Interactivity with 3D Models

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Final Report
About Me

• 2nd Year undergraduate Student at UCSD
• Double major in Computer Science and Computer in Art and Music
• Osaka University PRIME student
• UCSD mentor: Professor Jurgen Schulze
• Host mentors: Kiyokawa-sensei, Shimojo-sensei, and Date-sensei
Research Proposal

- Joint project with Tokyo PRIME student, Velu. – NICT and Osaka University
  - I worked on interaction
  - Velu worked on displaying the 3D content
  - Integrate both projects at the end
- Create a stable environment for real-time interaction between a human and 3D model using a video camera.
- Use OpenCV and existing tracking technologies to create a stable and easy to use interactive interface.
- Demonstrate this project at the 1300 Anniversary of the old capitol, Nara, Japan
Things to Consider

• Users of the System
  – Certain tracking implementations and interfaces may not work for certain people
    • Age
    • Color of Skin
    • Intelligence

• Design and layout of exhibition space
  – Lighting effects tracking
  – Dimensions of the building
  – Colors of the inside of the building
  – Other considerations as well
Things to Consider Continued

• Tracking
  – Only want to track one face at a time
  – how do I decide what face I want to track?
  – How do I know I am tracking the face I want to track?
  – Tracking that works in a busy environment

• Data Sending
  – How can I send my data to the rendering system?
General Layout of System

Calibration

Tracking Module

Send x, y, z data through network

Receiving module for rendering system

See result on Tiled Wall Display

Manipulate virtual camera in rendering system
• Tracking Module
  – OpenCV Haar classifier algorithm as a basis for face tracking
    • Detailed Explanation of Haar classifiers is beyond the scope of this project
    • Used OpenCV’s profile_face classifier to detect faces
      – Classifiers consist of a bunch of images of the proposed object
  – Several optimizations
    • Region of Interest tracking – speed up processing of system by a few magnitudes
    • Tracking only the biggest face – assume that the closest person to the camera is the most important person
  – Getting X, Y, Z from 2D image using homography matrix
  – Send data through UDP/IP
Software System in Detail

- Recieving module and virtual camera manipulation module
  - Recieve data from tracking module when ready to accept
  - Using x, y , and z, calculate rotation of camera around virtual 3D object
    - Not panning, but rotation around the object so you can see the sides of the 3D object
- openCOVER
  - Virtual Reality rendering system which runs on the cluster
  - The receiving module run on the cluster as well
  - 3D model that Velu create will also run in openCOVER
  - I take control of virtual camera, not the object
Physical System in Detail

PointGrey Flea3 monochrome firewire camera with VGA resolution

Other equipment
- Ethernet cable to send data through IP protocol
- 1394b bus and cable
- Camera mount

TDW that will display 3D content – runs on a cluster which I send coordinate data to

32 bit desktop running the Tracking module
Exhibition Site

- Old Capitol grounds in Nara
Results

• For the most part, the desired effect was created.
• Many families enjoyed the interface
• Some were scared to try it

Example of face tracking

• Almost no one tilted their heads in an awkward position
  • Set up of exhibition

Cannot Track Tilted Heads
Results

Faces drawn on paper can work too.

• See Video
Wonderful Aspects of My System

• Easy to use
  – Do not need to wear any markers such as strange hats or glasses

• Independent tracking module which can be used for many applications
  – Immersive Visualization
    • New way to help visualize data – ex: viewing molecules
  – Video games – Natal, DS, Playstation

• One camera
  – Integration into laptops since most laptops have good enough webcams for tracking
Problems Occurred during Exhibition

• Trouble tracking certain people
  – Children with small eyes, people wearing hats, and people with hair in front of their face caused some problems with face detection.

• Coordinate system on slave nodes of the tiled wall display are undefined in openCOVER rendering system

• Some people did not understand how to use the system

• Very difficult to track faces when there are too many of them in the camera viewpoint
Suggested Improvements

• Improve face tracking
  – Initial face detect, then switch to tracking algorithm using methods such as Kalman Filter
  – Need a way to deal with occlusions and blocking of the face by hats, hair, etc.
  – Kids with small faces
  – Get orientation of head to get more realistic viewpoint changes

• Introduce gestures
  – Spin the model with a hand swipe
  – Holding gestures to ‘hold’ the virtual 3D model
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