Interactive Layered Character Animation in Immersive Virtual Environments

Mykhaylo Kostandov* Radu Jianu* Wenjin Zhou* Tomer Moscovich*
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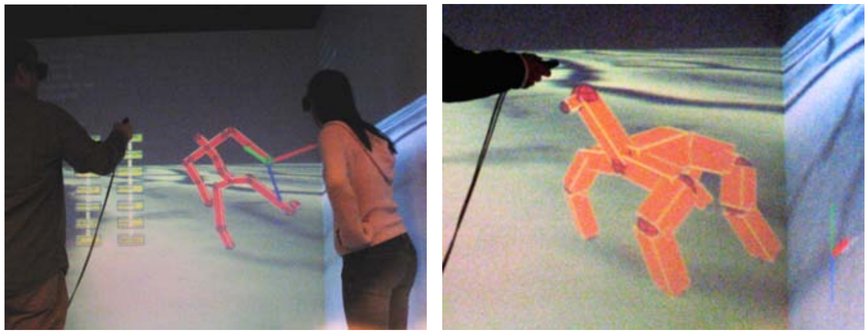

We present a novel method for creating 3D animations by letting users act directly on 3D characters in a virtual reality Cave [Cruz-Neira et al. 1993] environment. Our system records the performance of the animator as she manipulates the character's joints and limbs using 3D trackers. By making multiple passes, animators can layer simple motions to create more complex animations. For example, an animator may first record a character's arm motion, and later the movement of its head. We believe our approach bridges the gap between animators and the characters they bring to life by making animators an integral part of the virtual world inhabited by their characters.

Methods Our approach relies on physically simulated character models, which behave as puppets or armatures. Using 3D trackers, animators pick and move body control points along trajectories in space. As these points move, the rest of the character's body responds in a physically realistic manner. To produce more complex animations, our system allows animators to compose multiple layers layers of animation in a manner similar to to that presented by Dontcheva et al. [Dontcheva et al. 2003]. The animator controls a different constraint in each layer of animation, recording it while the previous layers are played back. During playback our system simulates the character response to all recorded constraints.

We rely on the Open Dynamics Engine [Smith] to solve our physics-based kinematics. Consequently, our skeletons are modeled as joint-and-body constructs that behave in a physically correct manner. One issue we had to address is that the lack of physical feedback from the character allows the users to attempt illegal operations, such as stretching a limb beyond its reach. To avoid this scenario, we allow the control point to deviate from the user defined trajectory if there is no physically correct solution to the motion. This approach also allows us to add together conflicting layers of animation, since the ODE constraint solver will interpolate to find the solution that best describes all layers.

Discussion This work presents a prototype interface for creating complex character animations which does not require extensive animation experience. Instead, our system relies on the animator's natural sense of timing and acting abilities. Since our technique runs the physical simulation during recording, the user always has a clear view of what the end result will look like. One drawback of our layering technique is that synchronizing complex motions becomes increasingly difficult as additional layers are recorded. Since the animator requires time to react to the motion of existing layers, the current layer may be slightly delayed. To address this problem, we plan on displaying a series of semi-transparent preview frames of the expected motion, so that the user can foresee the upcoming positions of the character's body.

Although we have only tested our system using a single tracking device, we expect a multi-tracker, and possibly multi-user, setup to be much more efficient in expressing complex motion that would be hard to achieve with layering alone. We hope to experiment with this idea in the future.

Perhaps the most desirable side-effect of using a physics based approach is that we can easily create "virtual marionettes" by instrumenting our models with physically simulated controls attached to the body with a series of jointed segments (see Figure 1). The advantage of virtual puppeteering is that after creating the base motion using the marionette control, the puppeteer can adjust aspects of the motion by layering additional constraints.

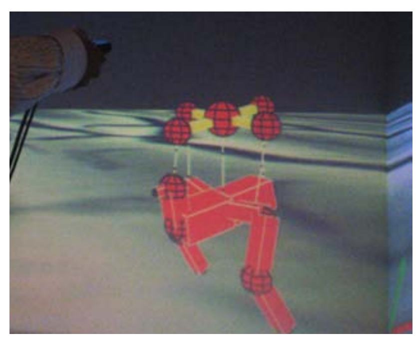

Figure 1: A user interacting with a virtual marionette in the Cave.

CRUZ-NEIRA, C., SANDIN, D. J., AND DEFANTI, T. A. 1993. Surround-screen projection-based virtual reality: The design and implementation of the cave. In *Proceedings of ACM SIGGRAPH*, vol. 27, ACM, 135–142.

DONTCHEVA, M., YNGVE, G., AND POPOVIĆ, Z. 2003. Layered acting for character animation. *ACM Trans. Graph. 22*, 3, 409–416.

SMITH, R. Open Dynamics Engine. `http://www.ode.org`.

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Introduction

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Methods

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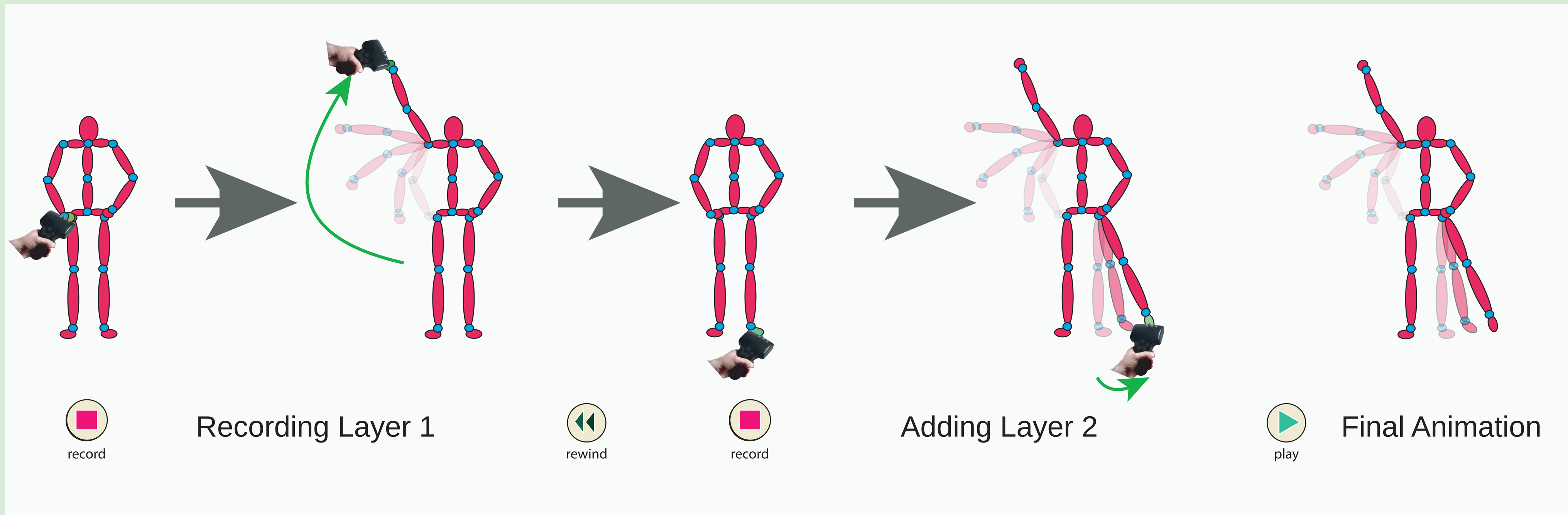
To produce more complex animations, our system allows animators to compose multiple layers layers of animation in a manner similar to to that presented by Dontcheva et al. The animator controls a different constraint in each layer of animation, recording it while the previous layers are played back. During playback our system simulates the character response to all recorded constraints.



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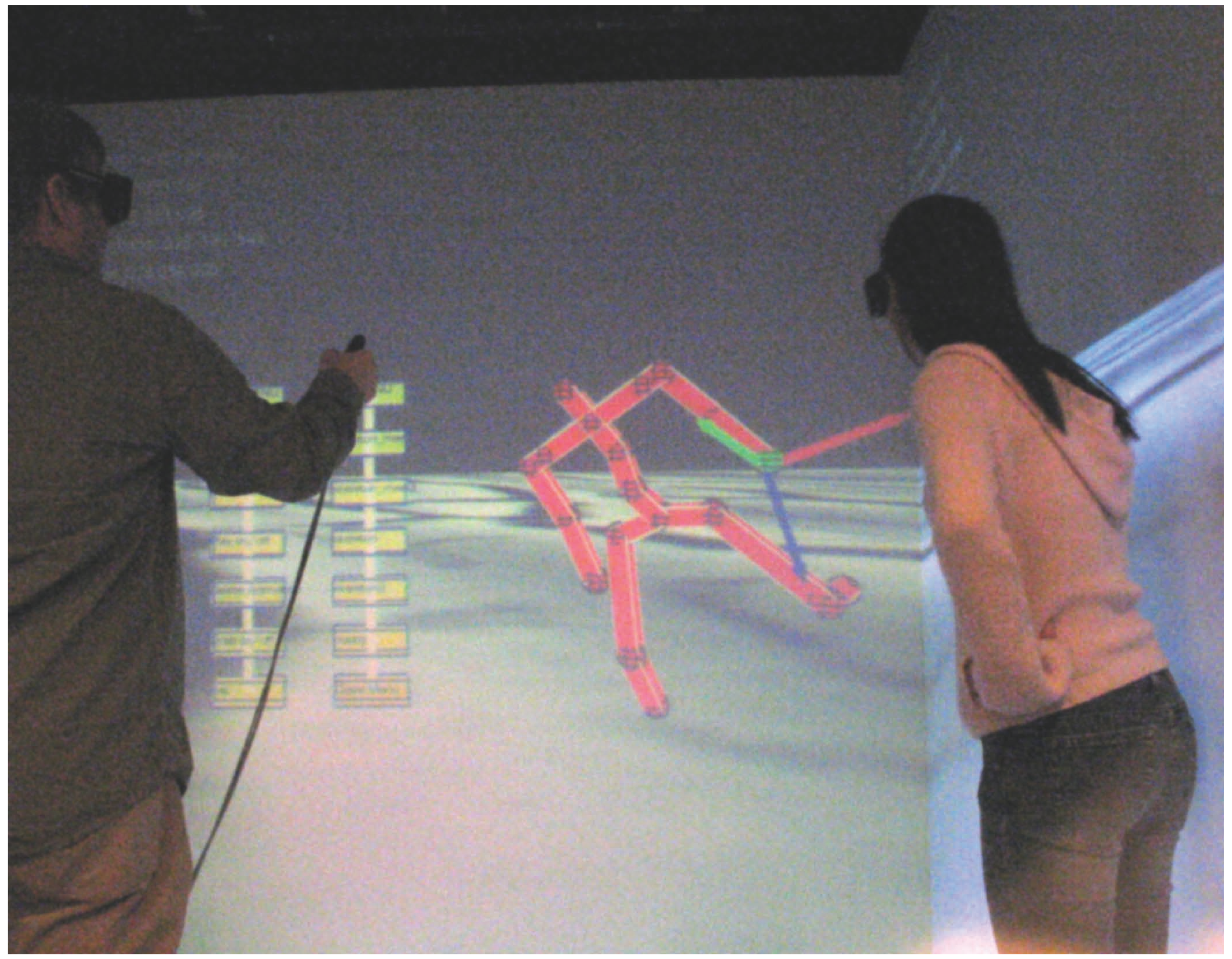

Discussion

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References:
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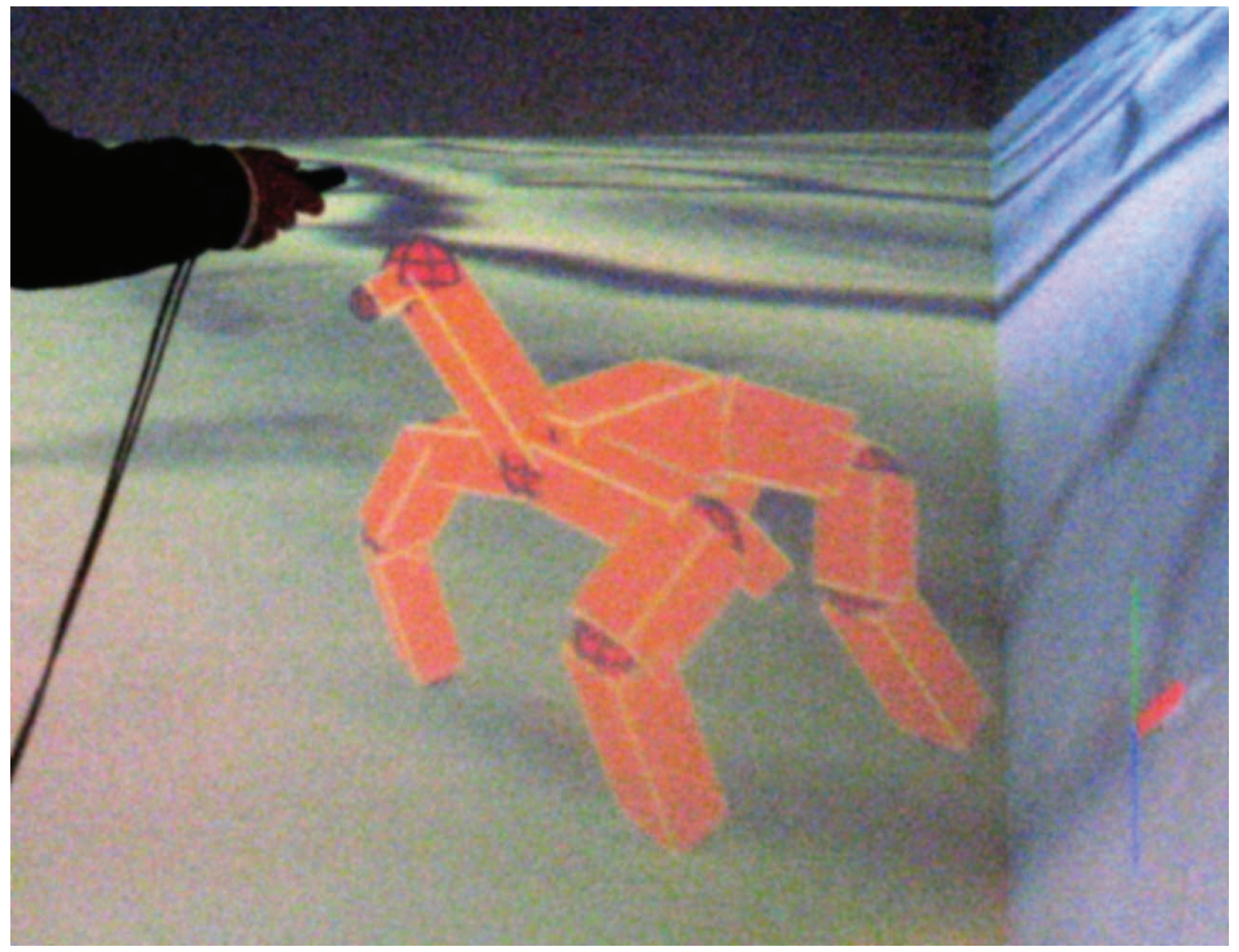
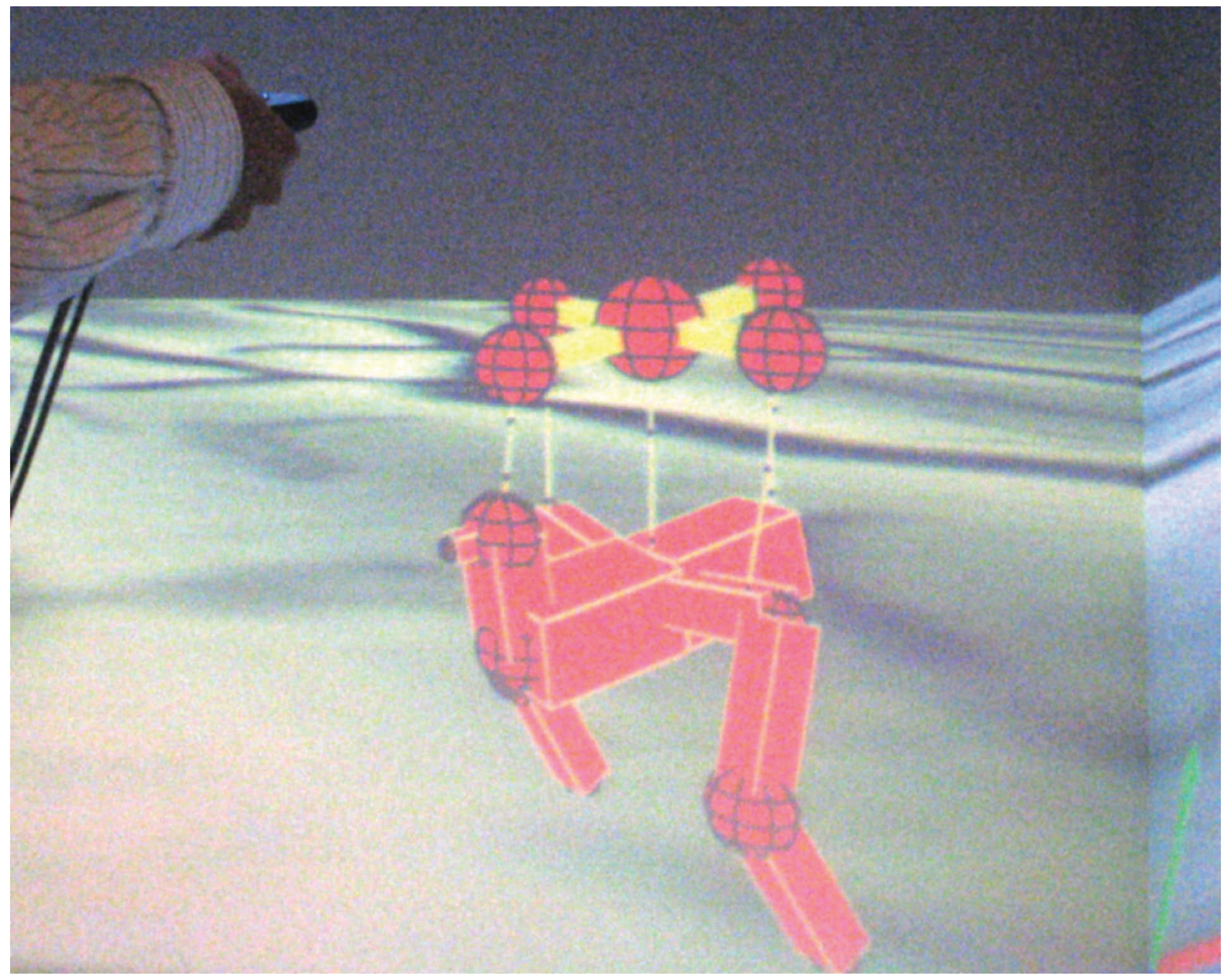


Perhaps the most desirable side-effect of using a physics based approach is that we can easily create "virtual marionettes" such as the one shown below. The advantage of virtual puppeteering is that after creating the base motion using the marionette control, the puppeteer can adjust aspects of the motion by layering additional constraints.



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