INTELLLIGENT SYSTEMS AND CONTROL (HABILITATION THESIS)

SUMMARY

The habilitation thesis presents the scientific, professional and academic works that I had chance to be involved in as member of Computer Science Department from Faculty of Automatic Control and Computers, University *Politehnica* of Bucharest.

Intelligent systems and the algorithms for controlling them have been the main focus of my research activity starting from my PhD studies and until now. Being a very dynamic and completely challenging domain, my research activity has performed in the context of national projects in which I participated as a member or as main coordinator. The research directions in which I am dynamically involved can be summarized as: *implementing interfaces for medical applications; integrating complex systems dedicated to rehabilitation of patients; control algorithms implementation; implementing observers and estimators for distributed systems, implementation of fuzzy models for controlling complex systems; the study of self-organizing systems and methods; algorithms for embedded systems implementation; e-Government systems and services.*

Recognition and the impact of my teaching and research activity is the most important and probably the unique measure for the validation of the results generated by the developed activity. The most relevant results of my research activity have been published in 6 books and chapters in books, 28 articles in relevant impact scientific international journals and ISI proceedings, 26 articles in journals and proceedings indexed in other international databases, all my publications having a cumulative impact factor of 14.49. The publications brought 53 citations in books, magazines and volumes of scientific that are ISI or IDB indexed.

The scientific community has become increasingly interested in so-called Rehabilitation Robotics, a branch of the areas of Robotics and Mechatronics that addresses to the study of complex robotic systems aiming to restore the human functions for those people who suffer major trauma as a result of strokes and cerebrovascular diseases (CVA). In this context I have coordinated projects as IHRG (started in 2012) and SINPHA (2007-2010). The thesis presents my research results on these subjects, emphasizing the accomplishments on the intelligent systems applied on medical and rehabilitation applications. For the project called "*Intelligent Robot Haptic Glove for the patient's suffering a cerebrovascular accident (IHRG)*", I am elaborating the control system for an intelligent glove to help rehabilitation of hand's movements for patients who have suffered a cerebrovascular accident. In the case of SINPHA project, an embedded system of a neuro-stimulator was developed and for hardware implementation, a FPGA implementation was used. The thesis also presents an intelligent fuzzy self-organizing system based on electroencephalogram (EEG) analyse.

The intelligent systems was constantly present in my research activity. In this context, the thesis presents my accomplishments in finding robust solutions in designing, modelling and

controlling robotic arms belonging to the class of hyper-redundant robots. They represents one of the most attractive domains of robotics during the last decades. The hyper-redundant arms are a class of arms that can achieve any position and orientation in 3D-space. The research contributions and some proposed solutions are presented here, underlying the articles where my work was published and emphasizing its impact. Another aspect of my work regards intelligent systems applied on e-Government, due to some projects developed together with Fraunhofer Institute for Open Communication Systems from Berlin. The thesis presents a project called *Point of Single Contact* which is an intelligent system through which service providers can find the information and complete the all the formalities necessary to doing business. In the same context, an application called *nPA connector* which allows a secure identification of a certain user using an electronic identity card (eID) over the Internet is shown.

An important aspect of this thesis consists of presenting some future research directions in Medical and Rehabilitation Applications that I am interested to follow in my research activity. The discussion underlines two directions. The first one regards solutions *using Brain Computer Interface (BCI)*. In this way, the movements of the hand could be done by our own thoughts. The second direction implies the perspective of designing and implementing *a new soft hyper-redundant robotic arm prototype for medical applications.*

I should mention that my main concern will be to form a strong research team for a laboratory dedicated to intelligent applications in medicine. The purpose of this team should be to develop innovative reconfigurable systems dedicated to the interoperability of different medical devices. I hope and I wish that the ideas and contributions presented in this thesis will pave the way to new projects, collaborations, ideas and contributions, closing the loop that will always move the exiting limits in any domain.

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