TEACHING INSTRUMENTATION AND METHODOLOGY IN HUMAN MOTION ANALYSIS

V. Medved
Faculty of Physical Education, University of Zagreb, Zagreb, Croatia

Abstract-**Applying technical devices of varying degree of complexity and sophistication with the purpose of diagnostics and treatment has been a hallmark of modern western medicine. Todays' medical praxis, for instance, relays heavily on CT, MRI, ultrasound, and other complex devices. One example, ever more present during the last decade, is the instrumentation for biomechanical (kinematic, kinetic and EMG) motion measurements and analysis. The paper describes some contributions in this realm at the University of Zagreb including the publishing of a comprehensive textbook on the subject and also the introducement of teaching curricula to implement the apropriate knowledge. Problems are discussed of educating professionals and disseminating knowledge of this kind to the interdisciplinary audience including biomedical engineers, medical doctors, kinesiologists, physical therapists, etc.**
Keywords: Movement, measurement, teaching

I. INTRODUCTION

Since the Muybridge's and Marey's time, and particularly with the Berkeley Group, human locomotion has been studied in an ever more quantitative way due to the development of measurement technology. Methodologically linked to robotics, biomechanical analysis of locomotion has matured into a clinically useful discipline. As in many other fields of application, the importance of influence of PCs in last decades can not be overemphasized [1]. Today, we witness growing of locomotion biomechanics curricula in top world universities. At the University of Zagreb, undergraduate teaching of locomotion biomechanics is provided only at the Faculty of Physical Education. Following a need to teach biomedical engineering students interested in this interdisciplinary subject as well, at the Faculty of Electrical Engineering and Computing a new course – bordering between biomechanics and robotics - has been offered recently, as an elective undergraduate and graduate course [2]. Human locomotion measurements are well established as an experimental scientific research tool and are frequently a routine clinical application as well. Fields of application encompass both healthy and pathological locomotion encountered in rehabilitation medicine, orthopedics, kinesiology, sports science and other related fields. A comprehensive text has been assembled and published, therefore, aimed at explaining, to the interdisciplinary audience, human locomotion measurement methodology and engineering solutions [3]. It follows, in a way, in line of biomechanics [4] and biomedical electronics [5] textbooks by the Zagreb biomedical engineering group. This paper describes the current status, and comments first results of these educational efforts.

II. METHODOLOGY

In a certain environment, a city or a larger region, many components are needeed for some professional area to develop and be implemented. In the case of human motion analysis inputs both from education (i.e. teaching professionals), and also from proper financing in health care (i.e. equipping facilities) are needed. The first prerequisite has been accomplished by writing a textbook and developing appropriate university teaching curricula.

III. RESULTS

The new course recently offered to students of electrical engineering and computing is entitled: "Multisensor Systems and Locomotion". Following are its units. The notion of robotics as an intelligent connection between perception and action. The analogy with biosystems. Vision sensors. Optoelectronic methods of scene measurement and acquisition. Photogrammetric tranformations and algorithms. Modeling of the environment. Measurement of forces, distributed pressures and tactile sensors. Other sensor modalities. Integration of sensor modalities. Kinematics, biomechanics and modeling of movement in biosystems. Locomotion. Artificial muscle: realizability. Prostheses: cybernetic and motor aspects and their functionality. Movement simulation and virtual reality. Through class and laboratory work the course is aimed at explaining the methodology and instrumentation in human movement analysis.

The new book is entitled: "Measurement of Human Locomotion" [3]. It provides comprehensive description of instrument systems for measurement of kinematics of human movement, kinetic quantities experienced by the human body in contact with the ground, and myoelectric changes associated with locomotor activity. Physical principles governing the operation of several measurement devices and relevant mathematics and

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engineering are presented, as well as signal processing issues that must be addressed in order to obtain and use quantitative measurement variables in the biomecanical context. Measurement data acquisition, processing, and presentation to the user in a computer based laboratory environment are explained. The ultimate goal is to contribute to the diagnostics and treatment of specific locomotion patterns. References to major historical landmarks in the development of measurement methodology are provided as well. Selected experimental data are shown and interpreted to illustrate the methods, some originating from the author's own research. Consequently, the reader may gain insight into the working principles, typical uses, and comparative advantages of a number of instruments, such as simple electrogoniometers, sophisticated stereometric instruments to capture human body kinematics, imbedded force plates, distributed pressure measurement systems, wire and telemetry electromyographs, ets. Systems oriented and interdisciplinary in character, this volume addresses biomedical engineers, active in industry or the clinical environment, physicians, kinesiologists, physical therapists, and students and researchers of human movement in clinics and academia. By focusing on locomotion measurements, the volume attempts to complement classical biomechanics, neurophysiology, and motor control-oriented texts. As such it covers a large part of the beforementioned course's teaching material.

IV. DISCUSSION

Being active only for a couple of years, the course is only beginning to obtain its "shape". Enrolling students have shown a good response, while their grading was realized through seminar papers. The majority of the students, having electrical engineering and computer science background, concentrated on problems such as neural control of motorics, EMG signal processing to study muscle fatigue, EMG-force relationship, prostheses of extremities, and the like. The course should prepare students for more advanced study into physiology of legged locomotion along Margarian and McMahonian lines [6], such as for instance thought at MIT or Johns Hopkins.

V. CONCLUSION

What has been mentioned represents a result of a long term study and research into biomechanical laboratory measurements and analysis of human movement, both healthy and pathological. At present, one can be satisfied with the status of written materials and curricula offered. (In this paper, classical locomotion biomechanics teaching curriculum offered to physical education students for nearly a decade already has been omitted). Laboratory clinical practices requiring substantial financial investments, however, are still underdeveloped. This is, therefore, the focus of our present efforts.

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