

ABSTRACT

The habilitation thesis *Contributions to the development of in-pipe inspection modular robotic systems and omnidirectional robots* presents the author's research activities since 2004 until present. The time interval 2004-2015 is correspondent to the period after the presentation of the PhD thesis (May 2004) and its confirmation by the Education and Research Ministry (August 2004).

The thesis is organized into three sections. The first section includes five chapters which present the author's main scientific achievements, the second section includes Career evolution and development plans and the third is represented by the References

The scientific results are based on original studies and research performed by the author within the Technical University of Cluj-Napoca.

Chapter 1 presents a short introduction into the in-pipe inspection robots research field and the developed research directions, related to this field.

The research activities concerning the in-pipe inspection robots were directed towards:

- development of a family of adaptable modular mobile systems for inspection and exploration.

- development of three-wheeled robots with adaptable structure that consists of two four-bar mechanisms, placed on two parallel planes and the modular systems that can be developed using these robots;

- development of in-pipe microrobots with adaptable structure.

Chapter 2 presents the author's contribution to the development of a family of adaptable modular mobile robotic systems for inspection and exploration that have as advantages: versatility, adaptability, light and robust modules, low power consumption and low manufacturing costs.

These modular robotic systems can be used for inspection and exploration tasks inside pipes with inner diameters ranged between 130 and 200 mm. The developed modular systems consist of driving modules which provide propulsion, based on linkage mechanisms, and passive modules that have the purpose of transporting the electronic equipment and the equipment needed for performing inspections, explorations etc.

The author's contribution to the development of a three-wheeled minirobots with adaptable structure that consists of two four-bar mechanisms, placed on two parallel planes and the modular systems that can be built using these minirobots, is presented in Chapter 3.

The developed minirobots can be used independently or as a driving modules, together with passive modules, for a modular minirobot systems for inspection and exploration. The developed minirobots with articulated mechanisms and the modular minirobotic systems are to be used for inspection of pipes with inner diameters ranged between 50 and 70 mm.

The inspection of small diameter pipes is a subject of great complexity, due to the small operating environment within which the tasks must be performed.

In this respect, Chapter 4 gives the author's contribution to the development of in-pipe inspection microrobots. The developed microrobot uses wheels for locomotion and it can adapt its structure to the diameter variations of the inspected pipe.

The microrobot is able to keep its balanced state due to the pressure exerted by the wheels onto the inner surface of the pipe and it can adapt its structure as to be used for pipes with inner diameters ranged between 30 and 50 mm.

These research activities had financial support from two research contracts (projects) into the field of mobile robots for inspection and exploration, which the author coordinated, as director, between 2006 and 2010:

- Project type A nr. 2783 / 2006, THEME: A13, CNCSIS code: 1295 – Modeling, simulation and development of mobile robots with adaptable structure, ongoing period 2006-2007.

- Project PN-II Idei-ID_1056, nr. 85/2007 – Modeling, simulation and development of a family of adaptable modular mobile robotic systems for inspection and exploration, ongoing period 2007-2010.

The results were disseminated by means of scientific papers presented in International Conferences and national and international journals (ISI Thomson and other international databases indexed and quoted), and by obtaining a patent, nr 127090/ 30 01 2013: Self-propelled modular robot, authors: Tătar, M.O., Aluței, A., Cirebea, C.

The mentioned projects and results certify the ability of the author to coordinate research and development projects and his ability to lead young researchers.

Besides the research in the field of in-pipe inspection robots, the author also performed research activities in the field of omnidirectional robots.

Thus, in chapter 5, after presenting several specific aspects regarding the standard and special wheel types used in omnidirectional robots, as well as a short introduction into the research field of omnidirectional robots, the author's contribution to the development of standard and special-wheeled omnidirectional robots is presented.

These research activities were put into practice by two omnidirectional minirobot prototypes with conventional wheels, which use the synchronous drive principle, two omnidirectional minirobot prototypes with swedish (universal) wheels and an omnidirectional minirobot prototype with Mecanum wheels.

The second section of the thesis presents *Development plans for the professional, scientific and academic career*.

The main professional achievements, from after receiving the PhD title, are presented.

In this period he published: 125 papers, of which 18 ISI quoted and indexed papers (11 as main author, 7 as co-author), 43 papers in other international databases - BDI, 47 papers published in the proceedings of international conferences, 2 books published by CNCSIS acknowledged publishers, 6 book chapters, 1 laboratory guide, a patent.

Also, he coordinated, as a director, two research projects, he was member of the research teams of 10 national research projects and he was a HR official for a POSDRU project.

The future research activities will continue to follow the same theme, but new research directions will also be approached. In this respect, the author wishes to obtain new developments in the following fields: inspection/exploration robots; omnidirectional robots; rehabilitation robots; microsystems.

The third section contains the bibliographical references for the first five chapters.

In conclusion, by taking into account the work done up to this date, nationally and internationally, and also the development plan that will be implemented, the author considers that the results can be greatly improved by increasing the research team by adding PhD candidates, coordinated as a result of his habilitation in Mechanical Engineering.