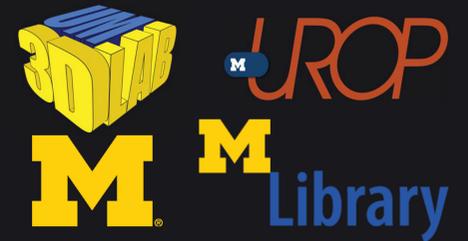


A Natural User Interface for 3D Environments

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Analyzing and understanding complex data often requires advanced 3D visualization, but this type of information can be hard to navigate using only a mouse and keyboard. What might an interface designed specifically for 3D data look like? Using the Microsoft Kinect and the Michigan Immersive Digital Experience Nexus, we have begun developing this interface, giving the user the ability to intuitively interact with data using only their physical body.



Concept

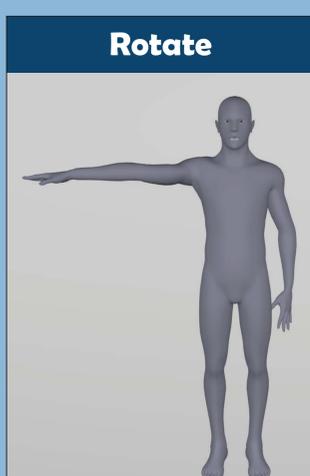
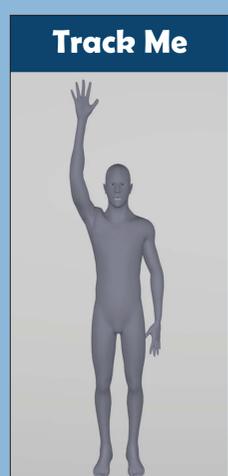
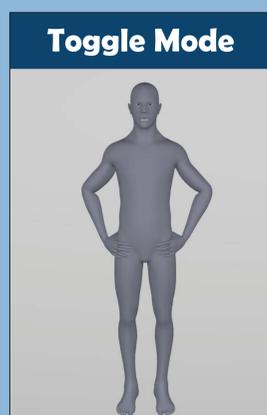
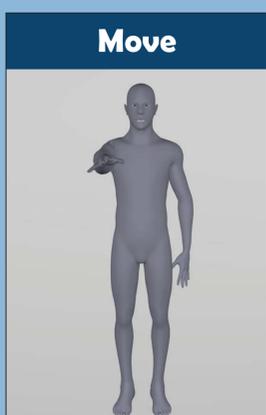
The input systems that we use today, such as joysticks and computer mice, do not provide a natural mode of interaction with complex information. This problem is amplified when we use these two-dimensional input systems to navigate within a three-dimensional space, as in the University of Michigan 3D Lab's Michigan Immersive Digital Experience Nexus (MIDEN), an immersive virtual reality space. In an effort to improve interactivity in the MIDEN, the Microsoft Kinect has been applied as a way of representing the physical body in a virtual space. By analyzing the data received from the Kinect, we have created a real-time, digital model of the body. This body represents an avatar that corresponds to the user's location in space, allowing them to interact with virtual objects. Because the MIDEN offers the user perspective and depth perception, interaction feels more natural than maneuvering an avatar on a screen; the user can reach out and directly "touch" objects.

As a supplement to physical interaction, a gesture-based user interface provides the user greater control in simulations (e.g. navigation, selection). By using the hands rather than other, more restrictive input systems, the experience becomes more immersive and the user can focus on their data analysis, training, or whatever other goals they may have.

Objective

We wanted to make interaction with the MIDEN feel as natural and immersive as possible, but still allow the user to control the virtual environment. By augmenting our direct-contact based system with gesture controls, we have provided the tools to move through and interact with simulations, data, and models while freeing the user from restrictive peripheral controllers and trackers.

Stage Two: Implement Gesture Recognition



Stage One: Integrate the Kinect with the MIDEN

(With Rob Soltesz)

1. Examine space and plan system design

- Identify ideal location for the Kinect
 - Kinects were best placed in the lower corners of the room
 - This arrangement is unobtrusive, but still provides reliable tracking
- Introduce a second Kinect to improve accuracy

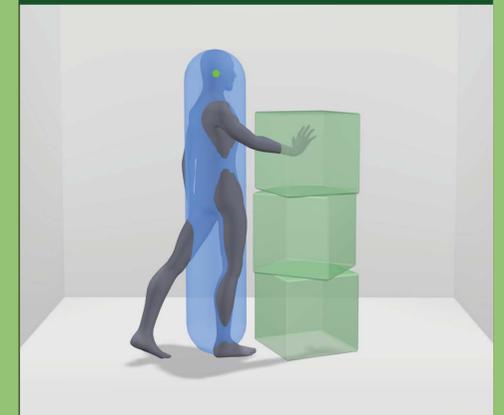
2. Develop integration software

- Implement client-server system to receive data from both Kinects
 - Because a single process cannot call on multiple Kinects, each device must be managed by a separate process
 - Each process passes data through a socket to the rendering engine
- Consolidate data for an improved skeleton
- Convert data to the coordinate system of the MIDEN
- Place digital body in appropriate location
 - Each data point corresponds to the location of a virtual object
 - These objects meet to form a model of the body in its current position

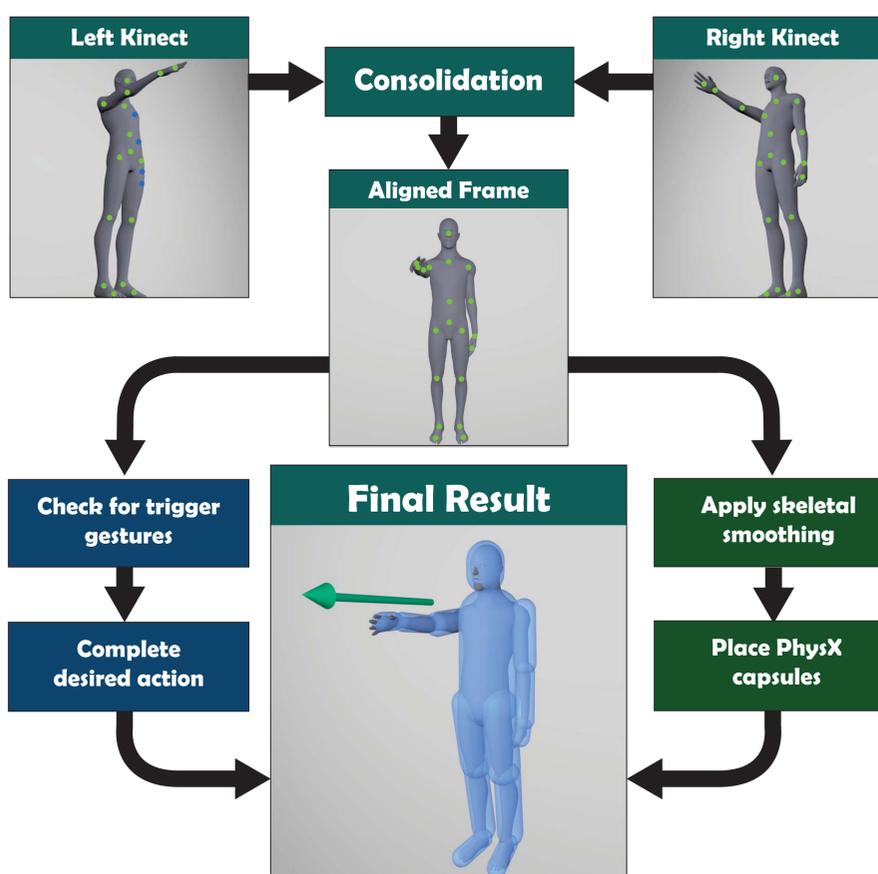
3. Place Kinects and calibrate system

- Hide Kinects, cables, etc. from viewer
- Measure offsets and angles of devices within the space

Before Kinect



With Kinect



1. Lay out gesture recognition architecture

- User's pose is compared to an array of trigger poses
- Trigger poses activate and deactivate gestures
- Dynamic gestures can be performed while triggers are active

2. Identify ideal trigger poses

- Poses must be simple, distinct, and comfortable
- Avoid false positives and failed recognition

3. Build pose recognition software

- Triggers must work dynamically, for all different body types
- Joint angles and relative positions work best
 - Hand over head, 90° arm angles
- Poses are compared to known gesture library

4. Link gestures to commands within MIDEN

- Move forward, rotate, etc.

Current Work

We now have a working demonstration of our application in the MIDEN that allows the user to interact directly with virtual objects, just as they would in a physical environment. To create this physical interactivity, we have placed two Kinect devices in front of the user to increase the interactive space within the MIDEN. We then consolidate the data given by each camera to create a single, improved skeleton that be used as a guide for placing a set of invisible PhysX capsules within the simulation. These capsules are overlaid on the user's body, giving them an avatar in Jugular's virtual space that can be used to interact with other objects with realistic physics. Additionally, we have implemented a small array of simple gesture controls, such as assuming control of the system and navigation.

Future Plans

In the near future, we plan to expand the gesture recognition system and include feedback to make the environment feel more responsive. We are also considering implementing a small visible interface that would give the user a wider array of available actions. Our goal is to create a simple, intuitive mode of interaction with the virtual world, allowing the user to focus on their task, rather than learning to use the technology. The interface will be applied to the navigation of large datasets that are too complex to interpret without 3D visualization techniques.

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