Capturing 3D Structures of Buildings and Human Activities

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Outline of my talk

- Motivation of 3D capturing
- 3D capturing of buildings
- 3D capturing of human activities
- Display 3D contents onto real world

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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

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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

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3D Contents to be Captured

- Historical Arts
- Buildings
- Humans
- Animals
-
-

Core items that form human society

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3D Capturing of Buildings

Relating Project for Capturing 3D Contents

- Digital Michelangelo Project (Stanford Univ.)

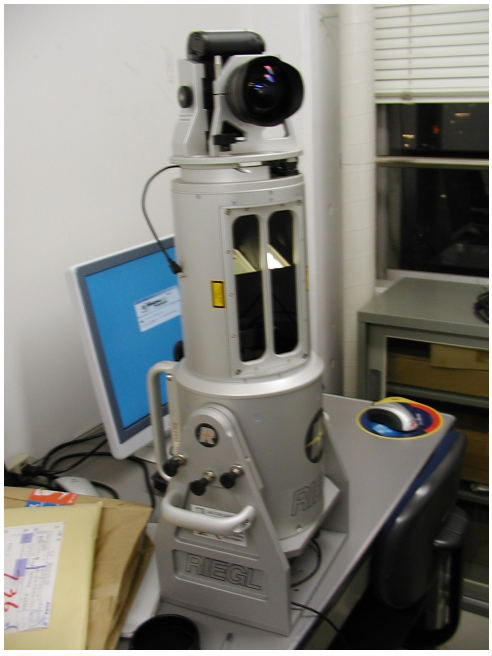
http://graphics.stanford.edu/projects/mich/

- 3D Digital Preservation of Cultural Heritages

  (Univ. of Tokyo)

Capturing the Mita Library

Riegle
3D Imaging Sensor
LMS-Z360i



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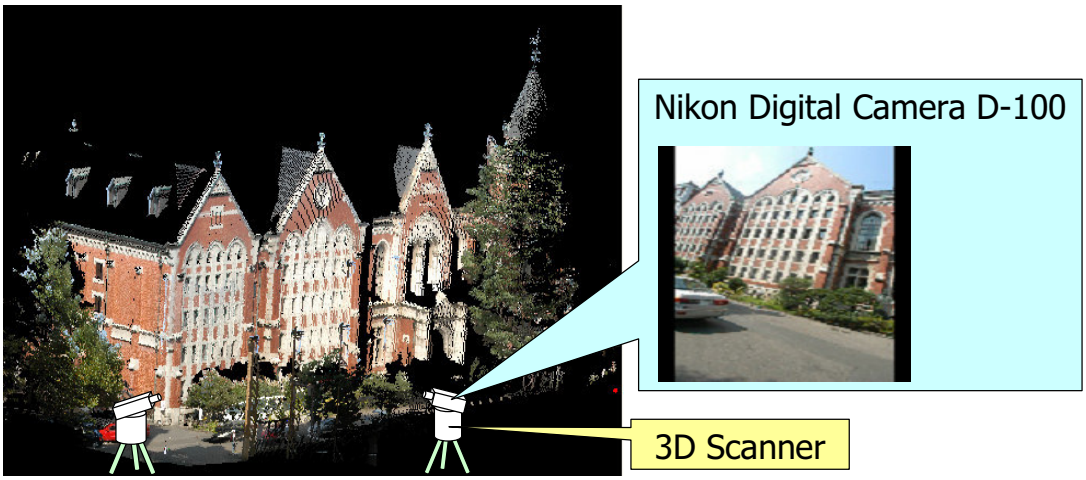
3D Scanning from Multiple-Viewpoint



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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

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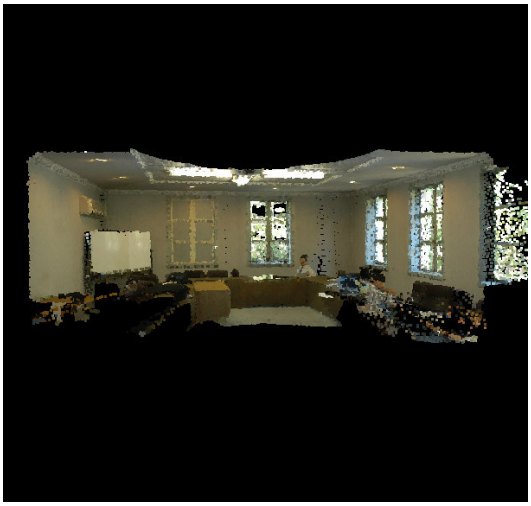
Example Results

(a) Outside



(b) Inside

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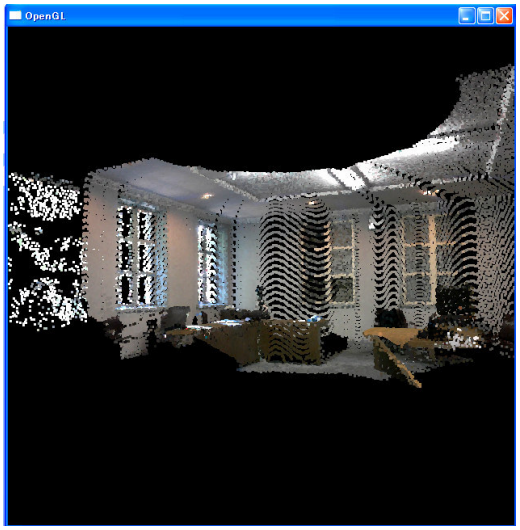
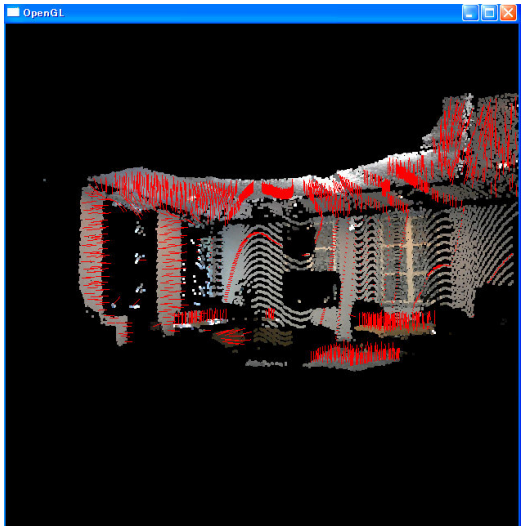
Extracting Planar Structure

Avoid wrong alignment caused by scattering point data



Input Data



Plane Extraction

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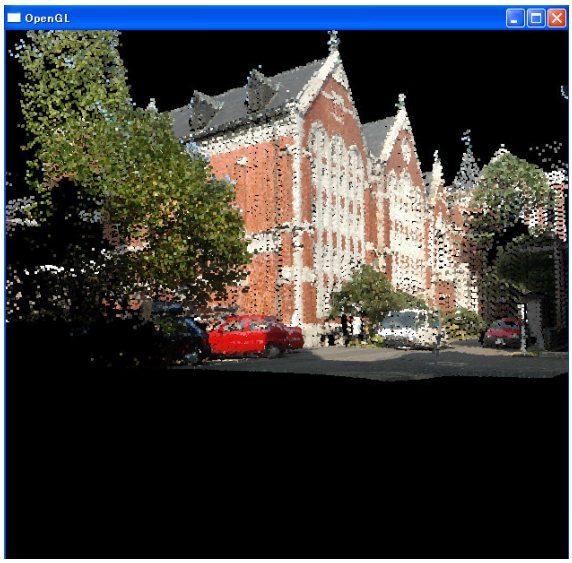
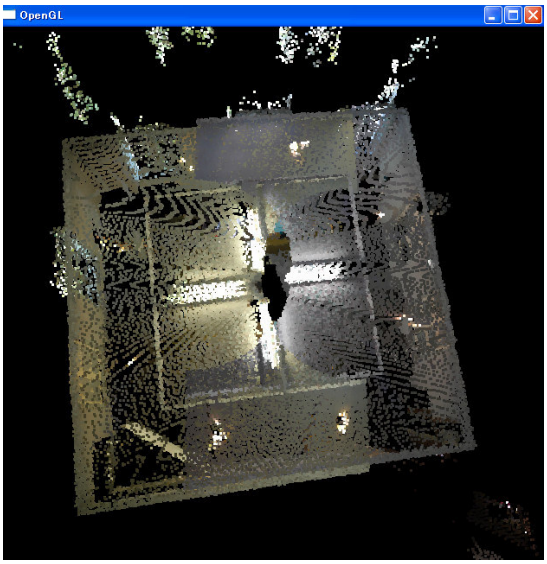
Result of Multiple View Alignment



Outside



Inside

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Comparison of Our Alignment with Conventional Alignment

Conventional

Out Method

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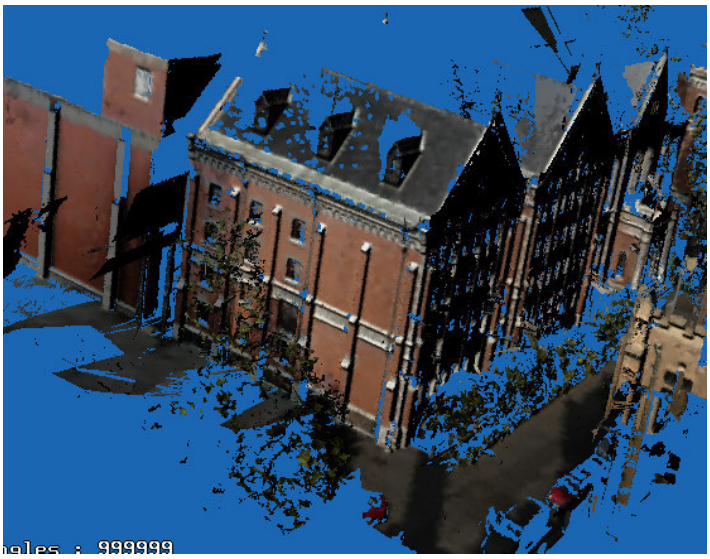
Example 3D Model



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3D Capturing of Human Activity

- Preservation of Special Behavior
- Educational Application

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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.

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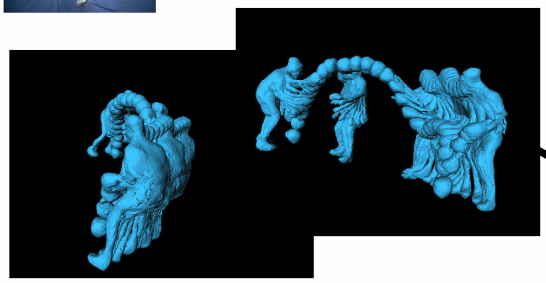
Virtualized Reality (CMU)

3D Room

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.

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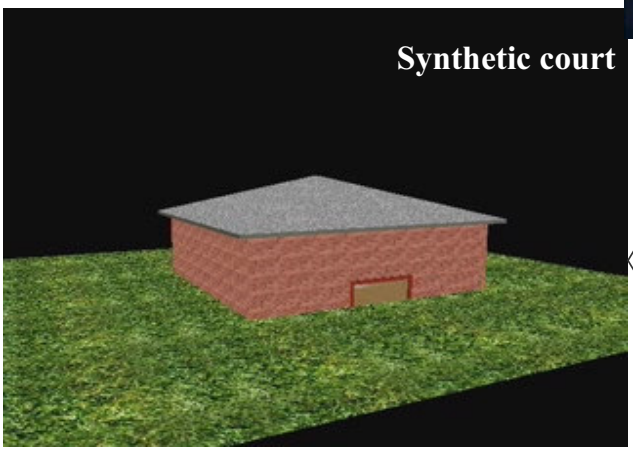
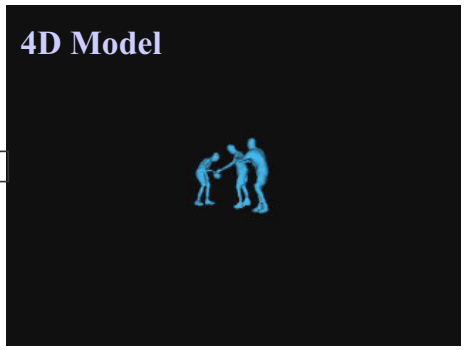
Example:
3-Man Basketball(1998)
Carnegie Mellon Univ.
(These are movies.)





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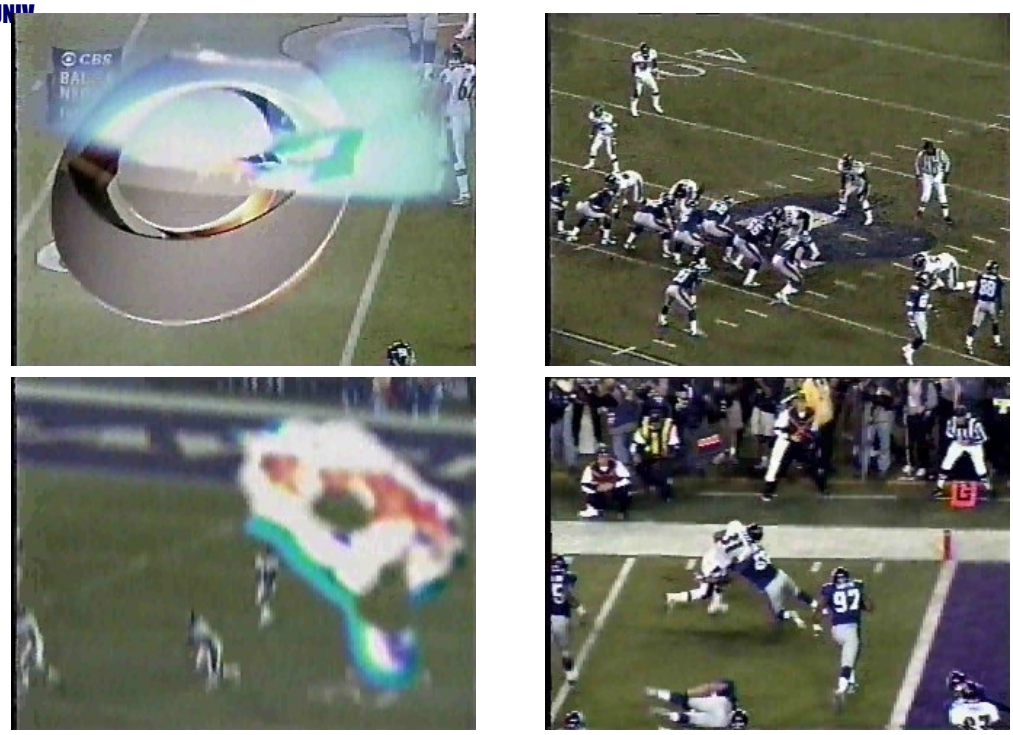
Commercial Application of Multiple Camera Capturing

www.whatisthematrix.com

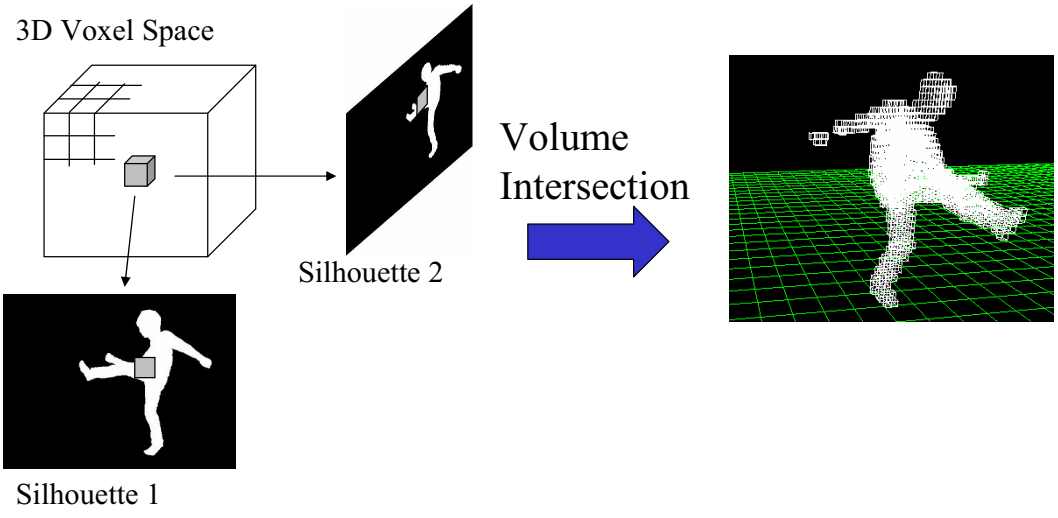
–Capturing with hundreds of cameras.
–Special Effect such as the camera is rotating around the object.

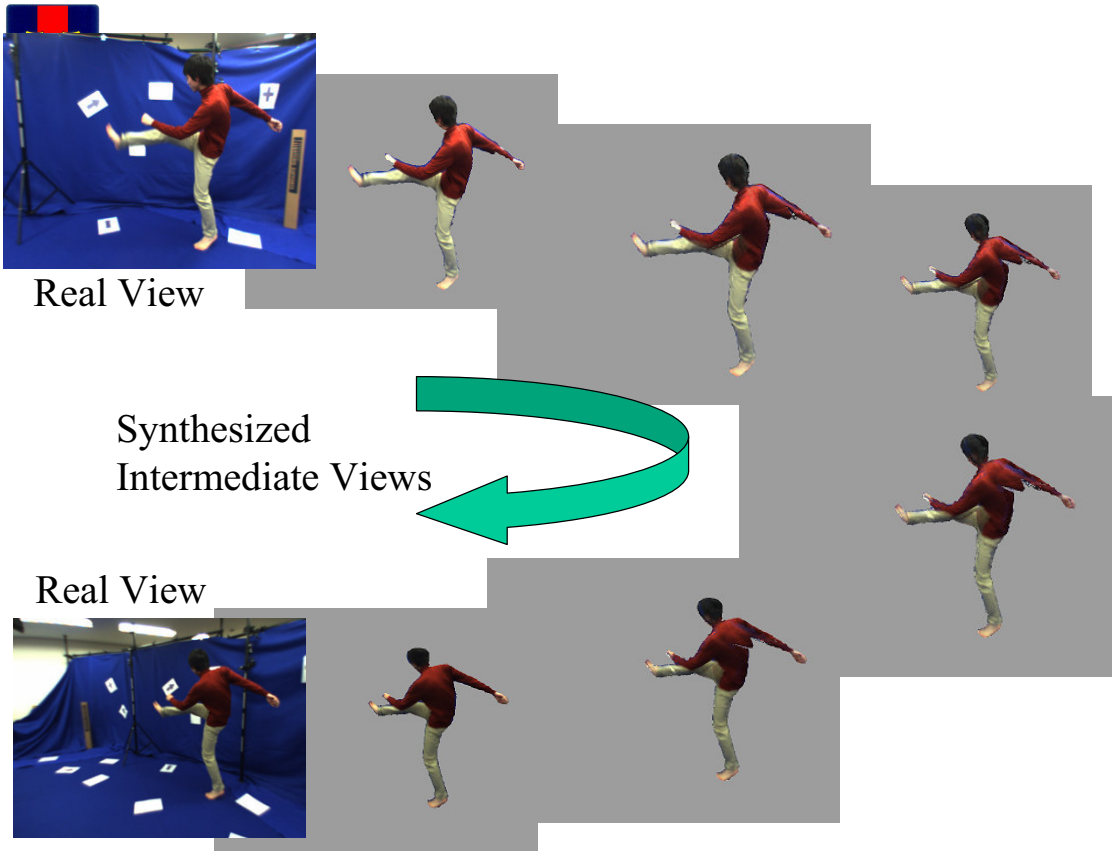
Multiple Cameras in Sports Event

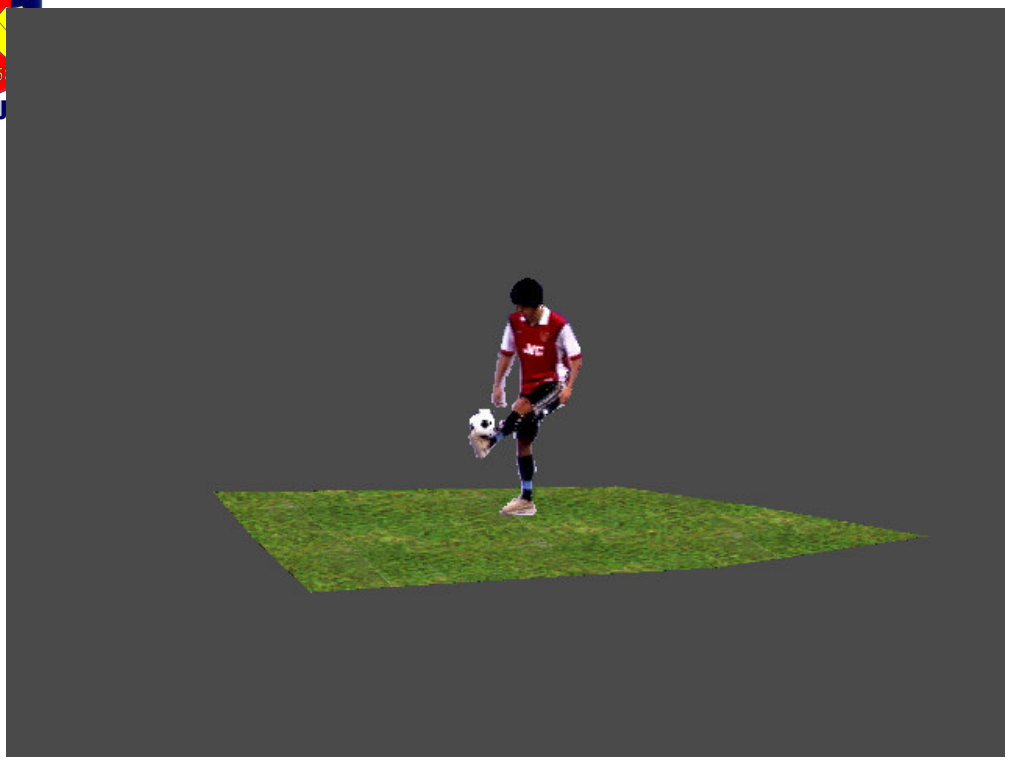
EyeVision, developed by CMU and CBS (2001)



Silhouette Intersection







Intermediate image sequence of 5 cameras

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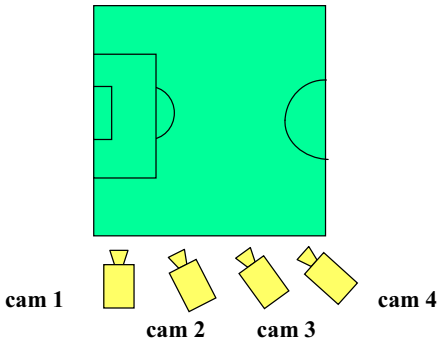
For soccer scenes




cam1


cam2


cam3


cam4

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Free Viewpoint Observation

Virtual Viewpoint Visual Effect
— like "the Matrix" —

Input Video

Synthesized Video
At Player's Viewpoint

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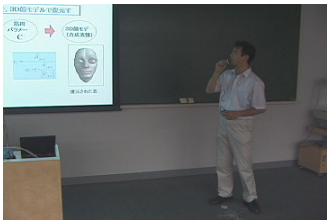
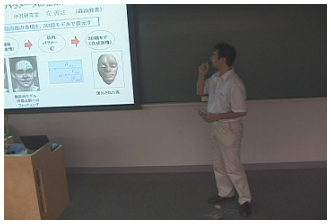
Multiple Camera Capturing of Lecture Scene

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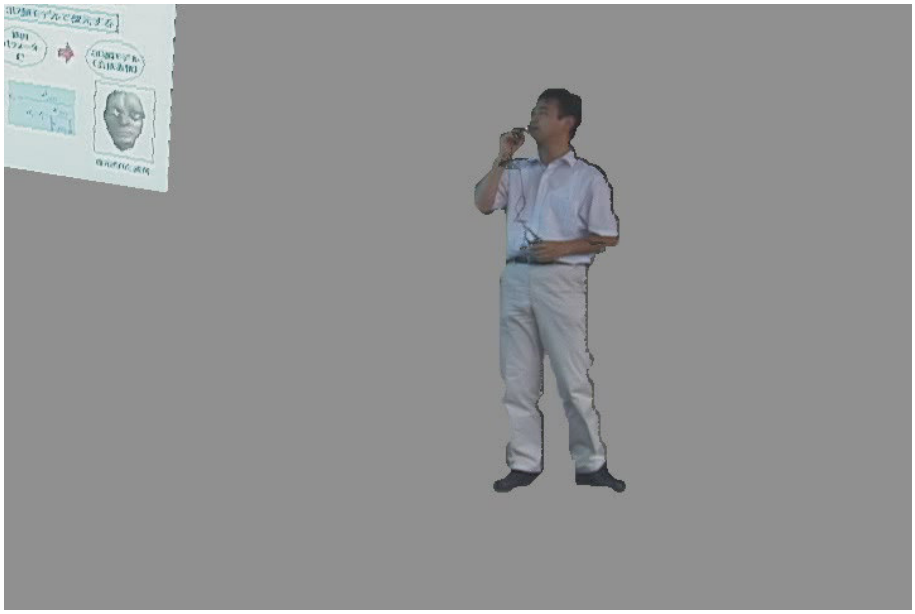
Virtual Display



Free Viewpoint Lecture Presentation

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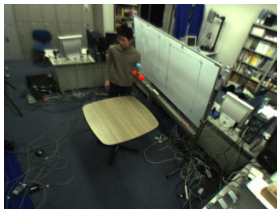


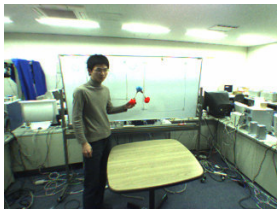
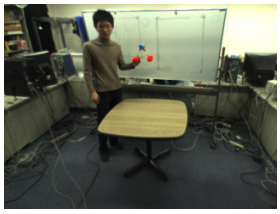

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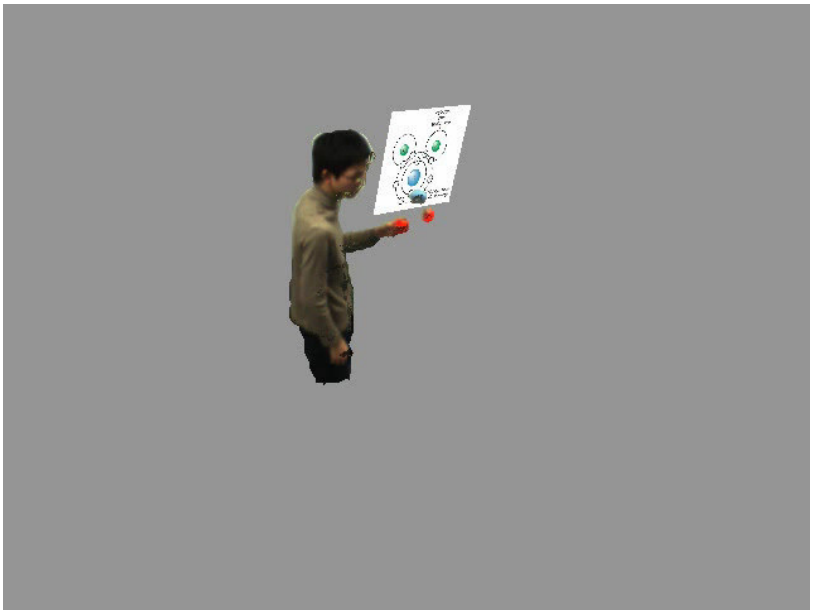
Chemistry Lecture



Lecture with 3D model.

Possible Applications

Learning of Special Activities

- Surgical operation

http://www.dent.nihon-u.ac.jp/hospital/j-hos51.html

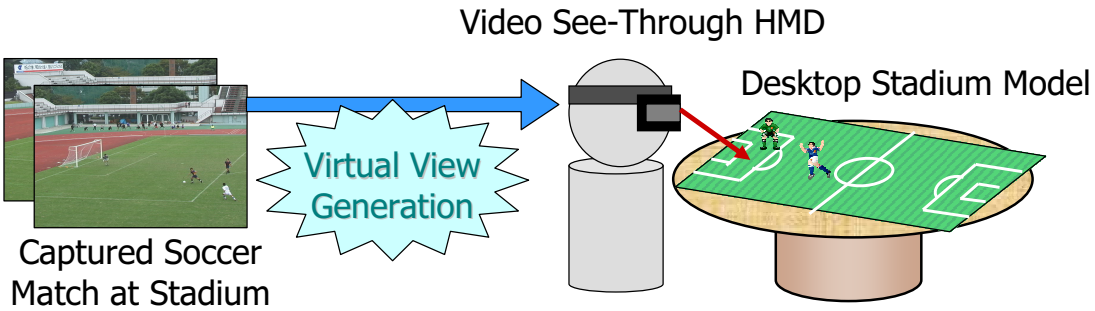
- Flower arrangement
- Sculpture

http://www.flower-studiof.com/

- 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.



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Immersive Observation System

Free Viewpoint Observation on the Desktop Stadium Mode with HMD

Stadium Model Captured by HMD Camera

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Result

Arbitrary View Observation with HMD

Overlaid Soccer Scene on Tabletop Stadium Model

Tangible Digital Media

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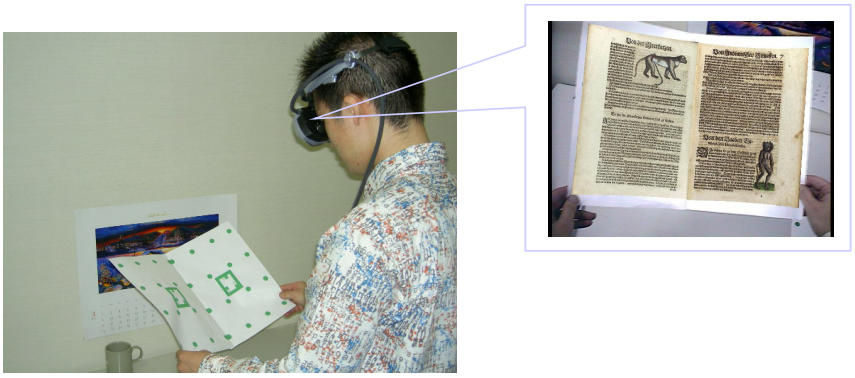
Our propose is to overlay textures onto a deformable surface of an object in real time using a video see-through HMD.

Observer feels as if he was reading a real book.



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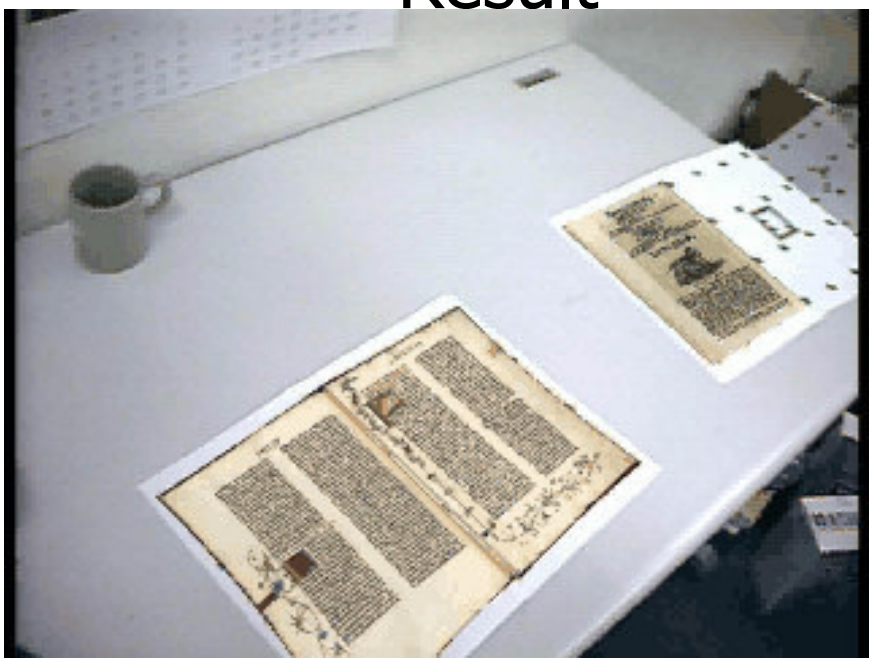
Result



Overlay images generated by the system

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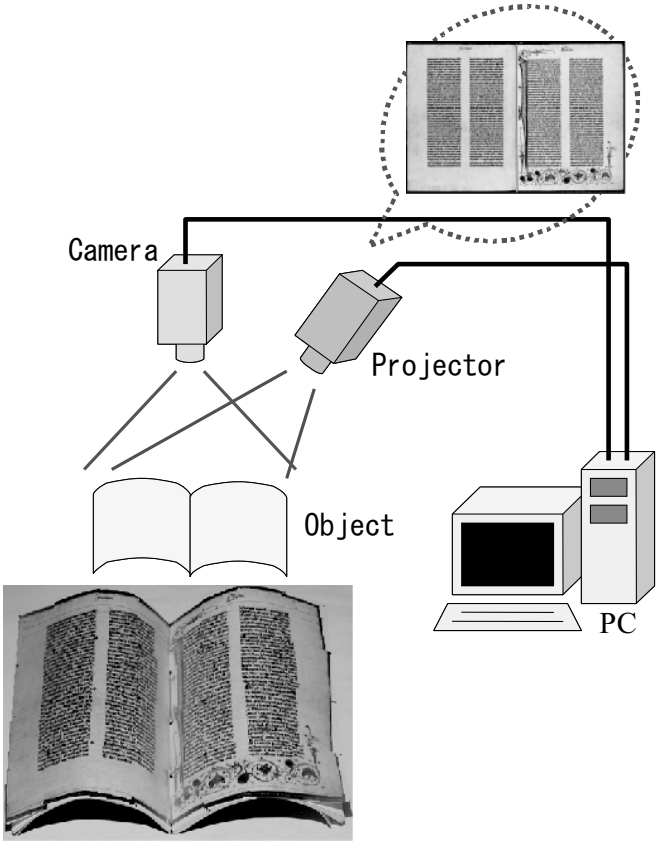

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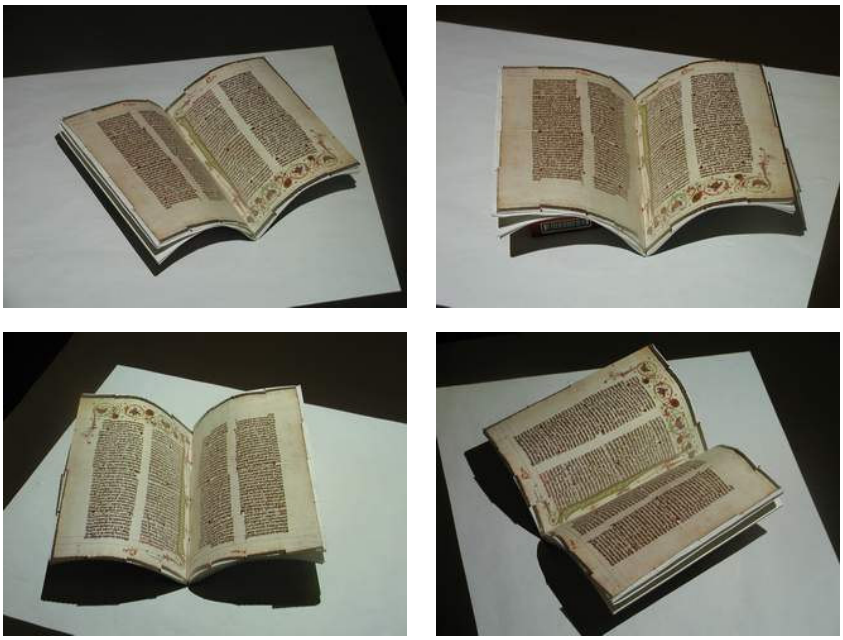
Projection of the Image of Gutenberg Bible



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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

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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)