



# **Virtual Humans: Behaviors and Physics, Acting, and Reacting**

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# Virtual Humans for Animation, Ergonomics, and Simulation

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## Abstract

The last few years have seen great maturation in the computation speed and control methods needed to portray 3D virtual humans suitable for real interactive applications. We first describe the state of the art, then focus on the particular approach taken at the University of Pennsylvania with the *Jack* system. Various aspects of real-time virtual humans are considered, such as appearance and motion, interactive control, autonomous action, gesture, attention, locomotion, and multiple individuals. The underlying architecture consists of a sense-control-act structure that permits reactive behaviors to be locally adaptive to the environment, and a PaT-Net parallel finite-state machine controller that can be used to drive virtual humans through complex tasks. We then argue for a deep connection between language and animation and describe current efforts in linking them through two systems: the *Jack Presenter* and the *Jack-MOO* extension to lambdaMOO. Finally, we describe the initial draft of a *Parameterized Action Representation* for mediating between language instructions and animated actions.

## 1 Virtual Humans

Only fifty years ago, computers were barely able to compute useful mathematical functions. Twenty-five years ago, enthusiastic computer researchers were predicting that all sorts of human tasks from game-playing to automatic robots that travel and communicate with us would be in our future. Today's truth lies somewhere in-between. We have balanced our expectations of complete machine autonomy with a more rational view that machines should assist people to accomplish meaningful,