IDEA GROUP PUBLISHING **ITB12285**

701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com

This paper appears in the publication, *Computational Intelligence for Movement Sciences: Neural Networks and Other Emerging Techniques* **edited by Rezaul Begg and Marimuthu Palaniswami** © 2006, Idea Group Inc.

Chapter III

Monitoring Human Movement with Body-Fixed Sensors and its Clinical Applications

Kamiar Aminian, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

ABSTRACT

In this chapter, first we outline the advantage of new technologies based on body-fixed sensors and particularly the possibility to perform field measurement, out of a laboratory and during the actual condition of the subject. The relevance of intelligent computing and its potential to enhance those features hidden in biomechanical signals are reviewed. An emphasis is made to show the results produced by these sensors when used alone and new possibilities offered when the information from different type of body fixed sensors are fused. In the second part, the relevance of body fixed sensors in medicine is presented by providing many clinical applications in orthopedics, Parkinson disease, physiology, pain management, and aging. Finally the chapter ends by emphasizing the potential of synergies between body fixed movement monitoring and other areas such as information technology which lead to the development of wearable body movement monitoring.

INTRODUCTION

Human movement analysis is an emerging field, which involves not only medical branches (orthopedics, physiology, neurology and sports), but even more technology and engineering sciences. Many investigators study and analyze human movement and particularly, gait, joint rotations and postural control in order to better understand motor function and describing motion ability alteration in term of health and disease. Standard technology for human motion capture is principally based on camera, magnetic and ultrasound systems which allow a complete 3D kinematics analysis of body segment but requires a dedicated laboratory. Ambulatory monitoring of body movement takes a different approach: collecting data from body-fixed sensors in the natural environment of the subject. It offers long-term monitoring, therefore providing complementary features, related both to the quantity (what activity, how often and for how long) and the quality (how) of the physical activities that are performed. Information provided by a set of complementary mobility-related parameters is essential for the objective assessment of a patient's functional ability.

Capturing human movement based on ambulatory technology is a relatively new field of research since it is directly related to the recent advances in miniature devices and sensors, new technologies for powerful microcontroller, high capacity memory and small power sources. Standard technologies provide body segment position relative to a fixed referential. Other kinematics such as velocity and acceleration are generally computed from the derivative of the positions. In contrast, the outputs of body fixed sensors are rather relative angles, segment acceleration or velocity. Finding 3D segment orientation, absolute angles and complete kinematics are a major difficulty when using body-fixed sensors. In this regard the use of intelligent computing such as bio-inspired algorithms is essential. Moreover, the current state of art in communication systems and wireless transmission has opened new possibilities for telemedicine and remote home care monitoring. Therefore, a new and promising field of research has been opened in gait and posture topics for in-field and outdoor measurement. This way many research questions that can not be elucidated in laboratory setting can now be studied based on these new technologies.

In this chapter, after a short review of standard technology, the advantage of body-fixed sensors and the relevance of intelligent computing for this technology are outlined. The major body-fixed sensors are presented and their uses for human motion capture are reported. An emphasis is made to show the results produced by these sensors when used alone and new possibilities offered when the information from different type of body fixed sensors are fused. Finally, the relevance of body-fixed sensors in medicine is presented by providing clinical applications in orthopedics, Parkinson disease, physiology, pain management, and aging. It is important to notice the potential of synergies between movement analysis based on ambulatory monitoring and other areas, such as nanotechnology, materials sciences, and information technology, which lead to the development of advanced mobile and ubiquitous body movement measurements such as wearable monitoring.