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

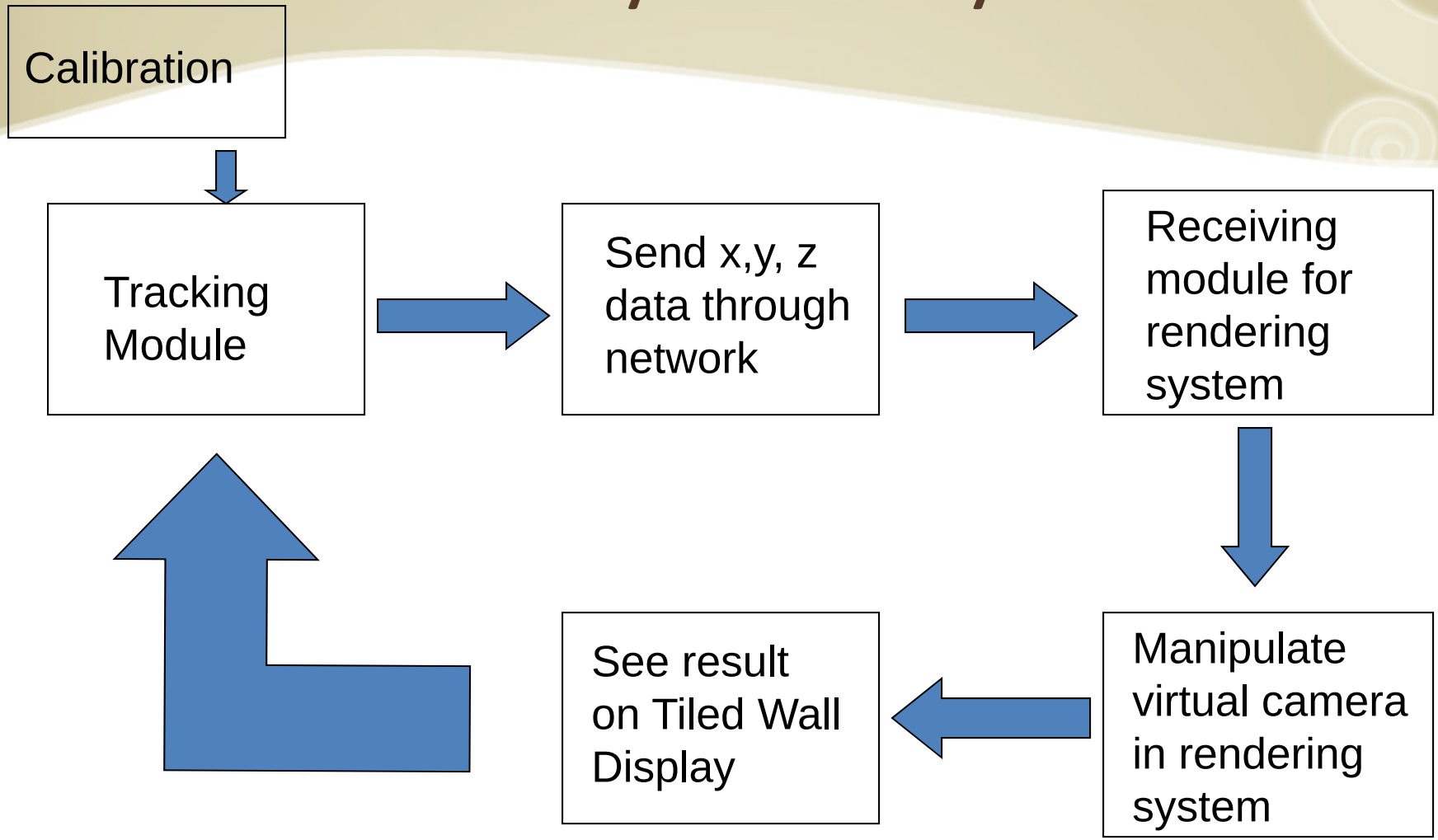
Things to Consider

- 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



Software System in Detail

- 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 closets 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
  - Viritual 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 opeCOVER
  - I take control of virtual camera, not the object

Physical System in Detail

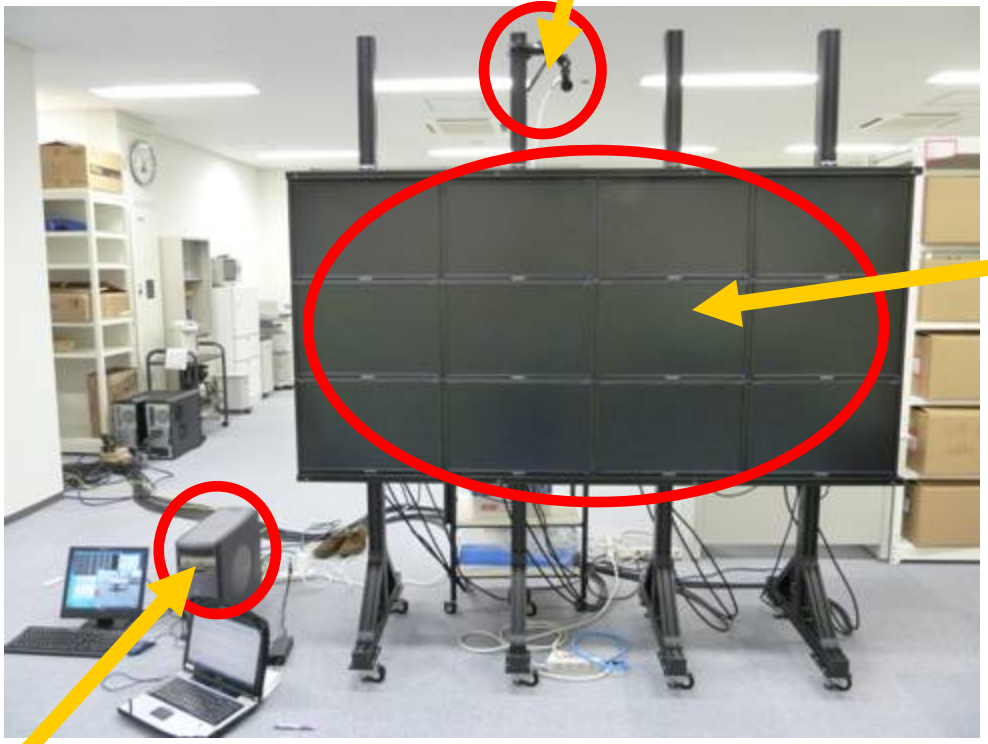
PointGrey Flea3 monochome firewire camera with VGA resolution

<u>Other equipment</u>

-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

NARA 710 - 2010

Exhibition Site

Exhibition Site

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 tiled 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 Occured 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 dispay 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

- Imrove 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 realitic viewpoint changes
- Introduce gestures
  - Spin the model with a hand swipe
  - Holding gestures to ‘hold’ the virtual 3D model

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Doumo!