



Universitatea *Transilvania* din Braşov

HABILITATION THESIS

SUMMARY

**Applied research in analyzing and modeling of the
human biosystems to improve quality of life**

Domain: Mechanical engineering

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Habilitation thesis entitled: *Applied research in biosystems modeling and analysis to improve the quality human life* is meant to be a summary of the author's professional activity in a period of almost 25 years of academic career. This highlights the significant results obtained in research after completing her doctoral internship as a normal continuation of these old concerns in the area of quality of life. The desire of the author to investigate human biosystems has roots in the 90s, when, with Prof.dr.eng. Virgil Olariu and a small team of colleagues have begun the journey to deciphering the mysteries of *Biomechanics*. Later research appeared in *Optometry* and then in *Medical Engineering*. Today in *Advanced Mechatronic Systems Research Center*, a research group is very involved and dedicated to medical applications, under an exceptional endowment.

In essence, this paper systematic presents two elements: scientific and professional achievements and plans for evolution and career development. The main objective of the research was related to the transfer of results to practical applications useful in evaluating and improving human health and therefore of the living conditions.

Judging from the perspective of **scientific and professional achievements** obtained previously, three main areas of research were identified:

- I. Analysis and recovery of visual function
- II. The behavior of the human body to shocks and vibrations
- III. Mechatronic systems for medical rehabilitation

As a first research direction, *Analysis and recovery of visual function* is actually a continuation of the doctoral thesis. With tens of millions of bioelectrical connections, capable of transmitting more than one million bio-impulses, visual analyzer is more complex in form and function than any other human biosystem. Therefore, it is necessary to study visual function and finding methods of protection, correction or recovery when its equilibrium is disturbed.

Referring to this research direction, in a first part, are presented researches made on optical simulation of visual function. This is useful for identifying refractive ocular problems and finding solutions to correct them, with higher accuracy. For this, the results of optical computing modeling of visual function and the image determination which is formed by an emmetropic eye, seen as a perfect optical system, are presented.

The second part of the first research direction shows a simulation method of the contact between the eye and eyelid. This is proving to be very useful for running people, especially for contact lens wearers. In such cases the stability of the lens between the eyelid and eyeball is very important to maintain within the normal limits of visual stability, spatial perception, good visual acuity and ocular comfort.

Other studies are related to applied research on visual function of drivers. The first one relates primarily to the evaluation of visual field, spatial perception and peripheral vision using in different traffic conditions. This is a method for simulation of the driving under conditions of narrowed visual field. Another study shows a subjective evaluation method of color vision and adaptation to darkness for drivers. This was done by simulating ocular exposure of the subjects at different wavelengths with a certain frequency of exposure.

Under the same direction can be included investigating cases of recovery of visual function in preschool children. For this, three different methods of testing and recovery of binocular vision, which were applied to a group of 45 children at a kindergarten in Brasov County, were conceived. The results were surprising and showed the importance of ocular evaluation of young children, so that they have the opportunity to early visual recovery.

Experimental tests, presented in this part of the thesis, were made with the students from *Optometry* study program, which the author tries to instill the desire to develop new testing and evaluation methods of visual function, to let them lead the way towards to a possible future research.

Identified as the second direction, *Behavior of the human body to shocks and vibrations* presents the applied researches made in this area. The idea of this study was of Prof.dr.ing. Sergiu T. Chiriacescu appeared during the author's doctoral internship and anticipates obtaining good results. Body vibration behavior problem is to explain physiological and pathological phenomena in predicting its behavior to other mechanical actions, determining the limits of the body's resistance to fatigue under extreme conditions, and in developing new means of protection. Based on these ideas, in this paper, the effects they have shocks and vibrations on the body, various type of numerical modeling of such behavior and experimental tests for verification of these are presented.

The third direction is related to *Mechatronic systems for medical rehabilitation*, considering that they are related to the equipment and devices designed to help patients recovering the normal physiological functions. The research aim was to design, development and implementation of a mechatronic system (an intelligent robotic orthosis), which could help people in a certain therapy of neuro-motor recovery. This are referring particularly to the knee and elbow joints, but the system can be adapted also on wrists, ankle, shoulder or thigh. All phases of research, from setting objectives to its experimental testing and optimization, are presented. As in other cases, some conclusions are established and possible future research directions are traced.

The second part of the thesis contains the evolution and academic career development plans, which have been established on three main areas: educational activities; research activities and organizational activities needed for continuous professional development and personal growth visibility. For each of them was identified the present state and future plans were drafted.

Following an significant research activities results: 12 books (4 for student use); 154 scientific papers (ISI 21 and 49 in other BDI); 3 national research projects as director and 13 as a team member and a proposal for patent published in ISI Web of Knowledge, obtaining the habilitation would allow passing the experience gathered in this years to young people who want to start on the way of scientific research through a doctoral internship.

Nothing is more beautiful than, what you have received in the youth, to give in return to the young people who want to follow the same route.