Generating 3D Interactive Behaviours

Y. Zheng*, Y. Hicks*, D. Cosker†, D. Marshal† and J. Chambers*

*School of Engineering, Cardiff University, UK, E-mail: {zhengy, hicksya, Chambersj}@cf.ac.uk
†School of Computer Science, Cardiff University, UK, E-mail: {D.P.Cosker, dave.marshall}@cs.cf.ac.uk

Keywords: Hidden Markov Model, Virtual Character, Generating Behaviours.

Abstract

In this paper, we present a novel approach for generating a variety of complex behaviours. Our approach is model-based. We train a dual Hidden Markov Model (HMM) on 3D motion capture (MoCap) data representing a number of interactions between two people. Then we track 3D motion of a person in ordinary 2D video. Finally, using the dual HMM and the Viterbi algorithm, we generate a moving "virtual friend" reacting to the given motion of tracked person.

1 Introduction

In recent years, there has been a large amount of research in producing virtual worlds and populating them with virtual characters. For example, in computer vision area, Johnson et al. [3] developed a system capable of producing a 2D silhouette of a virtual person interacting with a real person in video and demonstrated it working with a handshake behaviour. In this paper, we describe a novel approach for generating interactive behaviours for fully articulated 3D virtual characters on the basis of visual analysis of the motion of a real person in video.

2 3D Human Body Tracking in a Video

To track fully articulated 3D motion of a person in video in a single camera view, we train an HMM on MoCap data of one person. Such data is always constrained by physical and dynamical factors, thus we reduce its dimensionality using Principal Component Analysis (PCA) prior to training an HMM. Then we track 3D pose of a person in 2D video as follows. We preprocess the video sequence by subtracting background and thus obtain a sequence of binary images. After that, we use annealed particle filtering [2] together with HMM trained in the previous stage to estimate 3D poses of the tracked person in the video.

3 Generating Interactive Behaviours

To generate intelligent behaviours for a "virtual friend", we train a dual HMM [1] on the 3D MoCap data of two real people. It is capable of representing several types of interactive behaviours, such as shaking hands. A dual HMM has two sets of states, but only one transition matrix. The first set of states models the poses for the first person, the second set of states models the poses for the second person. Each state in the model is represented with a Gaussian. Using this dual HMM, we can estimate a sequence of 3D poses for a virtual character given a sequence of 3D poses of the tracked person. Given as input a sequence of poses for the tracked person, we generate a corresponding sequence of poses for the "virtual friend" in the following way. We estimate a corresponding sequence of states in our dual HMM using the Viterbi algorithm, and as a result obtain a sequence of appropriate poses for the "virtual friend". After that, we smooth the generated behaviour using a weighted averaging filter.

4 Experiments and Conclusions

We conducted three separate experiments, each time with a different type of motion: two people shaking hands, one person pulling another person and one person pushing another person. We asked 10 independent observers to evaluate how convincing the generated motions are. Five out of ten commented on the motion of the generated character for the shaking hands behaviour who seemed to float, a common problem with generated behaviours. However, three out of ten people also commented on the motion of the real person during the pushing behaviour, who seemed to them wobbly. Also one observer out of ten commented that during the pushing behaviour with a generated character one person did not touch another. From these results, we conclude that the generated behaviours look very similar to the real behaviours.

Figure 1. Interactions with a virtual character (handshake)

References

[1] D. Cosker, D. Marshall, P. L. Rosin and Y. Hicks. "Speech driven facial animation using a hidden markov coarticulation model", *IEEE ICPR*, **pp**. 314-321, (2004).

[2] J. Deutscher, A. Blake and I. Reid. "Articulated body motion capture by annealed particle filtering", *IEEE CVPR Proceedings*, volume 2, **pp**. 126-133, (2000).

[3] N. Johnson, A. Galata and D. Hogg. "The acquisition and use of interaction behaviour model", *IEEE CVPR Proceedings*, **pp**. 866-871, (1998).