Haptic modeling of a street intersection using the Novint Falcon

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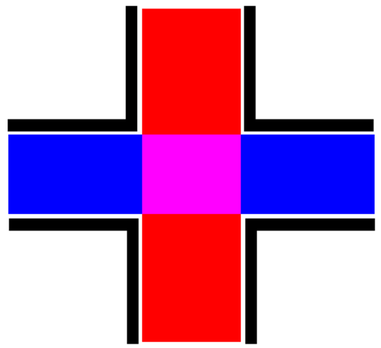
Overview

•Blind individuals face many challenges in orientation and navigation
  •Visual aids such as street signs are not accessible
  •Tactile maps are difficult to make, and can't convey enough information
  •Virtual maps look promising, but haptic devices often cost $10,000 or more!

• The Novint Falcon is a new haptic device that is priced for consumers
  •Our experiments show the Falcon is suitable for modeling virtual maps
  • Price is under $200 – affordable enough to use at home



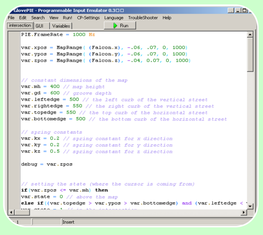
Intersection Model

•This picture shows a view of the intersection from above
  • The colored areas are the grooves that the user can move in freely
  • The user gets pushed out of the white area because that is supposed to be the "solid" object
  • This picture shows three of the four colored areas. The fourth colored area is above the surface of the map.

Novint Falcon

• 3D haptic device lets user feel virtual shapes and objects
• Sends position coordinates to application
• The application must calculate the force vector and update device 1000 times per second

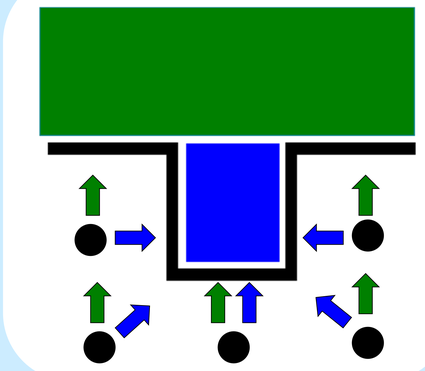
GlovePIE



• Scripting language for programming input devices such as Falcon, Wiimote, and MIDI
• Provides an easy interface to program with the Falcon
• Downside: not as efficient as writing Falcon applications in C++

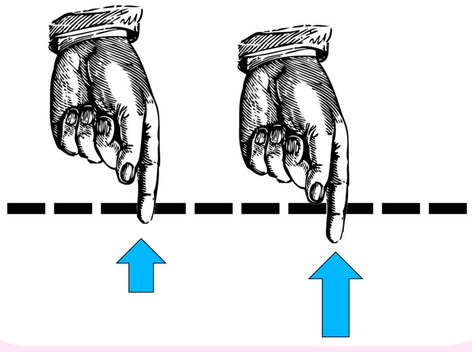
States and Force

• This picture shows a cross-section of the intersection from the side
• The current state is the last colored area that the user has passed through
  • The state determines the direction of the force vector when the user enters the white area
  • The user gets pushed back into the last area he or she was in
  • This method keeps the user from falling through corners and edges



Force Model

• All solid surfaces are modeled with springs
•User "pushes through" surface and is pushed back by force
•Hooke's Law: Force = - [spring constant] * [distance from surface]



Constants

Horizontal groove width = 0.6 cm
Vertical groove width = 0.6 cm
Depth of grooves = 2.4 cm

Spring constant for X and Y directions = 15.38 Newtons/meter
Spring constant for Z direction = 45.45 Newtons/meter

The spring constant in the Z direction is much higher because:

1. We found that users tend to use the most force while pushing away from the body.
2. If the X and Y spring constants are too high, then the Falcon will bounce back and forth against the edges of the grooves and oscillate.