Annex nr. 6

ACADEMIA ROMÂNĂ
SCOSAAR

HABILITATION THESIS ABSTRACT

TITLE: Real Time Control of Robotic and Mechatronic Systems

Habilitation domain: *Mechanical Engineering*

Author: dr. ing. Victor Vlădăreanu

The thesis contains a review of the author's most important research achievements and activity after the award of his PhD title (February 2015). The main scientific fields of interest focus on rehabilitation robots, aerial and terrestrial vectors for search and rescue missions, artificial neural networks, computer vision, decision support systems, fuzzy systems, and evolutionary optimization algorithms. The undertaken research is supported by papers, patents and the participation in national and international projects, which is discussed at length in the conclusion section.

An important area of contribution is in the design and implementation of intelligent interfaces for the robot environment virtualization platform VIPRO. This has been successfully introduced into robotic research applications in laboratory, outdoor and industrial environments. Each project or application uses a slightly modified version of the platform, adapted to its particular needs. The focus is on the intelligent control interfaces, automated parameter estimation, model optimization and interpolation for the experimental data in an industrial environment, automated decision support systems, and optimized aerial vector missions, within projects such as RABOT (FP7), SMOOTH (H2020) and MultiMonD2 (PNIII - PCCDI).

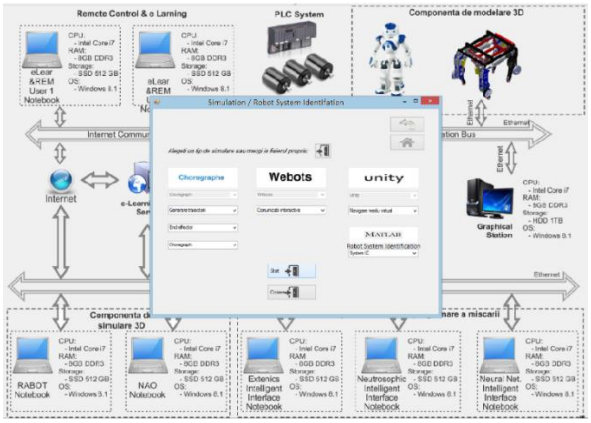
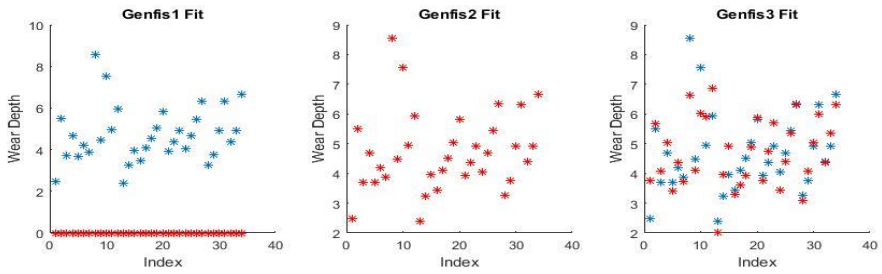


Figure 2.9. Robot system identification on the VIPRO platform

In the field of Tribology, using advanced statistical and optimization algorithms on a dataset obtained from the hardware simulation, the results of the research led to modelling a dependency between the various variables of interest involved in the friction process. The subject draws a growing interest from the research community with the advent of highly advanced, intelligent classification, optimization and regression algorithms.



(**a**) (**b**) (**c**)

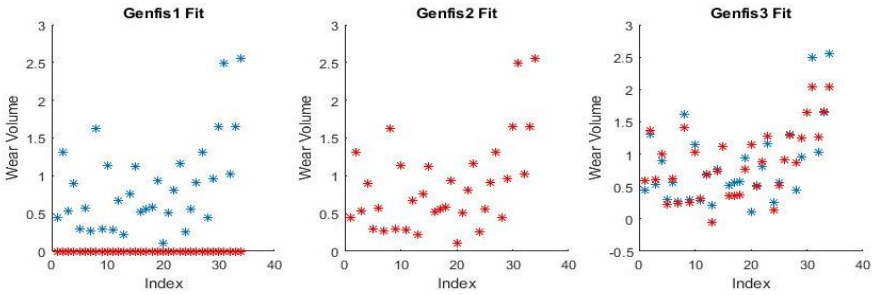


Figure 4.6. FIS fit generated through (a) grid partitioning; (b) sub-clustering; and (c) FCM clustering for wear depth in binary coding (above) and wear volume in numerical coding (below)

In data processing and machine learning, the work describes the steps involved in obtaining a set of relevant data sources and the accompanying method using software-based sensors to detect anomalous behaviour in modern smartphones based on machine-learning classifiers. Three classes of models are investigated for classification: logistic regressions, shallow neural nets, and support vector machines. The design, implementation, and comparative evaluation of all three classes are discussed. The approach is to be extended to other computing devices, once appropriate changes are made to the software infrastructure, based upon mandatory capabilities of the underlying hardware.

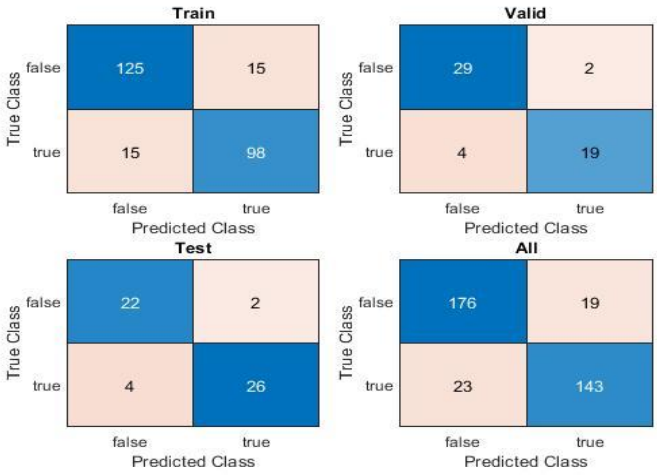


Figure 4.14. SVM Confusion Matrix

The results presented in the thesis are supported by numerous papers published in high impact journals, participation at scientific conferences, national and international projects, international collaboration, invention patents, publication of two monographs in the field, as well as teaching activity in undergraduate studies in two schools at university.

The thesis presents the tendencies and improvements of the intelligent control of autonomous mobile robots in uneven and unstructured environments with obstacles through the use of innovative techniques for dynamic stability, orientation and navigation, detection and obstacle avoidance, multi-sensor systems' optimization for positioning, inertial, optical and proximity information. The obtained results allow for future studies in the field of robot control in virtual environments and virtualization of industrial processes, as well as computer vision, adaptive optimization algorithms, innovation automation frameworks and refinement of extended control.

The publication and project participation activities undertaken in the past few years allow the development of my scientific interests to new fields, of national and international interest, found at the limit of the state of the art in mechatronics, robotics and artificial intelligence, such as computer vision (research contract for image processing and recognition on a prototype board), simultaneous localization and mapping (project proposal PNII – TE and published papers) and decision support systems (close collaboration with the founders of Extenics and Neutrosophy, published papers, book and book chapters, project proposal PNIII – PD Research, development secondment in Extenics at Guangdong University), integrated innovative solutions for First Responder support in rescue missions (project proposal iMars for H2020 – ERC 2021 and PNIII - PD) and firefighting (project proposal QFiRBot for H2020 – Technologies for First Responders 2020).

As a continuation of working with students, I am actively engaged in graduate and postgraduate studies, teaching a course and three laboratories for the University Politehnica Bucharest, as an invited scholar. This involvement is also supported through initiating and leading the internship program offered by the Institute for the past five years. A very fruitful collaboration with PhD students has yielded significant results in common research projects and publications. Thus, a straightforward direction for development is submitting this thesis with a view to obtaining the right to supervise PhD theses, thereby benefitting the Institute and the Department by extending the academic opportunities offered by the Doctoral School.