A Human Motion Simulation Method for Satisfying Obstacle Avoidance Constraints

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Although various models exist for simulating human motions, many of them do not address the obstacle avoidance problem. The models considering obstacle avoidance as one of several constraints to be satisfied are generally time consuming (> few minutes).

This study presents a motion assimilation method developed to predict representative human motions in the presence of obstacles within a reasonable computation time. In a way similar to the previously developed angle-time based motion modification method (Park et al., 2000), the motion assimilation method is inspired by generalized motor program theory (Schmidt et al., 1976) and utilizes exiting motion samples, called "root motions", to synthesize new motions.

The motion assimilation process consists of three steps: 1) Given the environment geometry, the kinematic model of the human figure, and the task description, generate arbitrary initial and final postures satisfying obstacle avoidance constraints; 2) Given the initial and final postures, generate an arbitrary motion that satisfies obstacle avoidance constraints. Note: The generated motion does not have to be human-like or smooth; 3) "Humanize" this initial motion by assimilation to a “root” motion selected from a motion database. The assimilation involves maximizing similarities between initial and root motions (e.g. Euclidean distance between the angular velocity profiles of initial and root motions), while satisfying all constraints.

It is shown that Step 1 and 2 can be achieved through the use of key frame interpolation methods, such as motion warping (Witkin and Popovic, 1995), since the generated motion does not have to be representative of normal human motions. An efficient optimization method has been developed for Step 3 to assure the latter.

The performance of the motion assimilation method is being evaluated based on experimentally recorded human lifting motions. Combined with a motion database, the assimilation method is expected to provide an efficient method of human motion simulation, and thus facilitate computerized design and ergonomic evaluations when motions are required around obstacles.

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