Capturing 3D Structures of Buildings and Human Activities

Hideo Saito

saito@ozawa.ics.keio.ac.jp
www.ozawa.ics.keio.ac.jp/Saito

Dept. Information and Computer Science,
Keio University, Japan

Outline of my talk

• Motivation of 3D capturing
• 3D capturing of buildings
• 3D capturing of human activities
• Display 3D contents onto real world
Digital Contents in 3D

Typical Media/Contents
- Speech : 1D
- Document : 2D? (Sentences: 1D)
- Paintings, Photographs : 2D
- Something: 3D

Important technology for circulating such media contents

Capturing
Sending/Archiving
Displaying

The contents

Shape as 3D Contents

- Essential information of objects
- Represented in 3D

Capturing 3D contents

Various techniques are developed in recent 10 years

- Merging Multiple View Images
- Pattern Projection
- Time of Flight of Light/Sound
3D Contents to be Captured

- Historical Arts
- Buildings
- Humans
- Animals

Core items that form human society

3D Capturing of Buildings
Relating Project for Capturing 3D Contents

- Digital Michelangelo Project (Stanford Univ.)
  http://graphics.stanford.edu/projects/mich/

- 3D Digital Preservation of Cultural Heritages (Univ. of Tokyo)

Capturing the Mita Library

Riegle
3D Imaging Sensor
LMS-Z360i
3D Scanning from Multiple-Viewpoint

Technical Key Point

- Alignment of Multiple View Scans
- Generation of 3D Model Data with
  - Efficient Handling
  - Efficient Viewing
  - High-Resolution Viewing
  - Easy Manipulation

Computer Vision, Graphics Pattern Recognition
Example Results

(a) Outside  (b) Inside

Extracting Planar Structure

Avoid wrong alignment caused by scattering point data

Input Data  Plane Extraction
Result of Multiple View Alignment

![Outside Image](image1)

![Inside Image](image2)

Comparison of Our Alignment with Conventional Alignment

![Conventional Image](image3)

![Out Method Image](image4)
Example 3D Model

3D Capturing of Human Activity

- Preservation of Special Behavior
- Educational Application
Multiple Video Cameras

- 3D Shape can be captured from multi-view 2D images
- Human moves, so using cameras is the only solution for capturing of human activities.

Virtualized Reality (CMU)

The 51-camera video sequence are processed to produce a complete 4-dimensional (time + 3D) description of an event.

A virtual video from completely arbitrary view points can be synthesized from the 4D description, including “placing” the event in a “new” environment, like a synthetic gym.
Example:
3-Man Basketball (1998)
Carnegie Mellon Univ.

Synthetic court

Input sequence

4D Model

Commercial Application of Multiple Camera Capturing

www.whatisthematrix.com

—Capturing with hundreds of cameras.
—Special Effect such as the camera is rotating around the object.
Multiple Cameras in Sports Event
EyeVision, developed by CMU and CBS (2001)

Silhouette Intersection
For soccer scenes

Free Viewpoint Observation
Virtual Viewpoint Visual Effect — like “The Matrix” —
Multiple Camera Capturing of Lecture Scene

Virtual Display

Free Viewpoint Lecture Presentation
Chemistry Lecture

Lecture with 3D model.
Possible Applications

Learning of Special Activities

- Surgical operation
- Flower arrangement
- Sculpture
- Playing musical instruments

Digital Media on Real Object

User sees a desktop stadium model in the real world with video see-through HMD and observes dynamic objects of soccer scene overlaid onto the display.
Immersive Observation System

Free Viewpoint Observation on the Desktop Stadium Mode with HMD

Stadium Model Captured by HMD Camera

Result

Arbitrary View Observation with HMD

Overlaid Soccer Scene on Tabletop Stadium Model
Tangible Digital Media

Our propose is to overlay textures onto a deformable surface of an object in real time using a video see-through HMD.

Observer feels as if he was reading a real book.

Result

Overlay images generated by the system
Conclusion

- Recent technologies for 3D capturing of buildings and human activities are presented.
- The Mita-Library Building
- Soccer Game
- Lecture Scene
- Display 3D contents onto real world

The Matrix, EyeVision, etc...

- Viewpoint can be moved, but just selecting cameras
- Viewpoint is still decided by the producers

What the real free-viewpoint video is:

1. No restriction of viewpoint (Free-Moving Space)
2. Viewer can decide viewpoint (Free-Decision Making)