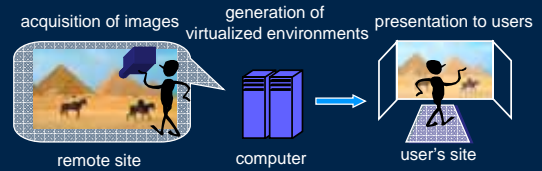


Immersive Telepresence System Using High-resolution Omnidirectional Video with Locomotion Interface

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1

Requirements for Telepresence System



- Reduction of Human Cost
 - in acquisition of images
 - in generation of virtualized environments
- Improvement of a Sense of Presence in presentation to users

2

Conventional Telepresence Systems

- S. Chen (1995) : QuickTime VR
 - ✗ Panoramic image generation by mosaicing technique at various camera positions
 - ✗ User interface using a standard display, a mouse and a keyboard
- D. Kotake et al. (2001) : Cybercity walker 2001
 - ✓ Omnidirectional video acquisition using multiple cameras mounted on a car
 - ✓ Presentation using an immersive display
 - ✗ Control of a virtual view position using a game controller

Blue : Reduction of Human Cost Red : Improvement of a Sense of Presence 3

Proposed Telepresence System

offline phase

Acquisition of Images



OMS: Omnidirectional Multi-camera System

Generation of Virtualized Environments

Estimation of Camera Path

Correction of Acquired Video

online phase

Presentation to Users

Immersive Display

+

Locomotion Interface



4

Proposed Telepresence System

offline phase

Acquisition of Images



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online phase

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5

Acquisition of Images with OMS

OMS : Omnidirectional Multi-camera System



Ladybug (Point Grey Research)

- six XGA camera units
- 15 fps video
- 75% full spherical view



input videos



panoramic video

Calibration

- lens distortion · camera pose
- limb darkening · color balance

6

Proposed Telepresence System

offline phase

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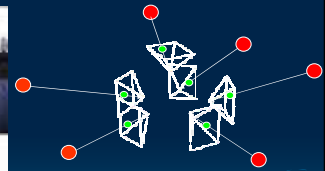
7

Estimation of Camera Path of OMS

T. Sato, et al. "Extrinsic camera parameter recovery from multiple image sequences captured by an omni-directional multi-camera system", ECCV2004



Natural feature tracking



View volumes of OMS

● : estimated 3-D position

● : detected 2-D position

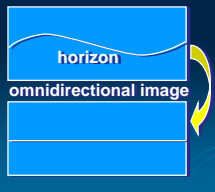
8

Correction of Omnidirectional Video

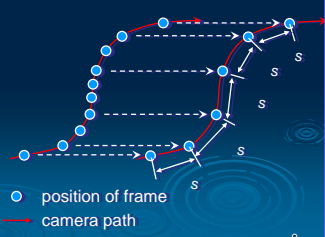
using the estimated orientation and position of OMS

□ Camera shake effect

... is caused by OMS's rotation & translation



□ Replay speed



○ position of frame

— camera path

9

Proposed Telepresence System

offline phase

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online phase

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+

Locomotion Interface



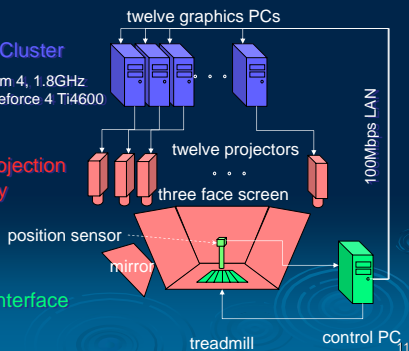
Immersive Display with Locomotion Interface

Graphics PC Cluster

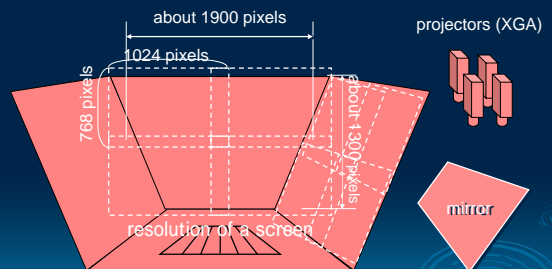
CPU: Intel Pentium 4, 1.8GHz
Graphic Card: Geforce 4 Ti4600

Immersive Projection Display

Locomotion Interface



Immersive Projection Display



12

Experimental Result

~ Acquired Videos & Estimated Camera Path ~

Acquired Videos
interval : 4 cm/frame
(capturing frame rate 15fps,
average speed 0.6 m/s)

Estimated Camera Path
length : 24 m
camera shake effect
(max rotation) : 4.1 deg
variation of speed: 0.3~0.9m/s

pyramid: view volume of
a reference camera at every 10 frames

Experimental Result

~ Correction of Camera Shake Effect ~

non-corrected

corrected

Experimental Result

~ Presentation of Virtualized Environment ~

Appearance User's view

frame rate 26fps

Summary

- Proposed telepresence system
 - Omnidirectional video acquisition using an **calibrated OMS**
 - Estimation of **camera path**
 - Reduction of shake effect
 - Correction of replay speed
 - **Locomotion interface**
- Observation

The proposed system provides users with a sense of walking in a remote site.

Future Work

- Quantitative Evaluation
- Relaxation of the limitation of the user's view point in a virtualized environment