Abstract

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Gait Prediction

Computer simulation of human gait (walking or running), based on measured motion data, is a well-established research technique for estimating the forces acting on the body's joints and muscles. Conversely, prediction of walking or running motions (known as gait prediction) is a relatively new and challenging area of research, which has not yet found widespread application because of its high computational cost (Anderson and Pandy, 2001).

Gait prediction has many potential applications including the investigation of:

- Motor control objectives in gait;
- The impact of musculoskeletal structure and injury on movement coordination;
- Predicting patient responses to surgical interventions;
- The effect of assistive devices on locomotion performance (e.g. lower limb prostheses).

In gait prediction, the mechanics of human locomotion are described in a mathematical way using Newton-Euler based equations of motion. The coordination of the body's motions by the central nervous system (CNS) is not modelled explicitly. Instead an optimisation approach is used to determine the gait motions that minimise an objective function that is believed to correspond to that of the CNS (e.g. minimise energy consumption).

In this study, a 14-segment (26 DOF) inverse dynamics model of the human body was combined with optimisation techniques to predict walking. To achieve this, walking is formulated as an optimal motor task, subject to multiple constraints, with minimisation of mechanical energy consumption being the performance criterion. Fourier series are used to represent the joint motions which determine the kinematic gait pattern. The Fourier coefficients are the optimisation variables that are adjusted to minimise energy consumption.