Technical University of Cluj-Napoca
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# Medical robotic systems with application in surgery, oncology and rehabilitation

**- Abstract –**

**- Habilitation thesis -**

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**"A wise man should consider that health is the greatest of human blessings, and learn how by his own thought to derive benefit from his illnesses." (*Hippocrates*)**

This thesis invites you, the reader, in an evolutionary journey of **Robotics in Medicine** presenting the major achievements to which I have contributed in the last eight years in:

- Minimally invasive robotic assisted surgery;
- Targeted treatment options of cancer using robotic guided instrumentation;
- Robotic assisted rehabilitation of post-stroke patients.

Chapter 1, "*Robotics in Medicine*" makes a critical analysis of this field with respect to the society needs which determine the strategic agenda of European research for the next decade. The European Commission has identified three major areas of interest where robotics would play an important role:

**Clinical robotics:** refer to robotic systems that interact directly with the patient supporting the "care" and "cure" processes. Some areas where such robots would apply are: diagnosis, treatment, surgical interventions and medication and also emergency. They would be used by trained medical personnel.

**Rehabilitation**: refer to robotic system that would be used following a medical condition (traumatic, post-operative or neurological) where their direct physical interaction with the patient would either enhance the recovery process or act as a replacement for a lost function.

**Assistive robotics**: refer to secondary aspects related to the medical process, providing assistance to the healthcare givers of the patients.

The domains of interest for the author and the research team from CESTER are summarized in the second part of the chapter describing briefly the specific challenges in minimally invasive procedures, cancer diagnosis and treatment and post-stroke rehabilitation.

Chapter 2, "*Surgical robotics and devices*", covers some achievements for minimally invasive procedures. In the first part, a multi-bend flexible instrument that increases the dexterity inside the patient with over 80% is presented. The second part presents a spherical robotic system for minimally invasive surgery that has an architecturally constraint Remote Centre of Motion.

Chapter 3, "*Robotic systems for brachytherapy*" describes two robotic structures for the treatment of malignant tumours using a focal therapy called brachytherapy.

Chapter 4 "*Advanced systems for minimally invasive percutaneous therapy*" presents the development of a spherical robotic system for transperineal prostate biopsy (for cancer diagnosis) and three instruments that, mounted on a robotic device achieve the diagnosis and treatment of cancer through: biopsy, brachytherapy and radiofrequency ablation.

Chapter 5 "*Robotic rehabilitation of the upper limb*" presents the development of a robotic device for the post-stroke rehabilitation of the upper limb with focus on the shoulder and elbow.

Chapter 6 "*Some final thoughts*" presents some final remarks and personal thoughts regarding the role of researchers in the society and the interdependency between research, engineering and education.