

Interactive, Real-time Animation of Human Locomotion

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Traditional keyframing supports the human animation process at a low, (joint-angle) level where an animator has to painstakingly specify many degrees of freedom over time in order to obtain a desired motion. It is very tedious and requires great skills to produce realistic and believable motion in this way. By incorporating knowledge about how real humans move directly into the control algorithms, certain motions can be animated more convincingly, autonomously and efficiently. We have successfully developed such algorithms level for human walking [1] and running [2].

The locomotion algorithm incorporates knowledge of how humans walk or run at several levels: *empirical* knowledge defines the relationship between locomotion parameters; for example, a change in locomotion velocity by the user triggers a change in step length to maintain a "natural" locomotion stride. *Physical* knowledge calculates the trajectory of the body during a step. Knowledge about limb-coordination of a locomotion stride is utilized for establishing both, *state-constraints* which define the single support, double support and flight states, and *phase-constraints* to "guide" the internal joint-angle interpolation for the stance and swing phases.

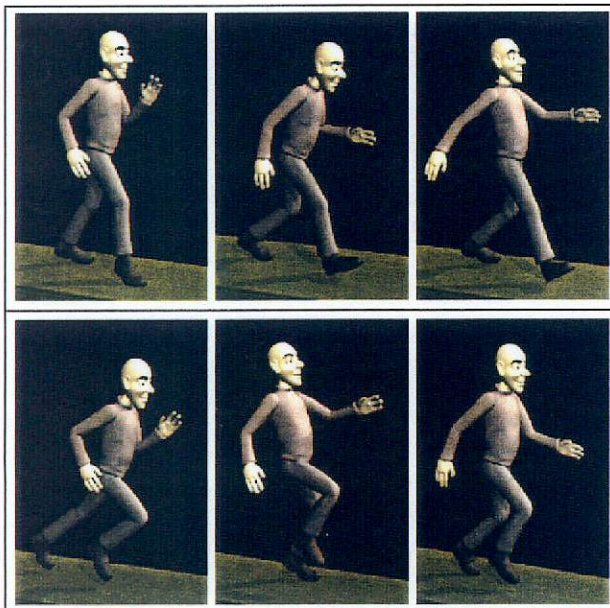


Figure 1: Snapshots of various sample walks (top) and runs (bottom).

A wide variety of convincing locomotion styles can be generated this way in real-time by the user (Figure 1) while interactively setting the values of high-level parameters such as desired velocity, step length, torso bend, pelvic rotation or bounciness. These parameters are changed via sliders while observing a locomotion figure on the screen (see Figure 2). The immediate feedback lends itself well to customizing walks or runs of particular style or personality as well as to interactively controlling locomotion figures in virtual applications. As opposed to other high level motion control schemes, the animator or user maintains the creative control over the outcome.

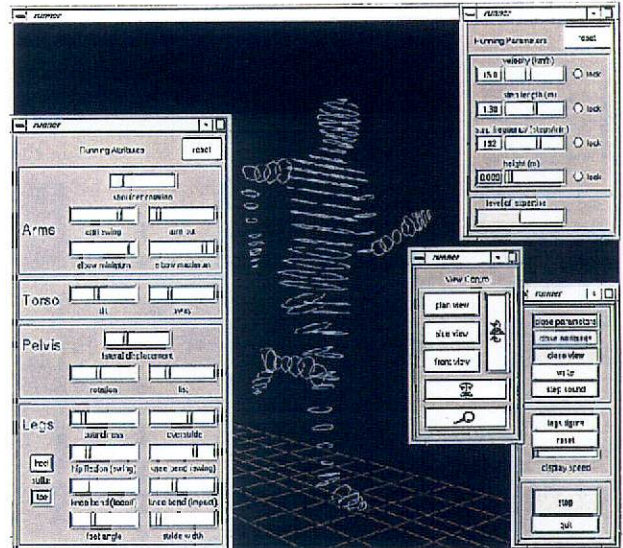


Figure 2: Locomotion program interface.

Note: The accompanying video tape shows an animation entitled "Runs" (approx. 1.5 minutes), which tells a short story about "people in locomotion"; all the walking and running sequences were not key-framed or motion-captured, but generated by our interactive, real-time locomotion system. The data were then imported into Softimage which we used for all the modeling, facial animation, fine-tuning and rendering. This way, it was very easy, for instance, to produce several figures all running at the same velocity but with different styles, or to generate various runs at the same beat to match the sound of the foot steps. Thanks to Michaela Zabranska for modeling and directing the animation short, and to ATR MIC for their support.

References

- [1] Armin Bruderlin and Tom Calvert, "Interactive animation of personalized human locomotion", in *Graphics Interface '93, Proceedings*, May 1993, pp. 17-23.
- [2] Armin Bruderlin and Tom Calvert, "Knowledge-driven, interactive animation of human running", in *Graphics Interface '96, Proceedings*, May 1996, pp. 213-221.