

## Chapter 46

# Analyzing and Tracking the Evolution of Rehabilitation Treatment for Patients with Locomotory Deficiencies

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### ABSTRACT

*The main concern of the work presented in this manuscript was setting up a complex system for the individualized management of mobility recovery for patients with neuromuscular and orthopaedics pathology through interdisciplinary research. Our goal is to aggregate information from multiple hardware devices into a single data acquisition and processing system with direct applicability in the human motility analysis, namely gait analysis. The authors combine high performance image acquisition techniques with the acquisition of clinically interpretable data. The purpose is setting up a complex database (medical, imagistic, biomechanical) and developing conceptual models for interpreting the available data, with direct applicability in choosing the adequate treatment and evaluating its efficiency. Since the authors are dealing with a system with open architecture, another aspect which concerned them was the security of the system. Consequently, they propose combining the conventional smart used for identification with biometric characteristics, namely fingerprints, substantially preventing unauthorised access to the confidential information*

### INTRODUCTION

Although the kinematics analysis of the human body has been performed through a variety of techniques, concepts and analytical methods, at present, there

still is a lack of unity and consistency of these approaches. This lack of consistency, combined with the various kinematics strategies used for modelling the functional activity, leads to a lack of synthesis of the kinematics information for daily activities (walking, running etc.).

DOI: 10.4018/978-1-61520-670-4.ch046

Our main concern was setting up a complex system for the individualized management of mobility recovery for patients with neuromuscular and orthopaedics pathology through interdisciplinary research. Another aspect which concerned us was the security of the system. Consequently, we chose to combine the conventional smart cards used for identification with biometric characteristics, namely fingerprints.

Through interdisciplinary research, pre and post interventional evaluation charts are elaborated, containing biomechanical parameters measured with an information system for kinetics and kinematics analysis of motion. These parameters reflect the functional state of the patient and, based on the medical history of the patient, will evaluate the potential of the subject with regard to the movements which would allow them to be functionally independent. Since it is based on measurement results, the system allows an objective evaluation of the rehabilitation process, thus eliminating the human subjectivity. A biomechanical model is created in order to facilitate the conduct of corrective and rehabilitative interventions. The creation of these models, based on objective data resulted from computerized analysis of the motion, enables the choice of efficient therapeutic interventions and the design of a complex database (medical, imagistic, biomechanical) accessible to a large number of specialists. In order to insure a high degree of security for our system, we use medical cards for patients' identification. On each card, at least 2 fingerprints of the patient are stored. These fingerprints will be further used for authentication.

## **BACKGROUND**

With the development of photography, it became possible to capture image sequences which reveal details of human and animal locomotion that are not noticeable by watching the movement with the naked eye. Eadweard Muybridge and Étienne-

Jules Marey were the pioneers of this idea in the early 1900s. It was photography which first revealed the detailed sequence of the horse "gallop" gait, which is usually mis-represented in paintings made prior to this discovery, for example.

Although research was done much earlier using film cameras, the widespread application of gait analysis to humans with pathological conditions such as cerebral palsy, Parkinson's disease, and neuromuscular disorders, began in the 1970s with the availability of video camera systems which could produce detailed studies of individual patients within realistic cost and time constraints. The development of treatment regimes, often involving orthopaedic surgery, based on gait analysis results, advanced significantly in the 1980s. Many leading orthopaedic hospitals worldwide now have gait labs which are routinely used in large numbers of cases, both to design treatment plans, and for follow-up monitoring.

The forefathers of this research are Murali Kadaba, HK Ramakrishnan, and Mary Wootten. Their main papers, dealing with Euler Angles, led to the development of a marker system. This marker system, referred to as the Helen Hayes Marker System is the predecessor of modern marker systems.

Gait analysis commonly involves the measurement of the movement of the body in space (kinematics) and the forces involved in producing these movements (kinetics) (Whittle, 1992).

Kinematics can be recorded using a variety of systems and methodologies:

1. Photography is the most basic method for the recording to movement and strobe lighting at known frequency has been used in the past to aid in the analysis of gait on single photographic images.
2. Video recordings using footage from single or multiple cameras can be used to measure joint angles and velocities. This method has been aided by the development of analysis software that greatly simplifies the analysis

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