Modeling Virtual Object Behavior within Virtual Environment

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Introduction

- Specification - Implementation - Evaluation

- Immersive VR Systems
  - Gap between implementation & evaluation environment

- VR Development Tools as Immersive VR Systems
Introduction

- Virtual World with Virtual Objects
  - Virtual Object
    - Form + Function + Behavior [Kim98]

- Constructing a Virtual World within Virtual Environment
Introduction

Related Works

- 3DM[Butterworth92], JDCAD[Liang94], CDS[Bowman95], ISAAC[Mine95]
Introduction

Related Works

- Lingua Graphica[Stiles92], Data Flow Representation[Steed96]
Introduction

Goal of this work

- Modeling Virtual Object “Behavior” within Virtual Environment
- Fully utilizing the merits of the “3D interaction”
Problem

- Immersive VR Systems
  - Provide high level of presence
  - Tracking device, HMD
  - Isolate subject from the real world
  - Hard to use conventional interfaces

- Modeling Virtual Object Behaviors
  - Mostly by text editing task
Approaches

- Virtual Terminal
- Metaphorical Objects
- Programming by Demonstration
Approaches

- Virtual Terminal
  - Text, 2D Graphics and others
  - Limits of device technology
  - Special alphanumeric I/O devices for VE
Approaches

- Metaphorical Objects
  - Visual Languages
    - Cube[Najork96], ToonTalk[Kahn96]
  - Data Flow Representation[Steed96]
Approaches

- Programming by Demonstration
  - “Direct manipulation for programming tasks” [Lieberman01]
  - Pavlov[Wolber97], KIDSIM[Smith94]
The PiP System

- Programming virtual object behavior in virtual reality Program

- Filling out the virtual object behavior model using 3D interactions
The PiP System

Implementation

- Hardware
  - PC platform
  - HMD
  - Fastrak
  - 5th Glove
  - 3-buttoned prop

- Software
  - Microsoft Windows OS
  - OpenGL
The PiP System

Virtual World Model

- The Universe
  - Variables
    - current time
    - Δtime
    - current world
  - Types
    - type1
    - type2
    - ...
  - Worlds
    - world1
      - object1
        - object2
      - ...
    - world2
      - ...

```xml
<universe>
  <world pond>
    <bgcolor>1.0 1.0 1.0</bgcolor>
  </world>
  <type fish>
    <appearances>
      <default>fish.obj</default>
    </appearances>
    <behavior>
      <action moveforward 1.0>
    </behavior>
  </type>
  <object fish1>
    type fish
    x 100
    y 100
    z 100
    world pond
  </object>
  <object>
    type fish
    x -50
    y 200
    z 100
    world pond
  </object>
</universe>
```
The PiP System

- Virtual Object Model
  - Form
    - Type, Position, Orientation, World, Appearance, Sound & User defined variables
  - Function
    - Change Variable(=, +, -, *, /, %), Create, Destroy, Move, Rotate, Scale, Play Sound
  - Behavior
The PiP System

ACE Behavior Model

- Event
  - Collision, Property Value Changed, Timer
- Context
  - Spatial
  - Non-spatial
- Action
The PiP System

Example behavior "eat food"

```xml
<behavior>
  <event collided food>

  <context>
    <roi back -10 -10 10 10 20 empty>
    <thisObject appearance != 1>
  </context>

  <action>
    <moveforward 1.0>
    <destroy eventedObject>
  </action>

</behavior>
```
The PiP System

- Interacting with Virtual Objects
  - Virtual Hand, 3D Widgets, Menu
    - Create, Destroy, Move, Rotate, Change Appearance and Play Sound
The PiP System

- Interactions for Behavior Modeling
  - Demonstrating Event, Contexts and Actions
Modeling Results

Virtual Undersea World

Romancing the Stone
Modeling Virtual Object Behavior within Virtual Environment

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Conclusion & Future Works

- Categorized approaches for modeling VO behavior within VE
- The PiP System
- Usability tests with other approaches and interfaces
- Virtual Object Models and 3D Interaction Methods
Thank you!

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References

Please refer to the paper.