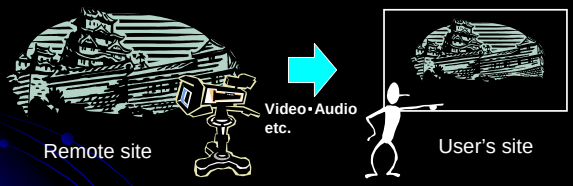
Novel View Telepresence Using Multiple Omni-directional Live Videos

Tomoya ISHIKAWA, D2

Vision and Media Computing Lab.

Telepresence

Telepresence allows users to experience a remote site through a virtualized real world.



Application fields

- Entertainment
- Education
- Remote surveillance
- Video conference

Telepresence Using Omni-directional Videos

↓ Omni-directional camera in remote site

↑ User ↑ User's view

- Arbitrary and interactive view-direction
- Viewpoint restricted onto camera path

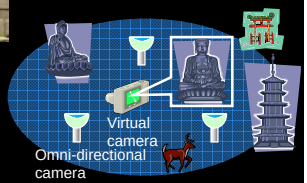
Novel View Generation

"Novel views" mean views captured by virtual camera.

- Arbitrary viewpoints are not restricted at camera positions.
- Novel views are synthesized from real view images.

3D Room (CMU)

Saito et al. [2003]



Our proposed method

Our Proposed Method

Novel view generation using multiple omni-directional videos

- Virtualizing both outside-in and inside-out observations from camera positions
- Real-time rendering and live video processing

↑ Novel view images

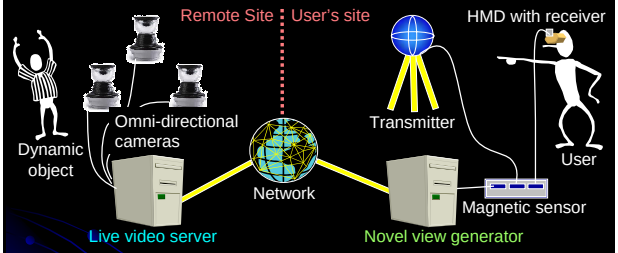
Objective

To Realize networked telepresence system which enables users to see a remote site at arbitrary viewpoint and in arbitrary view-direction

Approach

- Virtualizing real dynamic scenes by our proposed method
  For generating novel views
- Server-client system
  For video transmission and distributed processing
- Using HMD with position and posture sensor
  For presenting view-dependent images

Proposed Telepresence System



Omni-directional Camera
Resolution: 640×480
FrameRate: 15fps
FieldOfView:
Horizontal angle 360°
Elevation 12°
Depression 50°

Live video server
CPU: Athlon64 X2 4400+
Memory: 2GB

Novel view generator
CPU: Pentium4 3.2GHz
Memory: 2GB
GPU: GeForce 6600GT

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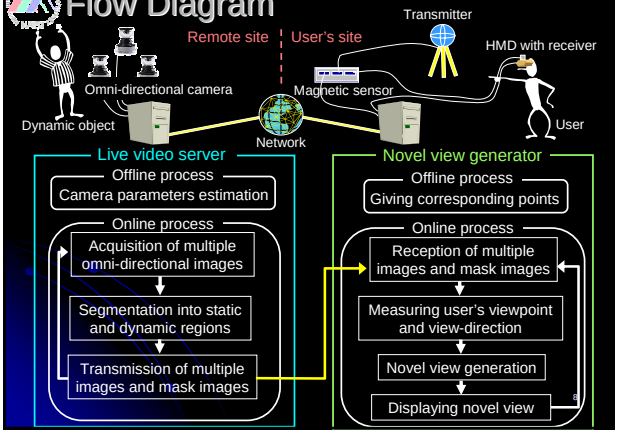
Flow Diagram



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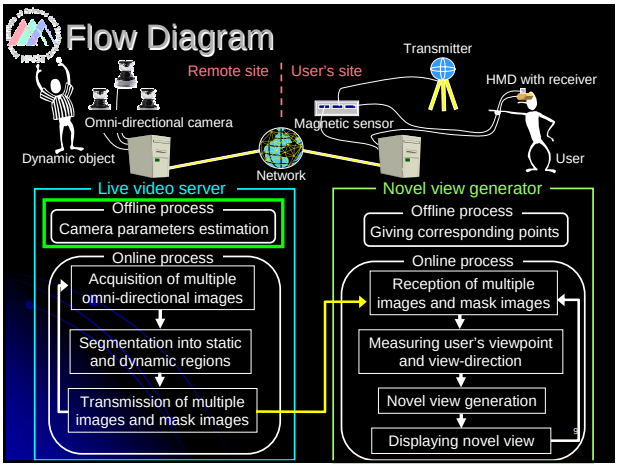
Flow Diagram



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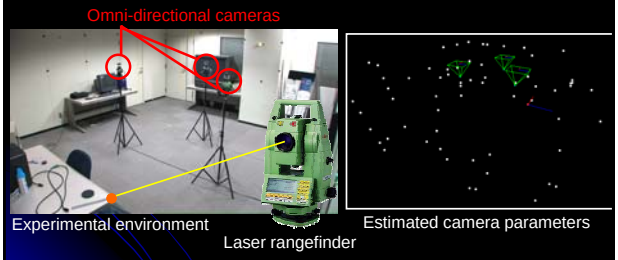
Camera Parameters Estimation

Estimating camera position, posture and focal length by using markers of known 3D position



The markers measured by the laser rangefinder are located in all azimuth from camera positions.

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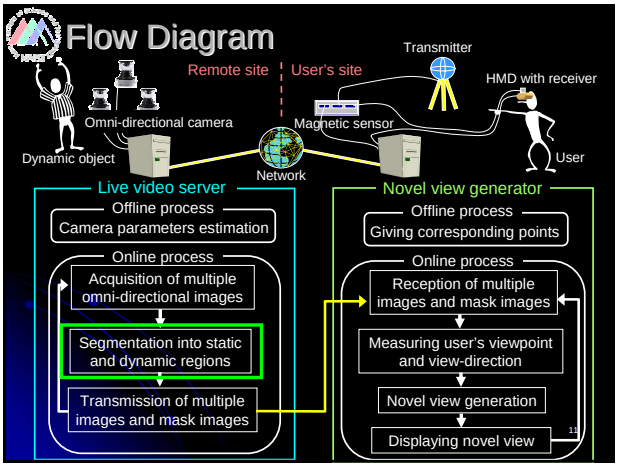
Flow Diagram



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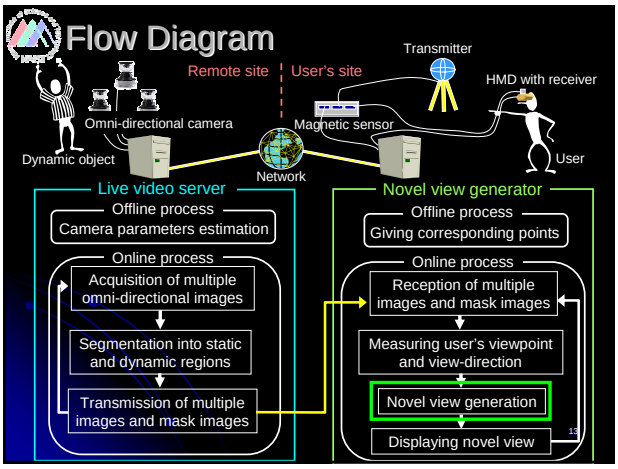
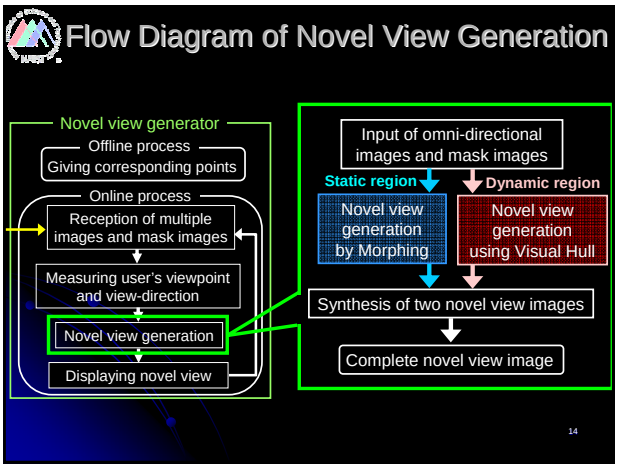
Segmentation into Static and Dynamic Regions

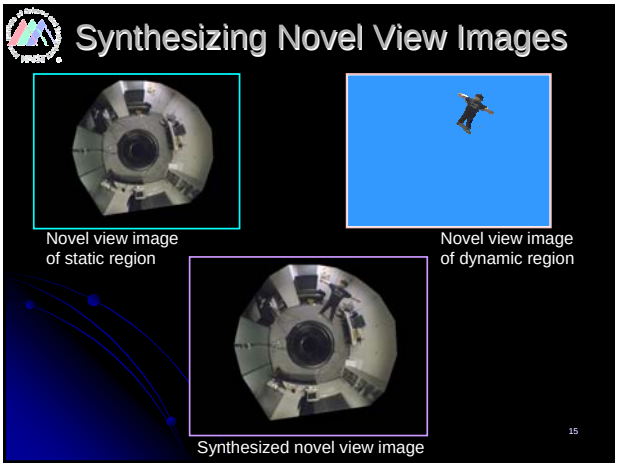
Robust background subtraction by adaptive threshold and renewing background

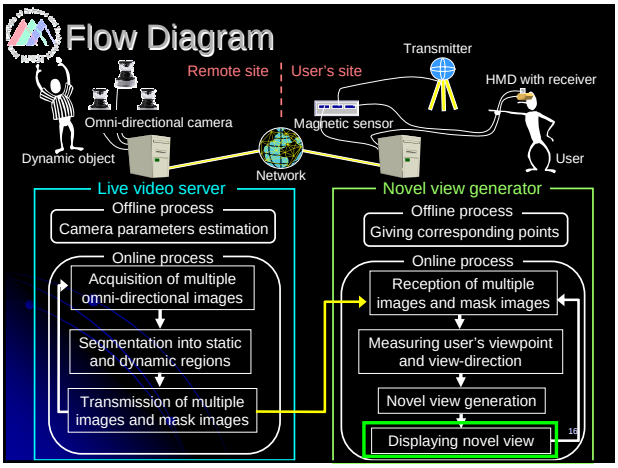
- Robustness for flicker and smooth lighting change

The view-independent process is calculated in server side.12


Flow Diagram
Remote site
User's site
Transmitter
HMD with receiver
Omni-directional camera
Magnetic sensor
Dynamic object
Network
User
Live video server
Offline process
Camera parameters estimation
Online process
Acquisition of multiple omni-directional images
Segmentation into static and dynamic regions
Transmission of multiple images and mask images
Novel view generator
Offline process
Giving corresponding points
Online process
Reception of multiple images and mask images
Measuring user's viewpoint and view-direction
Novel view generation
Displaying novel view


Flow Diagram of Novel View Generation
Novel view generator
Offline process
Giving corresponding points
Online process
Reception of multiple images and mask images
Measuring user's viewpoint and view-direction
Novel view generation
Displaying novel view
Input of omni-directional images and mask images
Static region
Dynamic region
Novel view generation by Morphing
Novel view generation using Visual Hull
Synthesis of two novel view images
Complete novel view image


Synthesizing Novel View Images
Novel view image of static region
Novel view image of dynamic region
Synthesized novel view image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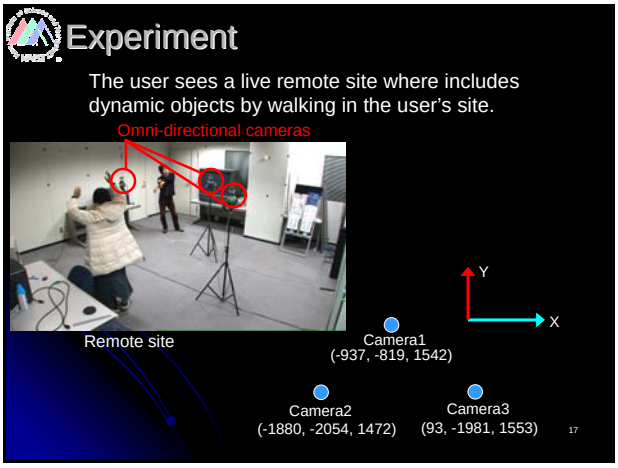
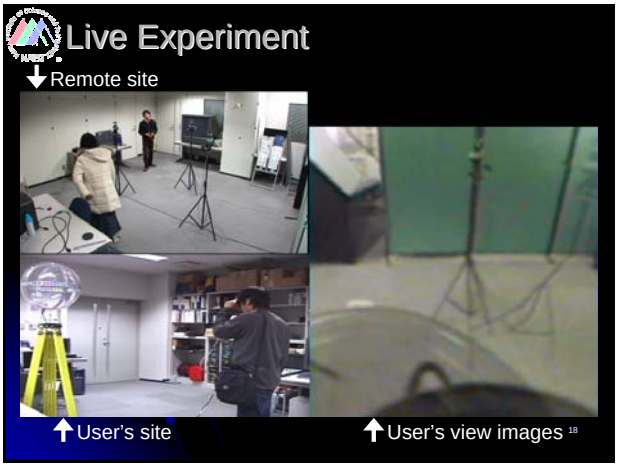

Experiment
The user sees a live remote site where includes dynamic objects by walking in the user's site.
Omni-directional cameras
Remote site
Y
X
Camera1
(-937, -819, 1542)
Camera2
(-1880, -2054, 1472)
Camera3
(93, -1981, 1553)


Live Experiment
Remote site
User's site
User's view images

Conclusion

- Networked telepresence system which enables a user to see a remote dynamic scene interactively
- We have confirmed that our system can give the feeling of being in a remote site to the user.

Future works

- Improvement of image quality
- Realizing telepresence system which enables to walk through remote wide areas

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