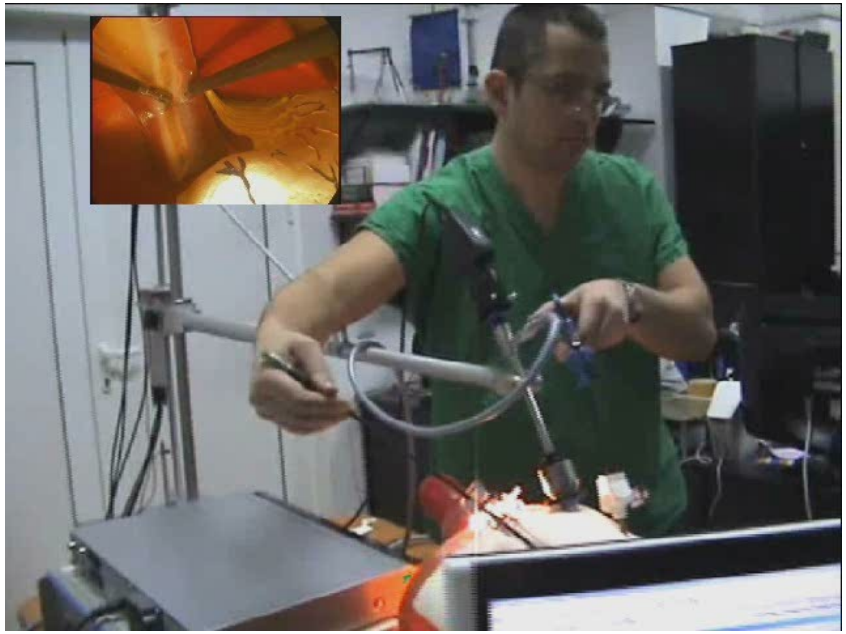
Creative Alliance in Research and Education focused on Medical and Service Robotics: CARE-robotics
Project type: International, Scopes IP Grant, no. IZ74Z0_137361/1 (2011-2014)
Web site: http://www.pupin.rs/RnDProfile/project-care.html
Description: CARE-Robotics proposes to increase the capacity and 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.

Past and present developments



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:

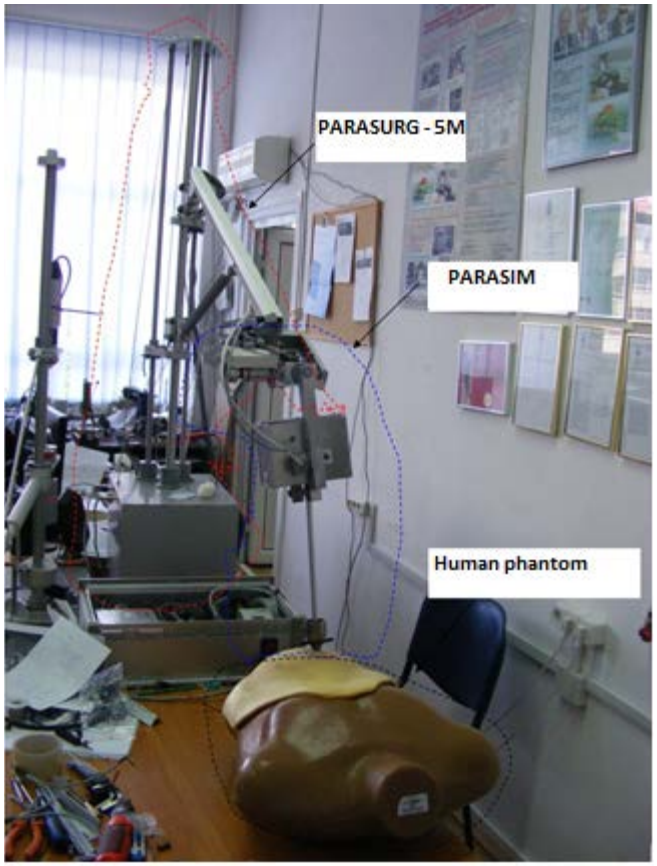
- joystick
- microphone
- keyboard & mouse
- haptic device

Past and present developments

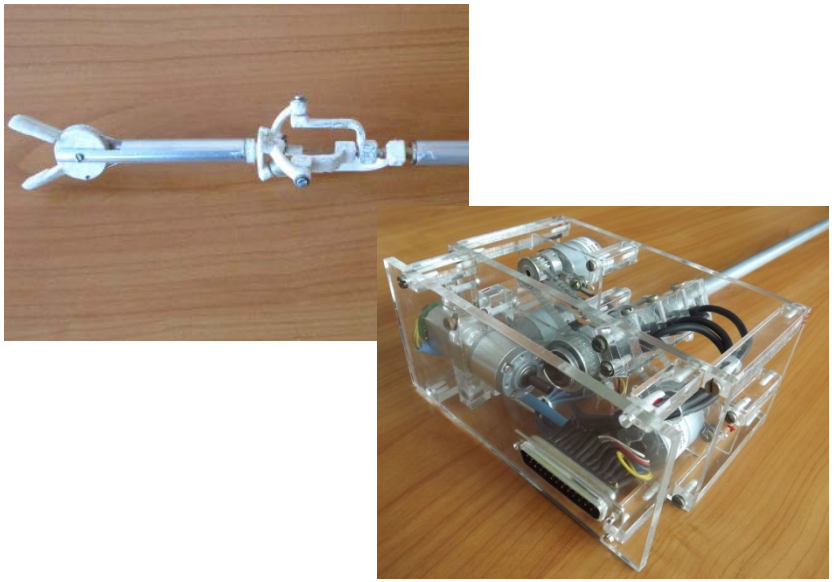
PARASURG-5M hybrid parallel robot
(Pisla, 2010; Gherman, 2011)

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

Past and present developments



The experimental model of PARASURG-9M



Active instrument PARASIM

Past and present developments

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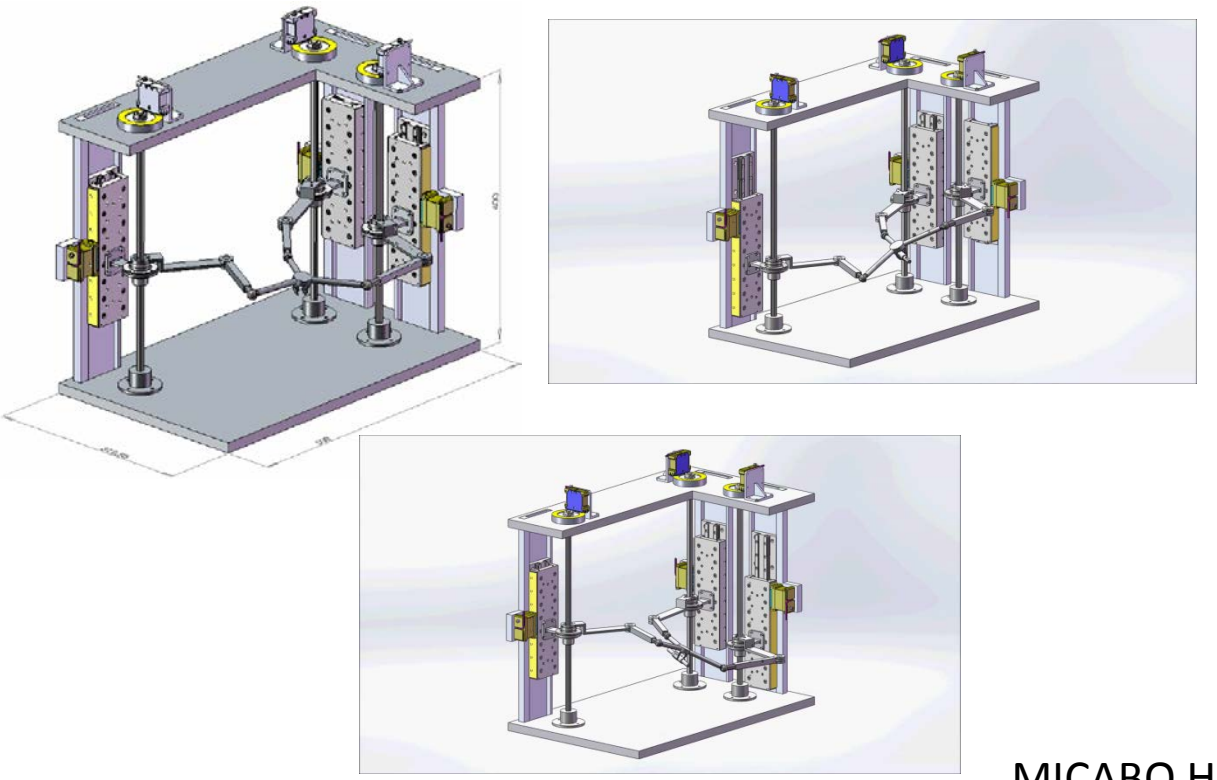
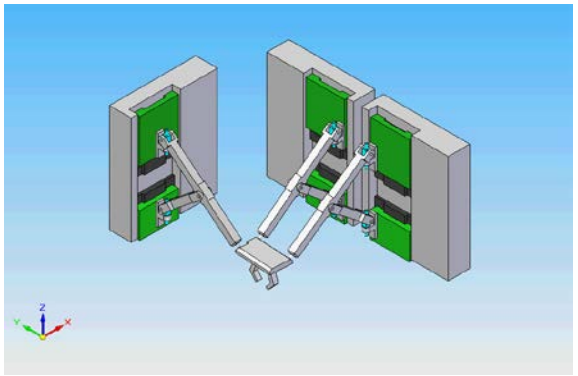
Reconfigurable parallel structures



RECROB – 6 DOF high precision reconfigurable robot



MICABO H – Original configuration with 6 DOF

Past and present developments

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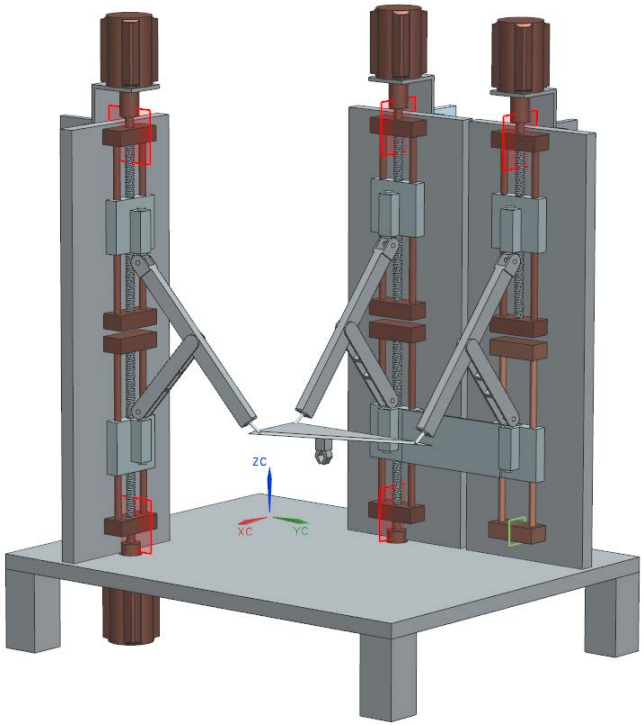
Reconfigurable parallel structures



Kinematic model

Experimental model

PENTROB – 5 DOF high precision reconfigurable robot

New complex national project

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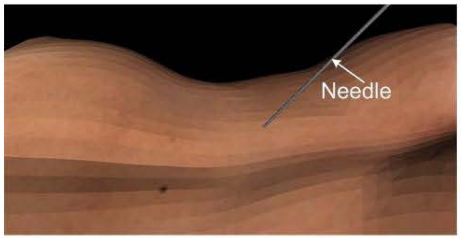
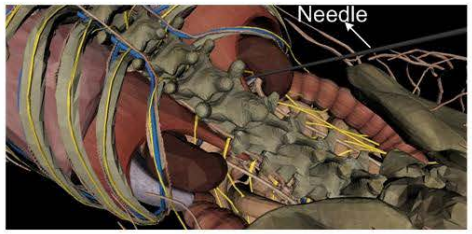
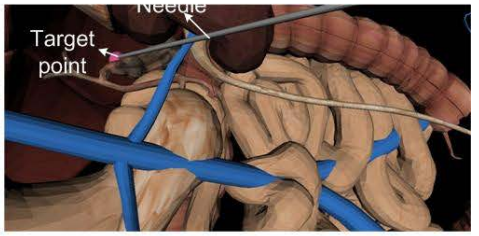
Development of innovative parallel robots for brachytherapy (2012-2015)



Insertion of branhyterapy needle



Needle avoiding the vital organs



Needle in the final position

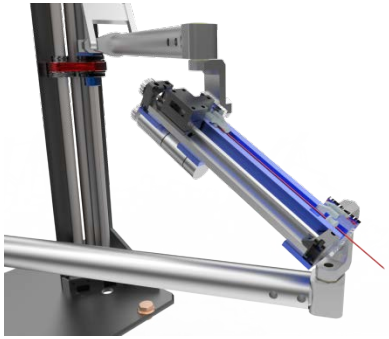
Pre-planning of a brachytherapy needle trajectory

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

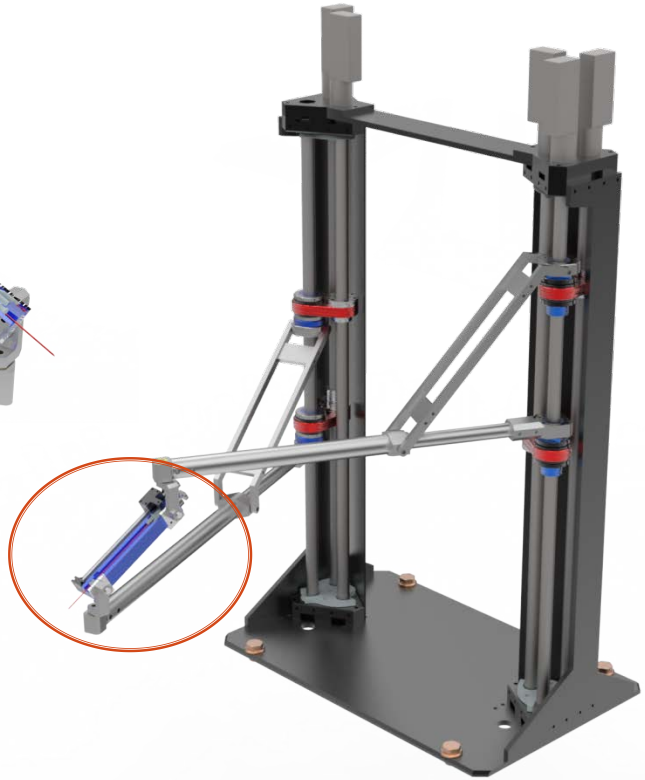
New complex national project

CESTER

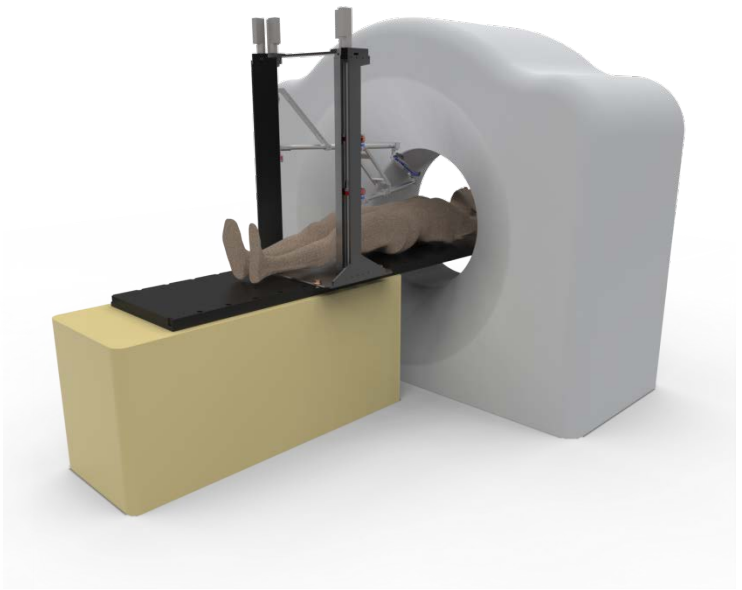
Development of innovative parallel robots for brachytherapy (2012-2015)



Needle insertion module



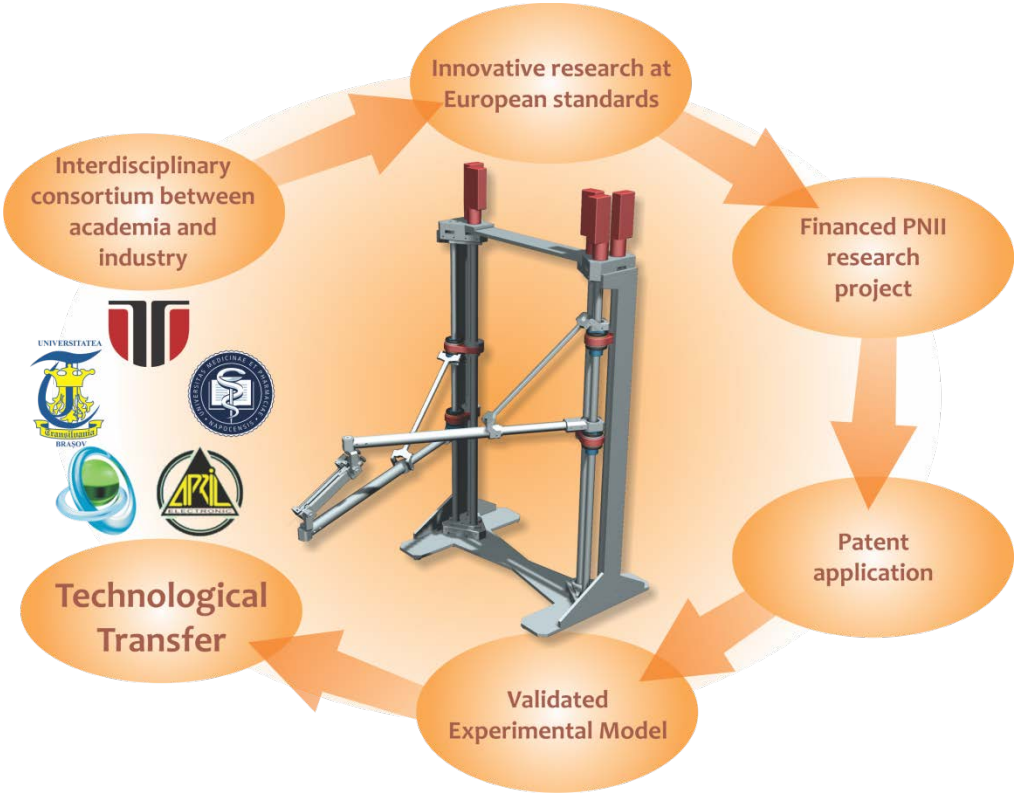
PARA-BRACHYROB experimental model



CT-Scan real-time position validation

PARA-BRACHYROB Parallel Robot for Brachytherapy (Patent pending, 2013)

Evolution of an innovative robotic system from an idea towards the technological transfer from academia to industry



Relevant publications

- ✓ Pisla, D., Gherman, B., Vaida, C., (c.a.), Suciu, M., Plitea, N., An active hybrid parallel robot for minimally invasive surgery, (2013), Robotics and Computer-Integrated Manufacturing, 29(4), pp. 203-221
- ✓ Vaida, C., Plitea, N., Pisla, D., Gherman, B.: Orientation module for surgical instruments—a systematical approach, (2013), Meccanica, Vol. 48(1), pp. 145-158, DOI 10.1007/s11012-012-9590-x.
- ✓ Pisla, D., Szilaghyi, A., Vaida, C., (c.a.), Plitea, N., Kinematics and workspace modeling of a new hybrid robot used in minimally invasive surgery, (2013) Robotics and Computer-Integrated Manufacturing 29(2) pp. 463–474
- ✓ Plitea, N., Lese, D., Pisla, D., Vaida, C., Structural design and kinematics of a new parallel reconfigurable robot, (2013), Robotics and Computer-Integrated Manufacturing, 29(1), pp. 219-235.
- ✓ Vaida, C., Plitea, N., Lese, D., Pisla, D., A Parallel Reconfigurable Robot with Six Degrees of Freedom, (2012), Applied Mechanics and Materials, Vol. 162, pp 204-213

Relevant publications

- ✓ Pisla, D., Gherman, B. Vaida, C., Plitea, N.: Kinematic modeling of a 5 DOF Parallel Hybrid Robot designed for Laparoscopic Surgery, (2012) Robotica, Cambridge University Press, Vol. 30(7), pp 1095-1107
- ✓ Gherman, B., Pisla, D., Vaida, C., Plitea N., Development of Inverse Dynamic Model for a Surgical Hybrid Parallel Robot with Equivalent Lumped Masses, (2012) Robotics and Computer-Integrated Manufacturing, 28 (3) , pp. 402-415.
- ✓ D. Pisla, B. Gherman, N. Plitea, B. Gyurka, C. Vaida (c.a.), L. Vlad, F. Graur, C. Radu, M. Suciu, A. Szilaghy, A. Stoica, PARASURG hybrid parallel robot for minimally invasive surgery, (2011), Chirurgia Vol. 106(5), pp. 619-625
- ✓ Pisla, D., Plitea, N., Vaida, C. (c.a.), Hesselbach, J., Raatz, A., Vlad, L., Graur, F., PARAMIS Parallel Robot for Laparoscopic Surgery, (2010), Chirurgia 105(5), pp. 677-683
- ✓ D. Pisla. N. Plitea and C. Vaida, Kinematic Modeling and Workspace Generation for a New Parallel Robot Used in Minimally invasive Surgery, Advances in Robot Kinematics, 2008, pp. 459-469, Ed. Springer ISBN-13: 978-1-4020-8599-4

Relevant patents

Plitea, N., Pîslă, D., Vaida, C., Gherman, B.: Surgical Robot. RO-126271, Romania (2012)

Vaida, C., Plitea, N., Pîslă, D., Gherman, B., Suciu, M.: **Orientation module with multiple bends**, Patent pending A10112/2011, (2011)

Plitea, N., Pisla, D., Vaida, C., Vidrean, M. Lese, D., Scurtu, L., **Family of robots for positioning with constant platform orientation**, Patent pending A/10021/29.09.2010, Romania (2010).

Plitea, N., Pisla, D., Vaida, C., Vidrean, A., Glogoveanu, M. Lese, D., **Family of robots with four degrees of freedom**, Patent pending A10022/30.09.2010, Romania (2010).

Plitea, N., Pisla, D., Vaida, C., Lese, D., Konya, B., Dadarlat, R., Scurtu, L., Sabou, C.: **Family of robots with six degrees of freedom**, Patent pending A/10013/2011, Romania (2011)

Plitea N., et al.: **Parallel robot for brachytherapy with two kinematic guiding chains of the platform (the needle) type 2CRRU and CRU**, Patent pending, A/10004/2013

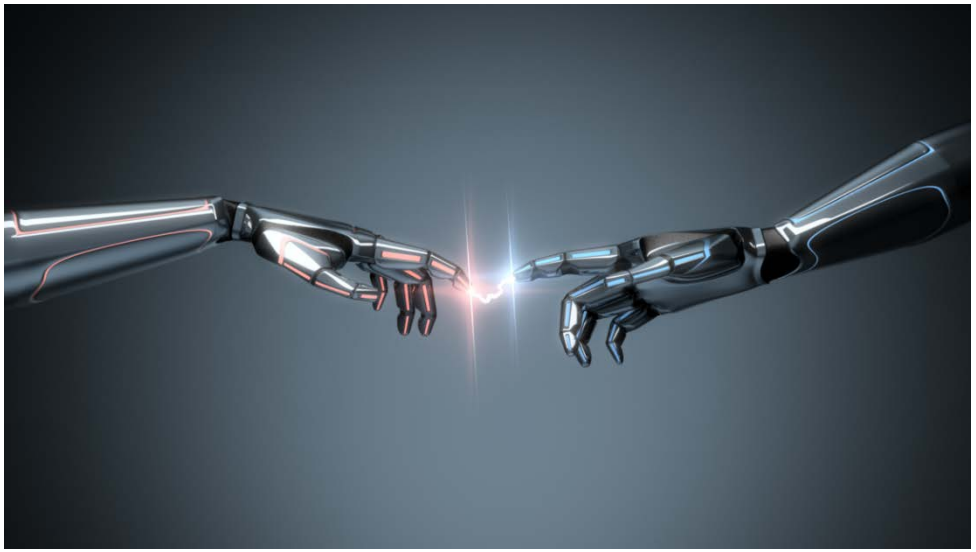
Plitea N., et al.: **Parallel robot for brachytherapy with two kinematic guiding chains of the platform (the needle) type 2CRRU and CYL-U**, Patent pending, A/10005/2013

Plitea N., et al.: **Parallel robot for brachytherapy with two kinematic guiding chains of the platform (the needle) type CYL-U**, Patent pending, A/10006/2013

Plitea N., et al.: **Parallel robot for brachytherapy with two parallel modules, one for positioning and one for orientation**, Patent pending, A/10007/2013

If we do not anticipate,

future will overtake us



Thank you very much for your attention!

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