MEASUREMENT OF MECHANICAL POWER OF HUMAN LOCOMOTION IN FREE-LIVING CONDITIONS

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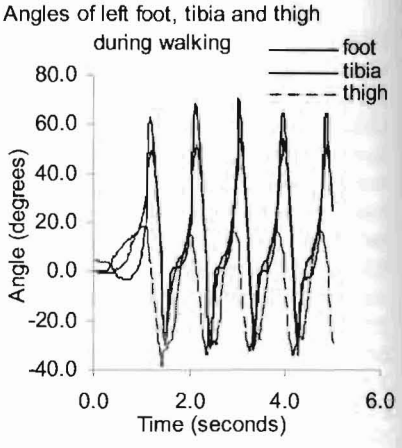
INTRODUCTION: The importance of accurate assessment of human locomotion in free-living conditions is increasingly recognized. Existing methods have significant limitations due to the complexities of motion and the difficulties of measurement techniques. Recent developments in technology have made it feasible now to use kinematical and kinetic analysis in assessing free-living locomotion. In this study, the parameters of each segment motion in outdoor field are recorded and analyzed by an Intelligent Device for Energy Expenditure and Activity (IDEEA) device (Zhang *et al*, 2003 & 2004), and the mechanical power (MP) of each joint is determined by a biomechanical model.

METHODS:
A Customized IDEEA: (MiniSun, CA, USA) consists of a data recorder (57 grams) and 7 sensors (each weighing 1.6 grams). The sensors are highly integrated for measuring angles of ankle, knee and hip joints in sagittal plane and other parameters of motion. Sensors are attached to the thigh, shank and the foot by hypoallergenic tape, and are connected by flexible cables to the recorder clipped to the belt. The recorder communicates with a computer via a USB cable by a Windows-based interface program. After the calibration, the cable is detached, and IDEEA then starts data collection with minimal inhibition of movement.
Modeling: Human body is modeled as seven segments at sagittal plane. The head, arms and trunk are considered as one segment and joints are considered frictionless. Limb angles (θ_i) measured by the device are inputs. Based on angles, angular velocities and angular accelerations, the moment of a joint is derived by using inverse dynamics mechanism (Nagono *et al*, 2000). Then, MP of a joint $P = M$ (the net joint moment) x ω (the joint angular velocity). Angle measurements and MP analysis are evaluated by using a fully equipped three-dimensional data capture system (Motion Analysis Corp., CA, US) in a motion analysis lab.

RESULTS AND DISCUSSION: The figure to right shows the angles of left foot, tibia and thigh measured by the device during walking. The study is still being carried out, but preliminary analysis shows that measurement can be used in sports/performance tests where high precision is required. The approach presented in this study allows for analysis of continuity of free-living locomotion and to understand problems that cannot be identified by other means. Consequently, not only can the MP during a specific interval be calculated, but also the intensity of locomotion of individual limb can be reconstructed moment by moment, which is ideal for monitoring fitness training and a great tool for sports trainers.



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