Animation 2000++

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In the next millennium, computer animation will be both the same as now and also very different. Animators will always have tools that allow specifying and controlling—through manual interactive interfaces—every nuance of shape, movement, and parameter settings. But whether for skilled animators or novices, the future of animation will present a fantastically expanded palette of possibilities: techniques, resources, and libraries for creating and controlling movements.

Animations will be created for a wide variety of applications because usable tools will be available and the expertise to apply them will become more widespread among the new generation of Web-, plug-in-, and graphics-savvy computer users. Besides the present applications of animation in special effects, games, short movies, and advertising, economically viable applications should explode in education, job training (beyond military simulations), and medicine. Animation will be a commodity medium for communicating process visualizations, paralleling textual materials for communicating ideas. Moreover, such knowledge-intensive animations will increasingly be produced with and by domain experts rather than just by specially trained and skilled animators.

Most animation is constructed through an iterative process of creation and refinement. Though the techniques vary, animations can be blocked out and refined, parameters varied until the right look is achieved, and objects and characters adjusted until they appear to interact in visual or 3D space. New tools and techniques available to the animator will enhance all aspects of this process, whether the final product is offline special effects, interactive games, or online virtual worlds.

Motion capture

Motion capture will continue to be an important source of natural movement. But new sensing techniques will free us from the encumbrances of the sensing equipment and the limitations of the studio. Computer vision techniques already on the horizon will capture both shape and movement information of people and animals. Even more exciting is the prospect of using a single handheld digital camera to capture live performance. In my talk at the first Virtual Humans conference in 1996 I predicted that within five years computer vision techniques would be viable for unencumbered and unmarked human motion capture. This is still on target for the millennium, in large part due to faster computer speeds suitable for vision algorithms but also because of model-based techniques that generally understand what they are looking for.[1]

Animators frequently act out their characters' actions to understand how they might move and behave.[2] These self-generated inputs will be captured (again, probably by computer vision rather than direct sensing contrivances) and entered into the animation package. Although these movements will still need editing, the initial encoding step may benefit the subsequent motion refinement process.

Natural language

Animation systems will understand the natural language of motion concepts. We will be able to talk to our characters to instruct or modify their actions. They will basically understand stage directions and the action modifiers that we use in conversing with other people. Directors today might show their actors how a scene might be played, but they also use words. An animator may manipulate her characters directly, but may also wish to outline actions, modify existing movements, or describe rules of behavior, emotional state, or reactions to situations.[3] A truly digital actor needs more intelligence than just instruction understanding, but following stage directions will start to break down the interface barrier between animators and the virtual beings they create.

Natural movements

By studying actual human movements we will have a better understanding of what makes natural-looking movements and how movements vary across individuals. Parameterized motions will allow interactive manipulation of expressive gestures across the whole body. Software will be able to generate automatically plausible human performances based on the emotions, culture, personality, and situation of the character. Parameterized walking, reaching, and facial expression systems are a start, but more biomechanical accuracy will be needed to effectively mimic even these human attributes.

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Evolving systems

Animation systems today appear to be a collection of tools or plug-ins within a common software interface framework. Surely animation systems will continue to expand plug-in variety and efficacy. Plug-ins primarily encapsulate the movement semantics of some class of objects, such as cloth, particles, liquids, or faces. They will evolve into a parameterized action library for animation—that is, such modules will generate behaviors on demand subject to input conditions and current constraints.[3,4] Animators now choose appropriate plug-ins and determine their parameters. Eventually artificial intelligence (AI) representations will at least assist in this process. The plug-in interactive system will grow into libraries of parameterized "self-knowledgeable" objects, characters, natural phenomena, and their respective behaviors.

Of course, with such representational complexity, interactions between entities will be both welcome and significant. Instead of leaving such interactions to the skill of the animator, the smart entities will understand the context of the scene they are being recruited for and can propose or adjust their behaviors accordingly. This might be called applied AI, but I think it's a role for representations not yet realized in that community.[5] Moreover, with so many tools, objects, and players, intelligent entity management systems will be developed.[6] The animator may choose to be relieved from manipulating the lowest level of detail only to become instead a knowledge engineer. Database exchange is a minor problem compared to functional model integration. Nonetheless, representational tools will emerge to support model exchange precisely because it should benefit developers as well as animators to have reusable components working within a community of intelligently interacting modules.

Other resources will become available to animators from outside the traditional graphics sources. Physics simulations will be based on increasingly complex physics models, as faster computers reduce the number of simplifying assumptions. Supercomputer codes for physical process simulations will be repackaged as plug-ins (or smart objects) and run fast enough on animator workstations.

Digital clones

We will learn how to make digital copies of specific individuals—not only their shapes but their mannerisms and behaviors. Digital clones won't just look like realistic people; they will have their personalities, reactions, and emotions. Input methods based on speech and text analysis, personality profiles, video imagery, and live interviews will be developed to aid in the capture of these aspects of the whole person. The legal and ethical questions of this topic may weigh far heavier than the technology issues.[7]

Just as animation tools will grow to cover an increasingly large space of phenomena, large-scale libraries of movements, behaviors, and personalities will appear. We will see digital libraries of animated objects, systems, and people doing things that are parameterized and reusable in novel contexts. We will have perpetual animated albums of celebrities, loved ones, and even pets, long after they have left us. We will see physiological models of people that go far beyond the static Visible Human, in libraries containing functioning models of organ systems and anatomy that serve medical and clinical applications as well as animation.

Interactive agents and avatars. (Courtesy of the students and staff at the Center for Human Modeling and Simulation, University of Pennsylvania.)[3]

Closing thoughts

The next two decades will be an exciting time for animation. We will see the maturation of computer vision shape and motion input tools, the development and assimilation of AI techniques for behaviors and character interactions, the evolution of large-scale smart entities from the plug-in systems of today, and the dramatic expansion of off-the-shelf parameterized animation libraries. Animators may still want to shift vertices, edit timing curves, and handcraft custom motions, but they will have a rich world of external resources available to create, manage, modify, and control animated worlds if they are so inclined. ■

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