Implementing a 3D Procedurally Animated Walking System

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Motivation

Many contemporary video games feature complex environments that player- and computer-controlled actors must navigate through as a component of gameplay. The increased graphical capabilities of modern computers have facilitated the simulation of more complex virtual environments; as such, there has arisen a greater need for animation systems that allow actors to traverse complex environmental features in a visually appealing manner. In many cases, the primary goal is to ensure that all locomotive limbs of the model are appropriately seated on a solid surface while moving.

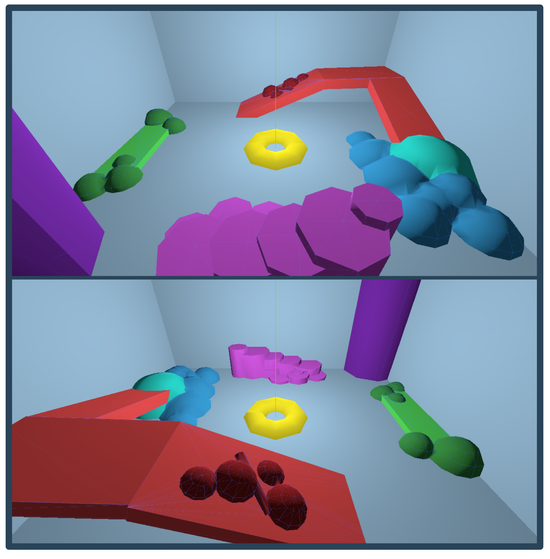


Figure 1: A 3D environment with complex features in the *Godot* game engine. The terrain seen here has been constructed out of groups of primitive shapes using a technique called "*constructive solid geometry*".

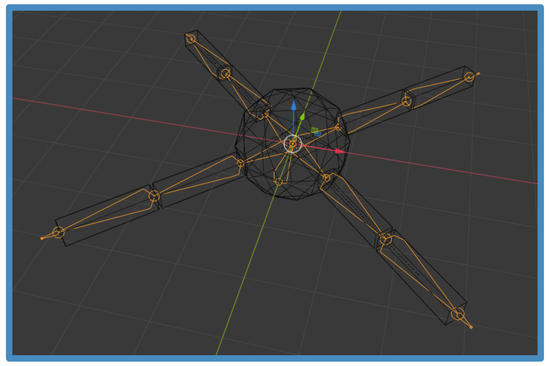


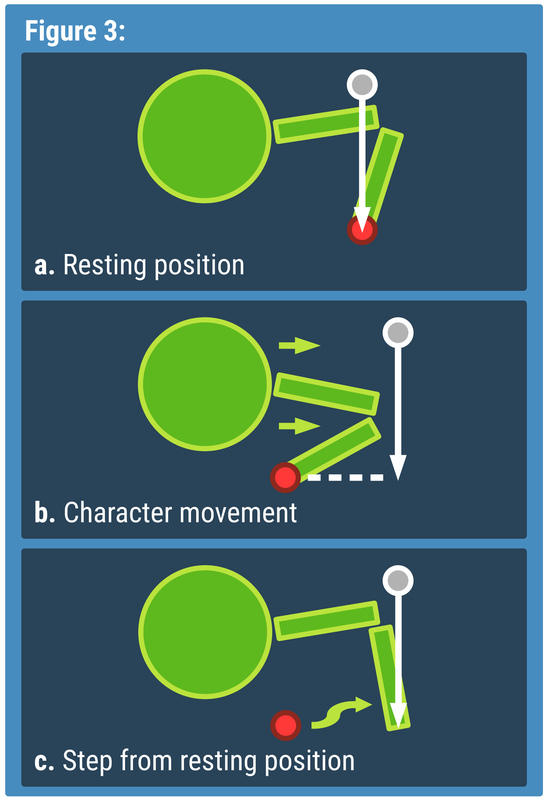
Figure 2: An example of a simple character model that has been rigged in *Blender* with a quadrupedal armature.

Methodology

When the rigged character model (*Fig. 2*) is imported into the project, a reference resting point is designated for the tip of each locomotive limb. When the simulation starts, a ray casting node is created for each limb and moved so that it is above the limb's resting point, facing downward. (*Fig. 3a*) The ray casting nodes are moved one step's length out along the character's current movement vector. (*Fig. 3b*) The model's limbs are sorted into staggered groups that are each given turns to take their step in time. A step is taken whenever the following conditions are satisfied:

- A minimum distance requirement between the limb's current location and target location is met
- The limb's group has its turn to step
- The limb's ray casting node has detected a solid surface to step on

The intermediate bones of the limb are then animated using the game engine's in-built *Inverse Kinematics* implementation. (*Fig. 3c*)



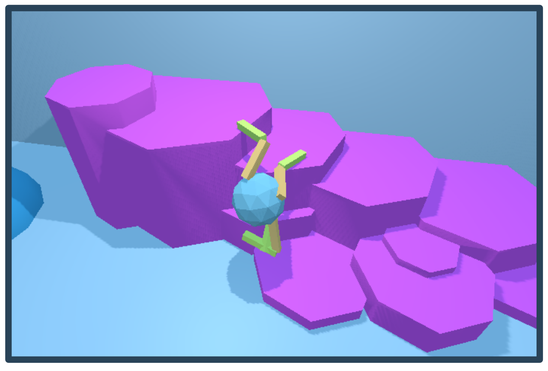


Figure 4: A quadrupedal character model is converted to a ragdoll and falls off of an environmental feature after failing to find sufficient footing.

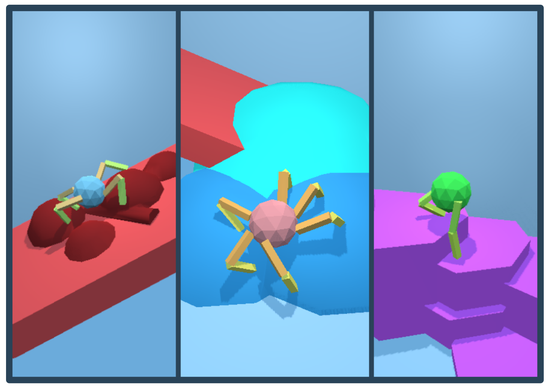


Figure 5: Character models with varying numbers of legs traversing complex environmental features. The locomotive limbs of each model have been procedurally animated and posed using the technique described in the "*Methodology*" section.

Findings

In creating a simple ground detection rig and applying a series of constraints to an animation system, a character model with any number of legs can be procedurally animated to traverse a complex environment in a visually appealing manner. The system can be additionally enhanced with extra features after minimal manipulation: ragdoll physics can be enabled on the character model when sufficient footing is not detecting, simulating the player falling over uneven terrain or off of ledges. (*Fig. 4*)

Source Code: gitlab.com/jessieh/procedural-walking-demo

blender®

GODOT Game engine

Millersville University