THREE DIMENSIONAL KINEMATICS AND KINETICS OF THE BODY CENTER OF GRAVITY IN RUNNING

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ABSTRACT

The present study was designed to investigate the methodology of the running kinematics derived from kinetic measurements. From a theoretical point of view, external forces acting on the body center of gravity (C/G) could determine acceleration, velocity, and displacement of C/G. These kinematic parameters of the C/G were mathematically derived from the ground reaction forces recorded by a set of force plates. Integral computing, however, to obtain the velocity and displacement must be carried out with much difficulties because of low frequency errors included in force signals.

The present study was composed of three parts: 1) how to reduce the errors in integration of force signals using either analogue or digital computer system, 2) choice of transducers such as strain gauges or quartz to record the reaction forces in jumping, stepping, knee bending, running and walking, 3) continous recording of the triaxial force acting on the C/G during treadmill running.

1) Low frequency errors was multiplied essentially in the force integration. The DC (Direct Current) component included in the force signals, even if a little, was considerably grown up in both velocity and displacement curves. These errors could be reduced by a mathematical filter in a digital computer system, or by a band-pass analogue filter. In general, the former was more advantageous to obtain on optimal compensation of integral errors than the latter whose usage was limited within relatively prolonged and periodical data.

2) Recently the strain gauge was competent for biomechanical analysis of human motions, as well as the quartz. The primary problem was not the transducer itself but the design of mechanical set-up of it. If the peak value of impulsive reaction force was not necessary and/or if the triaxial measurement was not necessary, the choice of transducers was dependent upon economical problems.

3) A motor-drive treadmill (250 Kg in mass) was fixed upon a set up of two force plates (kistler, 60x40 cm). Head and tail parts of the treadmill were supported by each force plate respectively. The sum of outputs from both plates showed the external force acting upon the C/G, because both plates could detect changes of mass distributions of a system of human body and treadmill. Motion equations of the system showed the acceleration of the body C/G during walk or run on the treadmill, where the C/G of the treadmill was not moved even at work. The velocity and displacement curves of C/G were calculated continuously in each triaxial direction by the digital computer system. The growth of the DC error in integration was approximated by a linear regression line related to time, and then it could be compensated numerically. On the other hand, the force signal was mixed with high frequency noise composed of mechanical vibrations of treadmill and motor at work. However, the high frequency noise did have little effect on the integrations.

The present method had some advantages in biomechanical analysis of running as well as walking.