Coordinating Full-Body Interactions with the Environment

Alain Juarez-Perez
University of California, Merced

Marcelo Kallmann
University of California, Merced

ABSTRACT

We present a methodology for synthesizing coordinated full-body motions in order to achieve autonomous virtual characters capable of interacting with the environment while walking. Starting with a parameterized walking controller and a set of mocap examples our method is then able to coordinate upper-body interactions with the walking controller in order to achieve full-body object interactions in generalized situations.

CCS CONCEPTS

• **Computing methodologies** → *Procedural animation*;

KEYWORDS

Full-Body Character Animation, Coordination Learning

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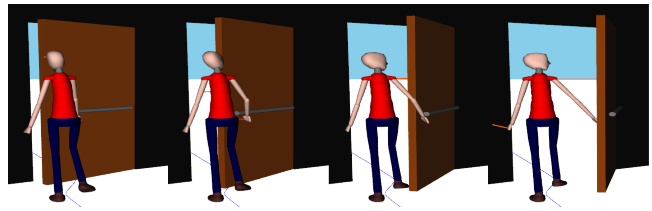

1 INTRODUCTION

Our approach is based on learning spatial coordination features from input example motions. Our features use the concept of tracking body-environment proximity in example interactions and associating the information to the states of the action. The states then become the input to a regression system that is able to generate new interactions for different situations in similar environments. The regression model is capable of encoding and re-using key spatial strategies with respect to body coordination and management of environment constraints. As a result we obtain an interactive controller able to synthesize coordinated full-body motions for a variety of complex interactions, such as opening doors.

2 METHOD

The system analyzes a set of features and its respective pose descriptors in order to generate a regression method which is applied to control a virtual character during complex interactions.

2.1 Features

To compute the features we first select the body sections of interest for a given interaction. In the presented example we use the torso, the left arm, and the right arm. The features mostly consist of the vector of minimum distance between each of our sections of interest and the environment. In the figure the feature vectors are shown as red lines connecting the character with the environment. Relying on such feature vectors instead of only joint angle values allows us to encode adaptation to the environment, proximity during interactions, and collision avoidance behavior, which represent needed information for our problems of interest. We compute a set of features for each of the poses in the given example motion capture file.

2.2 Regression

Our goal is a system capable of performing learned actions in new situations. The locomotion is independently controlled following computed trajectories. During synthesis new features with respect to the current environment are computed and the regression model returns target poses for the body sections to best adapt to the environment. We optimize the upper-body to reach the predicted poses and targets, allowing us to achieve upper-body motions successfully accomplishing the given interaction.

The current feature vector **Y** will most likely lie outside of our example motions, however we have observed that the structure of the example actions and the continuity of the motion lead to an interesting space capable of generating smooth interpolations among the example data. The regression is performed by searching the k-nearest feature vectors to **Y** and determining the respective weights based on proximity. We can then generate the interpolated target upper-body pose to use in the motion synthesis.

2.3 Synthesis

To test our system we have captured examples of opening door motions. The locomotion synthesis is generated by following a path passing through the door. The locomotion is not aware of the interaction with the door or of the need to slow down at the moment of opening the door. Our system then collects feature vectors while controlling the walking, and as the character approaches the door from different angles, the regression model returns velocity adjustments and upper-body pose targets suggesting arm, spine, and head rotations to be employed. With this information we optimize the current pose in order to reach the suggested targets. This procedure achieves poses correctly reacting to the environment and leading to successful environment interactions.

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In the presented image it is possible to observe some of the synthesized frames of the proposed method. The upper-body configuration and the speed of the locomotion are automatically controlled and generate a successful interaction. We are currently extending and experimenting our methods to additional actions and scenarios.