Acting like a Turtle: A NetLogo Kinect Extension

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Abstract

The Microsoft Kinect 3-d camera offers new and exciting possibilities for constructionist learning. This Constructionist Media Demonstration presents a NetLogo extension that enables learners to use the Kinect as an input device to NetLogo models. We have so far constructed three learning experiences, designed using NetLogo and the Kinect. At the end of this paper, we discuss some theoretical implications for using Natural Interfaces for constructionist learning and discuss the challenges that it poses to us as designers of constructionist learning environments.

Keywords

NetLogo, agent based modelling, constructionism, kinect, embodied learning

Introduction

NetLogo (Wilensky, 1999) is an agent-based modelling language with a long history of facilitating constructionist learning in sciences (e.g. Levy & Wilensky, 2009; Sengupta & Wilensky, 2009; Wilensky, 2003; Wilensky & Reisman, 2006). The NetLogo Extensions API, first released in 2004, allows users to expand on the NetLogo programming language by coding new NetLogo primitives and data structures in Java, sometimes introducing new technologies as in- or output to NetLogo models. An example of the latter is Blikstein and Wilensky's (2007) work on bifocal modelling, in which they used the NetLogo Extensions API to connect GoGo Boards (Sipitakiat, Blikstein, & Cavallo, 2004) to NetLogo models. The purpose of this short paper is to demonstrate how we used the NetLogo Extensions API to combine the Kinect and NetLogo, and to provide a few examples of what we think are fun and interesting possibilities for learning and expression using this powerful new technology.

Model 1: Stop thinking like a turtle and act like one!

When working with kids and geometry, Papert (1982) encouraged his learners to "think like a turtle" and use the Turtle as a transitional object. Eisenberg (2003) later argued that it is in fact the turtle-plus-language system that constitutes the transitional object. With the Kinect, we expand on this view to a 'turtle-plus-language-plus-body system'. This NetLogo/Kinect model builds on Papert's body syntonic approach by letting users draw shapes using their bodies, and saving them in NetLogo. A 'drawing turtle' is first created, and the learner can raise their arm to ask the turtle to start recording what they do. The learner can then walk around the room in the shape they wish to draw, while NetLogo records their movement. Finally, the learner can raise their arm to ask the turtle to stop recording, give their new shape a name, and save it (See Figure 1).

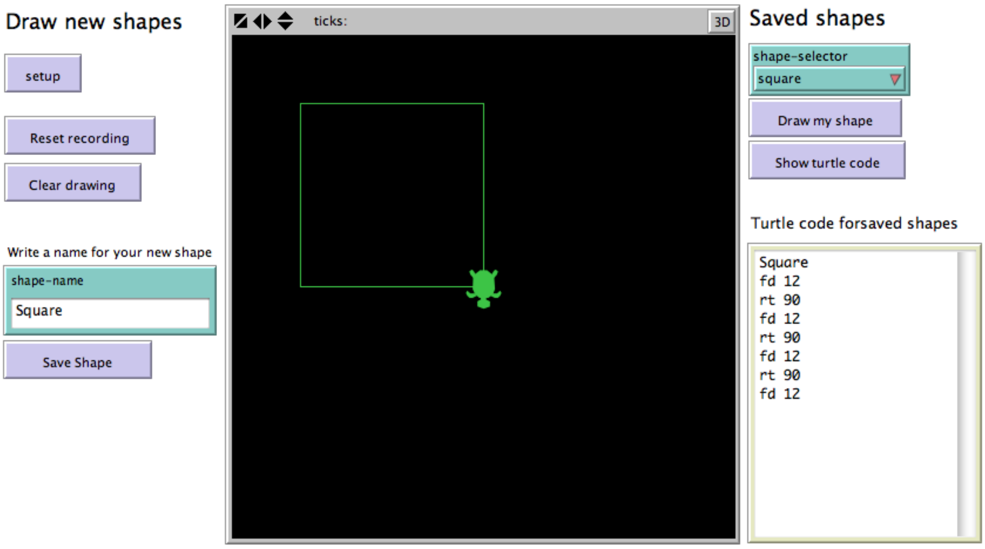

Figure 1. Kinect Turtle Geometry: Interface

Learners can now ask the turtle to draw the shape they moved in, or they can ask the turtle to show the NetLogo turtle code for this movement. Learners can construct a collection of shape-turtles that each "remember" the shape in which the learner moved. Classic Logo shapes such as a circle or a square can thus be bodily constructed; and later combined into more complex structures.

By allowing learners to shift between multiple representations of movement, shapes, and geometry; by using their bodies to 'write' turtle code that they can later work with *as* code; and ultimately to both *think* and *act* as turtles, it is our hope that leaners can construct more embodied understandings of geometry.

Model 2: To flock or not to flock

Complex Systems theorists (Johnson, 2001; Wilensky, 2001) have argued that some of nature's complex patterns arise out of interactions between simple behaviours of individual agents. One of our favourite models illustrating this principle is the NetLogo *Flocking* model (Wilensky 1998). However, while the surprising and beautiful patterns that emerge from these simple interactions demonstrate the power of multi-agent modelling. However, using the model, learners can explore a range of patterns and experiment with variations of the generating rules, but they are not able to participate bodily in the formation, breaking, and sustaining of these patterns.

We extended the 3-D version of the NetLogo model *Flocking* (See figure 2). By allowing a user to steer one bird with their body (See Figure 3), learners can now not only modify and change the behaviour of the individual birds, but also experience how their steering of one bird can interact with the system as a whole.

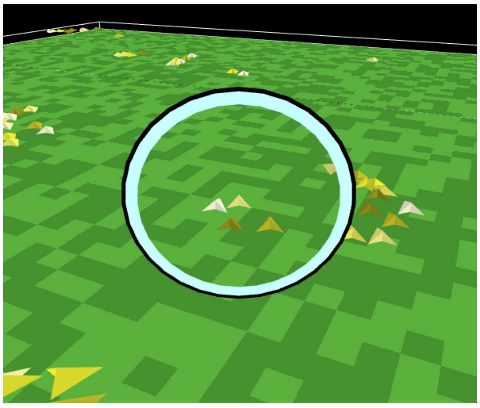

Figure 2. The learner can control a bird with their body, and attempt to "become one" with the flock, or try to disrupt the emergent formations by breaking out of it.

By being able to interact with the complex system by directly manipulating just one bird, we hope that learners gain a more embodied way of experiencing and engaging with flocking behaviour and with emergent complexity.

Model 3: Mutual Attraction?

DiSessa's (1993) research on children's conceptions of tidal bulges highlights two important points: First, that children (and, may we add, adults!) struggle with the concept of the two tidal bulges. Second, that explicating and becoming aware of one's own conceptions about the forces between Earth, water, and the Moon is a necessary first step towards making sense of this complex phenomenon.

To address this, we designed a 2-learner model. In the model, one learner takes on the role of Earth, and the other the role of the Moon. Each learner controls their celestial body by walking around the room. The model automatically simulates gravitation between Earth, the Moon, and the water on Earth, creating one of the two tidal bulges, the one that is more widely understood – the one facing the Moon.

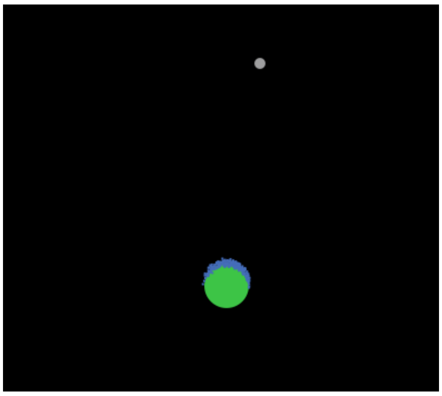

Figure 3. The tidal bulge facing the Moon is created by gravitational forces between the water turtles and the moon turtle in the top of the image.

The two learners must now find out how to move relative to each other so that they can recreate a correct representation of both tidal bulges. Only by moving around each other, simulating the centripetal power that creates the tidal bulge on the opposite side of the Moon, can learners successfully do so. Our goal is that through the coordination, the learners will engage in conversation that helps them articulate their own conceptions, and engage with each other's conceptions in fruitful ways.

Conclusion

In this brief paper we described three examples of models that we believe have he potential to be engaging and meaningful learning experiences, utilizing the Kinect extension for NetLogo. Ultimately the usefulness to education of "natural Interfaces" like the Kinect is of course an empirical question. We plan to study these activities with a variety of learners and analyse both engagement and learning.

We faced some new, interesting, and challenging questions as we were designing the Kinect extension. As designers of constructionist learning environments, our ambition is to develop tools-to-think-with. Part of this work, then, consists of creating external representations of knowledge and thinking with which people can construct their personally meaningful objects. Particularly, when we design learning environments that include programming, we must pay attention to how the design of our programming primitives affects their thinking-with*ness*. But how do we think with our bodies? If we stand up and raise a hand, most people would agree that our hand is now "above" our head. But what if we lie down on our back? Would a hand "above" our head float in front of us, its *aboveness* assessed by its larger distance from the core of the Earth? Or would we raise our hand like we did when we stand up, assessing the aboveness by a feeling of embodiment that tells us that "up" runs from our feet, through our spine and neck and into our heads? What is "up", anyway?

These questions, although maybe silly on the surface, are important to understanding how to design programming primitives for people to think with. Part of our work over the coming years will therefore be focused on articulating a *constructionist vocabulary for natural Interfaces*.

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