



Universitatea *Transilvania* din Braşov

HABILITATION THESIS

SUMMARY

Title: METHODS AND TECHNIQUES FOR MEASURING AND ASSESSING HUMAN PERFORMANCE

Domain: PHYSICAL EDUCATION AND SPORT SCIENCE

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SUMMARY

The habilitation thesis entitled **METHODS AND TECHNIQUES FOR MEASURING AND ASSESSING HUMAN PERFORMANCE** comprises the main concerns of the candidate and the researches he has conducted after obtaining the PhD title.

The area of expertise and the research themes are framed in the vast field of Sport Science and Physical Education, but also in interdisciplinary fields, thereby contributing to the novelty and providing possibilities for the exploration of human performance using the latest techniques of data acquisition and processing.

The habilitation thesis has two parts. The first part contains the candidate's accomplishments grouped in research directions after obtaining the PhD title. The second part comprises the future research directions and opportunities offered by the new tools that the candidate created in order to evaluate the human performance.

In 2008 the candidate presented his Thesis entitled "Effectiveness of using audio-visual means within the lessons of physical education with the secondary school students" and obtained the PhD title in Republic of Moldova, a title that has also been later certified by CNATDCU, in Romania.

After obtaining the PhD title the candidate has defined his research directions and has managed to channel his energy and ideas towards realistic and feasible objectives, in order to reach a certain research maturity.

The main research directions are presented in the first part of the habilitation thesis. Six research directions have been identified that also have the same title as the chapters, as follows:

1. The efficiency of audio-visual mean in physical education classes. Improvement of neuro-motor and sensorial-perceptual skills. New approaches related to physical education and sports management.
2. Investigation of the athletes' peculiarities using MGM test for energetic and the control parameters
3. Biomechanical study using the kinect sensors
4. Modeling the upper and lower limbs. Assessing the magnitude of muscle forces.
5. LateraTEST –device for assessing laterality
6. Device for monitoring the athletic skills in real conditions

The first chapter describes the candidate's achievements in his PhD thesis field, through studies related to the influence of audiovisual means on the functional parameters, such as pulse, blood pressure, vital capacity, etc., but also on the psycho-motor stimulation and perceptive capacity and on knowledge acquisition.

Other studies presented in this chapter aim at new approaches of the content of the physical education lesson based on operational calculus and game theory, but also at new approaches to sport management starting from the principles of BPR (Business Process Reengineering), by customizing them in this kind of management. The chapter contains also a

mathematical model based on regression analysis of dependence between the degree of knowledge assimilation and the number of repetitions and practical exercises performed by students.

The second chapter, entitled Investigation of the athletes' peculiarities using MGM test for energetic and the control parameters presents the results of studies carried out using this test, the interpretation of energetic and control parameters provided by the MGM test and the extent to which certain factors influence the values of the parameters. Different athletes from different sport branches such as: athletes, football players, tennis players were evaluated. For some of these the kinetic, potential and total energies were calculated and the average speed was determined.

Regression analysis showed the extent to which somatic factors, body mass indices, the plantar surface, the contact pressure and the conventional density influence the energetic and control parameters. It was also carried out a study on the influence of spatial perception on the parameters provided by the MGM test. In this chapter it has also been described the interface that provides instant reports on the status of tested athletes and more importantly, their interpretation.

Biomechanical study using the kinect sensors is the title of the third chapter of the first part in which is presented the motion sensor and the equipment that was used to conduct analysis of human normal and pathological gait, as well as postural analysis. Studies have allowed highlighting asymmetrical joints, as well as the deviation from the vertical posture.

The fourth chapter entitled "Modeling the upper and lower limbs. Assessing the magnitude of muscle forces" includes virtual modeling studies of upper and lower limbs considered kinematic chains, as well as the estimation of muscle forces considered applied forces. The upper limb model was simulated during the execution of a flexion and during push-up motions, highlighting the lengthening of muscle fibers, the velocities and accelerations. For the evaluation of muscle forces, the Hill's model was used and the results were validated using electromyography, highlighting also the muscle activity phases. Based on the virtual model a dynamic simulation was achieved, and studies have provided the reaction forces and torques in joints.

The fifth chapter, entitled LateraTEST –device for assessing laterality presents the construction and operation of a mechatronic system for determining and improving the speed and responsiveness of the brain hemispheres-named LateraTEST, in order to reduce imbalances between the right and left laterality and the improvement of the speed reaction to visual stimuli. The mechatronic system is comprised of an experimental platform and application software that runs under Windows on a personal computer (PC) such as desktop or notebook. This mechatronic system will be used for the indirect assessment of laterality, measuring the speed of reaction to visual stimulus for the right and for the left limb, using several white and colored light tests. The data collected are processed by specially designed software, and the results are automatically generated in the form of status reports. Finally, the user interface, which allows viewing and printing status reports, is shown.

The sixth chapter entitled: Device for monitoring the athletic skills in real conditions presents the practical achievement of the assembly pressure sensor- electronic device, which has the main purpose to acquire special data relating to the study of gait and race in athletics and studying simple running step with its three phases: damping phase, vertical axis, and pulse as well as energy and control parameters that influence the achievement of increased performance.

The device can be used to detect deficiencies in terms of accuracy aiming at the sync mismatch of the left and right leg during the the race, the force differences, the ground pressure differences, force and speed imbalances and beyond. All of these considerations are based on the study of the fundamental element of running, the main link, represented by the action impulse of the foot on the ground.

The second part of the habilitation thesis includes directions for the candidates future development according to two coordinates: research and academic activity.

Future research directions follow up those already presented, given that there are challenges and opportunities in each of the directions mentioned above.

New approaches in physical education and sports will be constant concerns, the dynamics of the area determined by education reform, requiring the scientific development, maintaining the status of physical education as an important component of the entire educational system, widening the area of scientific research concerning human motricity.

Extensive research will be possible in the future as well as through the development of new applications in the case of the MGM test. These will aim at various sports, such as handball, badminton, and the ability to generate status reports which shall contain in addition to the test results, their interpretation, will ease the work coaches'. They will develop customized training programs for each athlete.

Including the Kinect sensor in this test will be another future focus research. The results provided by the sensor will be the basis for assessing the joints reaction forces and torques while jumping is performed. Scheduled training session will take account of these stresses and will focus on increasing joints resistance in order to prevent injuries.

Kinect sensor and applications specially designed to be used for analyzing run time techniques for various sports, pointing out technical executions mistakes using a frame by frame analysis of records provided by the sensor. Unlike video footage, recordings made using the kinect sensor are linearized and thus is possible to analyse other characteristics such as execution speed, acceleration, but also the magnitude of the stresses in joints, as well as their time variation during execution.

The mecatronic device for assessing laterality named LateraTEST was awarded the national Salon of UGAL -INVENT with the gold medal. Its practical realization is the first step of the extensive research, which will be an interdisciplinary one.

Laterality refers to the knowledge of the two parts of the body (left and right) and expresses the functional inequality between the right side and the left side of the body, as a

consequence of the difference in development and distribution functions in the cerebral hemispheres. Functional dominance of a body part over the other determines laterality.

Dynamic synthesis between the body scheme, motor coordination and perceptive-motor task play an important role in learning the motor skills, through mental training. Neuromuscular reaction time improvement, increasing the aerobic capacity and sports skills development, doesn't need to be achieved only in a manner that simulates the competition conditions, but also using high-performance simulators.

LaterATEST represents a special equipment designed to improve reaction time, hand-eye coordination and muscle strength. It will develop training programs for improving the speed of reaction for athletes, with the aim of enhancing the two hemispheres of the cerebral cortex, in children, but also to people with neuro-motor disabilities. These programs will be individualized, based on the status and progress reports of each athlete.

The proposed mechatronic system is an innovative one, because there are not such devices for determination of laterality and improving the speed of reaction on the left/right hemispheres. The system will be successfully used by elite athletes, by kinetotherapists for recovering the persons who temporarily lost the upper limb mobility, children in order to stimulate the two cerebral hemispheres, from early age.

The mechatronic device will open up new research directions in the field of evaluation of laterality as well as in the study of the neural processes that determine the reaction to stimuli. Another research direction implies the realization of a portable device, which will be able to provide data regarding laterality and reaction rate in real terms, with the help of a software application installed on a tablet or on a mobile phone with android, with wireless data transmission.

Another direction for future research will involve the monitoring device for specific skills of athletics. It has as its direct utility data acquisition on the one hand related to the study of gait and race in athletics and studying simple running step. Academic activity will be directed to the teaching process, the activities in the interest of the school and activities with students.