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Augmented Telepresence from the Sky: AR using Autopilot Airship and Omni-directional Camera

Fumio Okura, Masayuki Kanbara, and Naokazu Yokoya
Nara Institute of Science and Technology (NAIST)

Augmented Telepresence

Augmented Reality

Telepresence

Augmented Telepresence

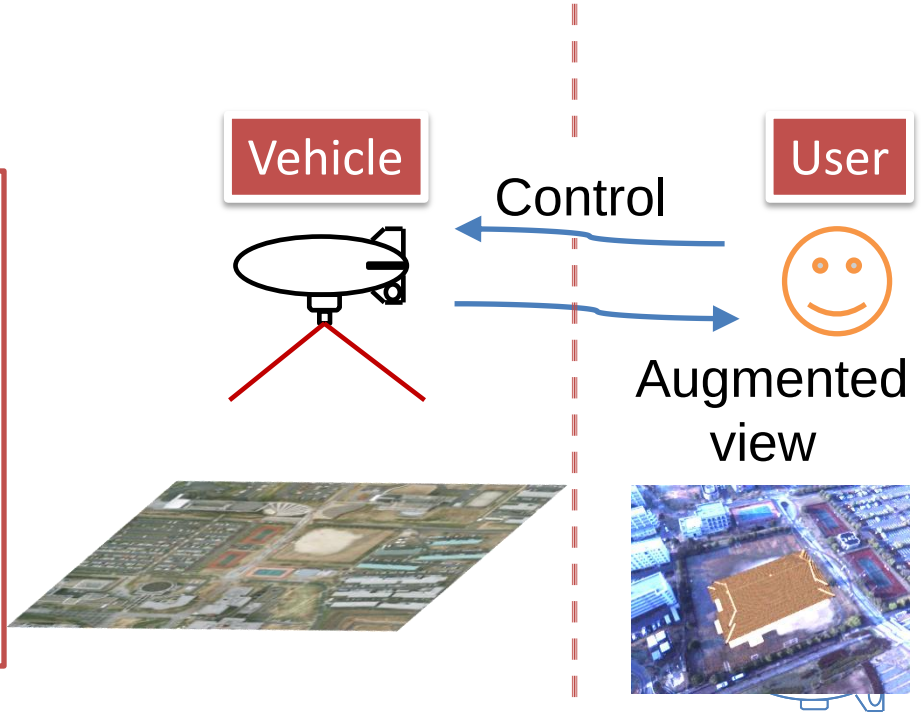
Augmented Telepresence using Remote Controlled Vehicle or Robots

Features

- A camera equipped with vehicle captures view of remote site.
- User can move around in remote site by controlling vehicle.

Expected information overlaid on images

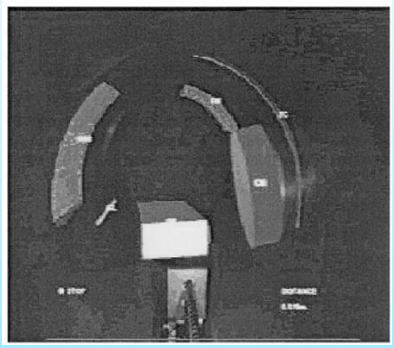
- Information for remote control of vehicle
- Annotation of buildings, landscape, and so on
- Old buildings used in cultural heritage application



Related Work

Augmented Telepresence using ground images
[S. Lawson, et al., 02]

- Information for remote control is overlaid on images taken by ground robot



Augmented Telepresence using aerial images
[H. Kim, et al., 99]

- Uses aerial images taken by a helicopter.
- Controls the helicopter manually.

Camera View

Augmented View

Benefits of Aerial Augmented Telepresence

Much information can be overlaid on the images because aerial vehicle can capture wide area.

Problem and Solutions

Problem

- A standard camera observes the real scene, hence rotation of vehicle is needed to change posture of user's view.
- Manual control of vehicle affected by many factors.

It's difficult for users to change position and posture of user's view to desired viewpoint.

Solution

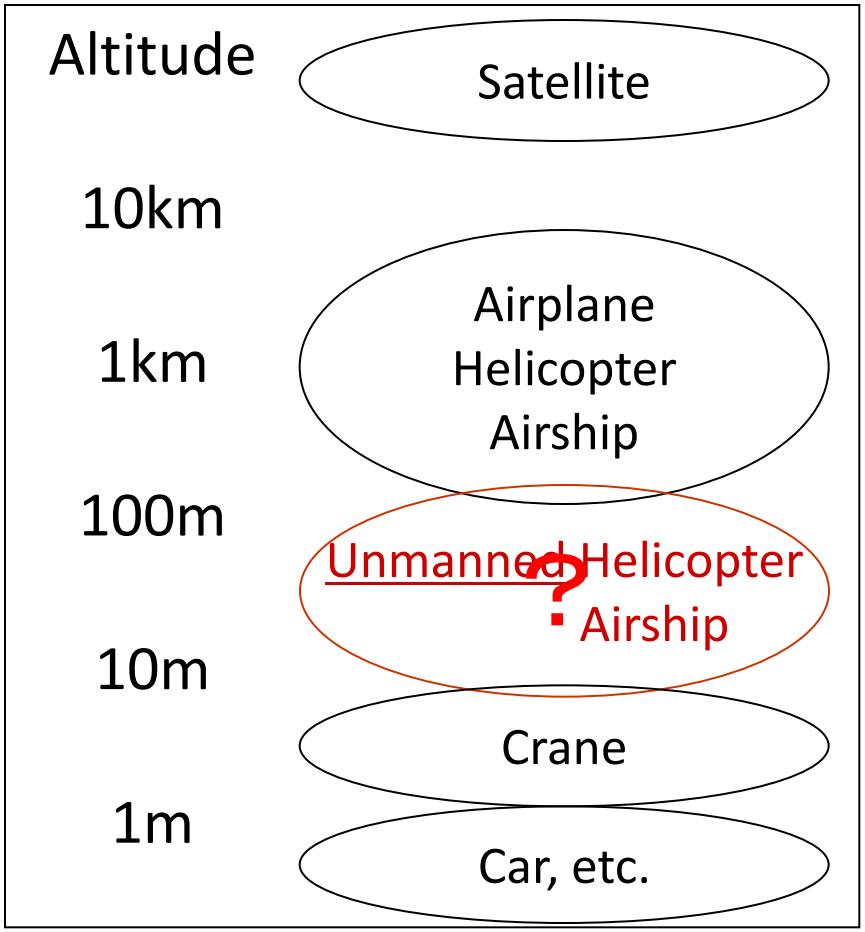
1. To change position of viewpoint

   Use an autopilot vehicle for support to change user's viewpoint

2. To change posture of view

   Use an omni-directional camera

What is the Best Vehicle for Aerial Augmented Telepresence?



Images for Augmented Telepresence

- Image acquisition with high resolution
- Capturing side face of buildings

Capturing from low altitude

Benefits to Use Airship

	Airplane	Helicopter	Airship
Altitude	High	Mid	Low
Flight speed	High	Mid	Low
Flight time	×	×	√
Easy to control	×	×	√
Safety	×	×	√

Unmanned airship is suitable for Aerial Augmented Telepresence.

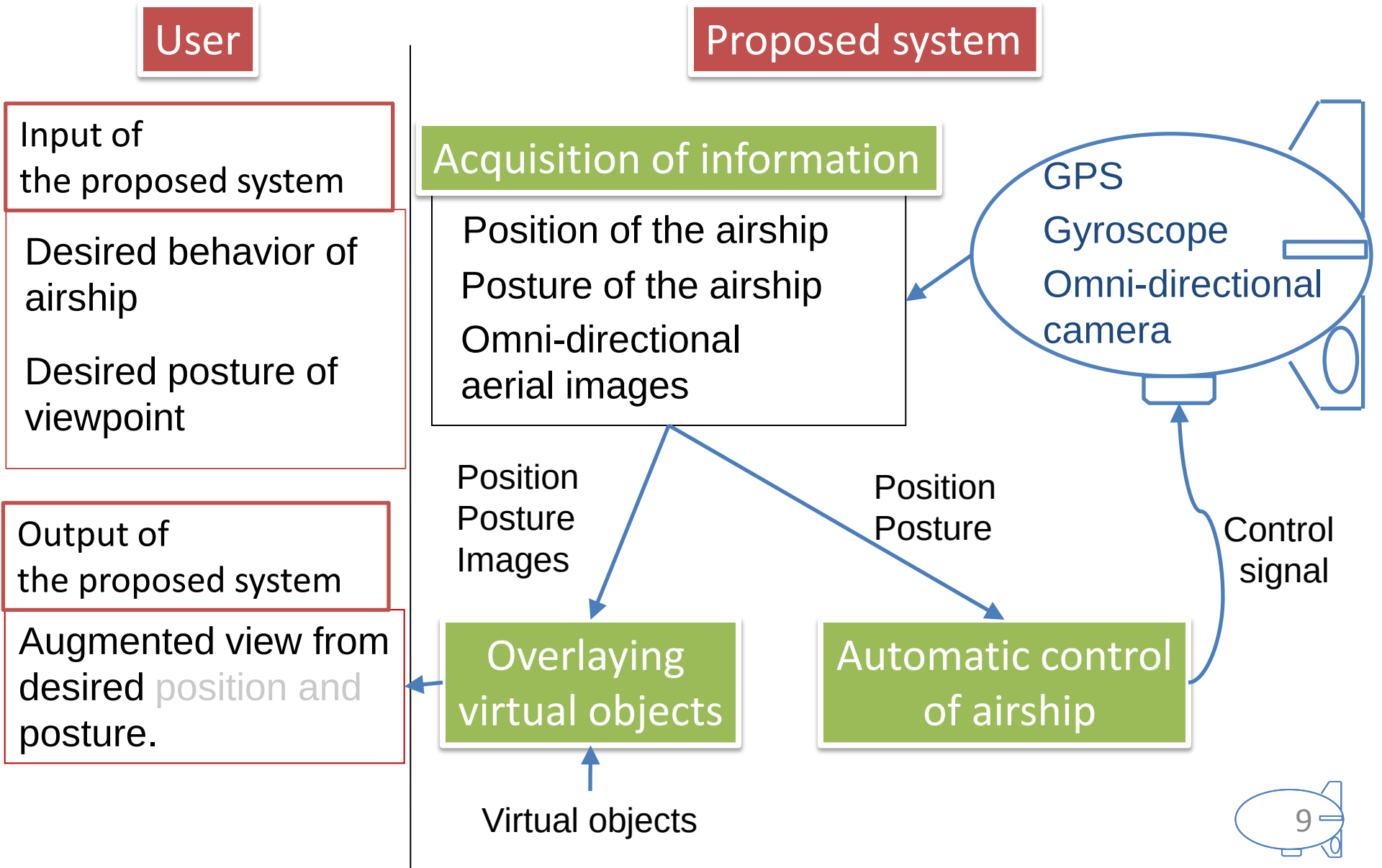
Goal

- Goal

  Development of Aerial Augmented Telepresence system which enables the users to change position and posture of the viewpoint easily

- Approach
  - Acquisition of information
    - Omni-directional aerial images
    - Position and posture of the airship
  - Overlaying virtual objects
  - Automatic control of the airship

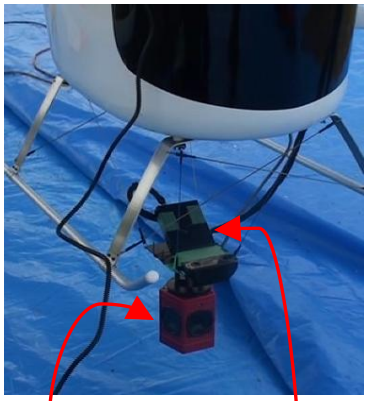
System Overview

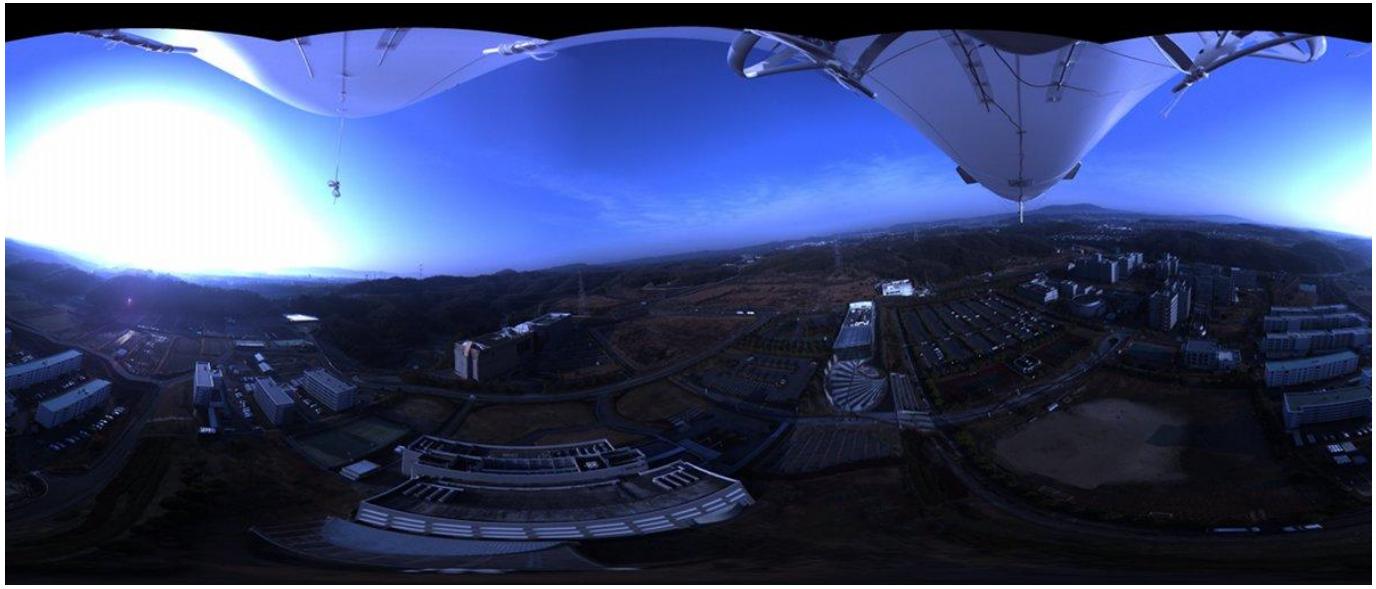


Acquisition of Information

- Position of airship: GPS
- Posture of airship: Gyroscope
- Omni-directional images: Omni-directional camera

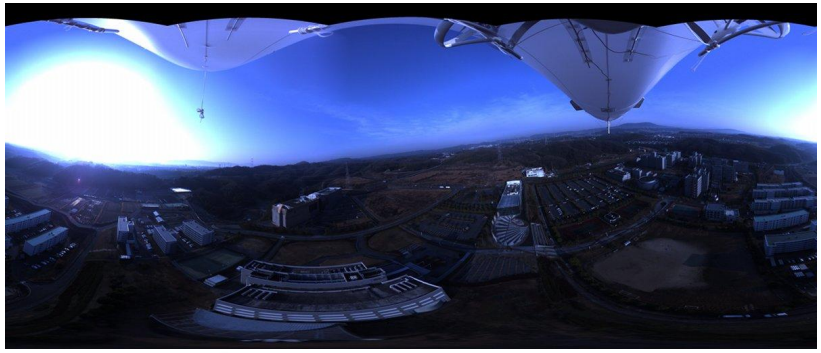
Camera position and posture information can be calculated from position and posture of airship.



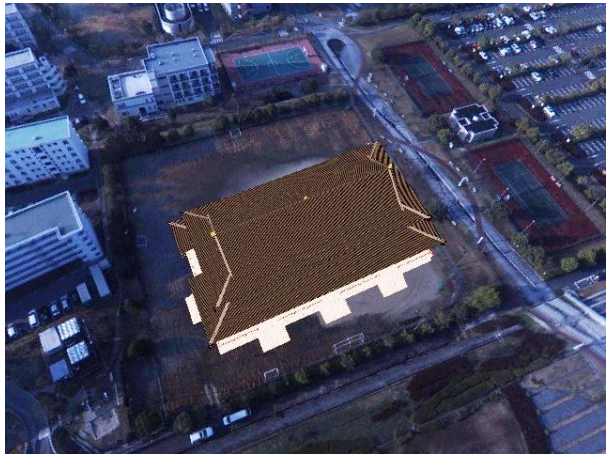


Aerial view taken by omni-directional camera

Overlaying Virtual Objects



1. A perspective image is produced from an omni-directional image by using desired posture of user's view.

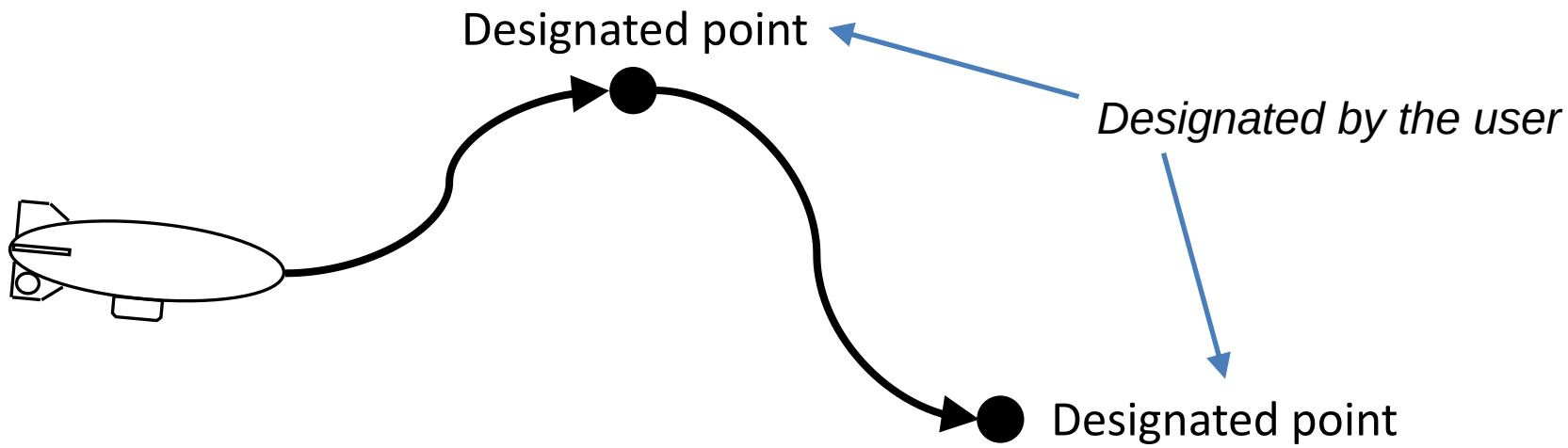


2. Position and posture information from GPS and gyroscope is used to overlay virtual objects to the images.

Automatic Control of Airship

Control around Designated Points

- The airship is controlled around designated points.
- The user can designate the points online.



This method is good for going to desired viewpoint.

Automatic Control of Airship

Reducing Degree of Freedom

Manual Control

- Control factors
  - Throttle
  - Rudder (right, left)
  - Elevator
  - Tilt, and so on
- Environmental factors
  - Wind
  - Buildings, and so on

Control supported by autopilot

- Control factors
  - Throttle
  - Rudder (right, left)

  Manual
  - Elevator
  - Tilt, and so on

  Automatic
- Environmental factors
  - Wind
  - Buildings, and so on

This method is good for “walk in the sky”.

Experiments

- Automatic control of airship
  - Controlled around two points (230m distance, 70m altitude from the ground)
  - Simple proportional control based on related work [Paiva, et al., 06] is applied.

- Overlaying a virtual object to aerial images captured in advance
  - Off-line implementation
  - The airship is controlled manually to take images.

System Constitution

Sky

Unmanned Airship
(12m length)

Differential
GPS

P4-GPS
(Nippon GPS Solutions)

Fiber-optic
Gyroscope

TISS-5-40
(Tokimec)

Omni-directional
Camera

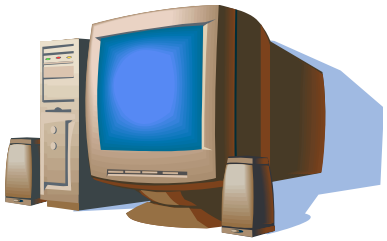
Ladybug3
(Point Grey Research)

Images
Position
Posture

Control signal

Ground

PC



D/A converter

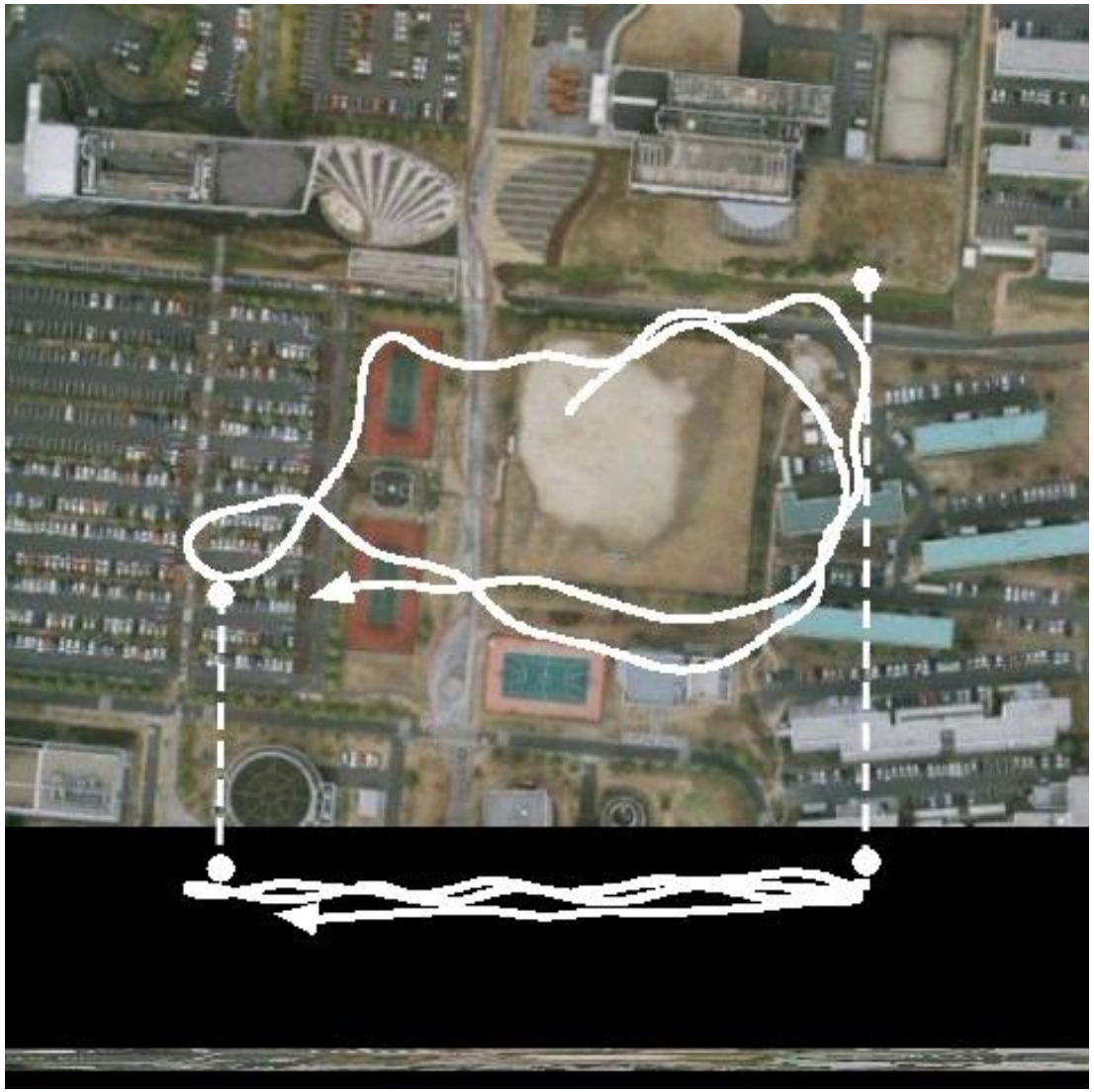
Control Signal

Transmitter

Experimental Result:
Automatic Control of Airship

Upper

Side

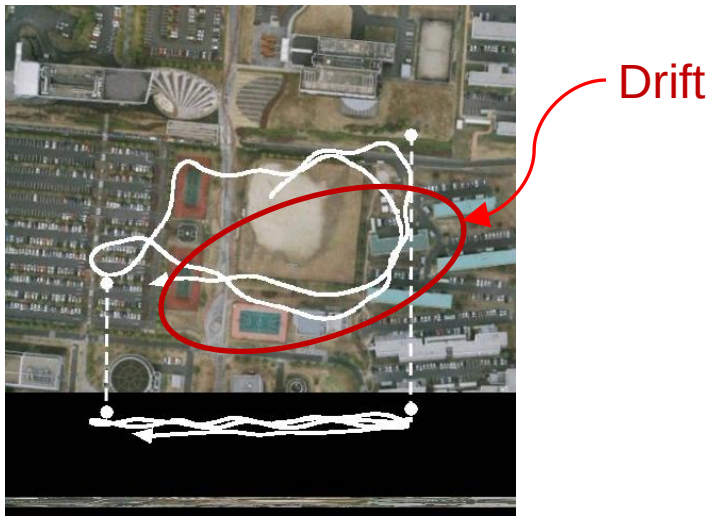


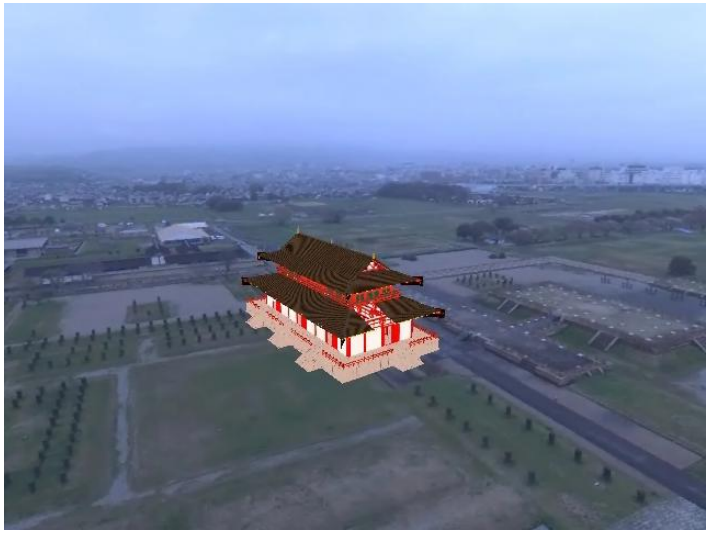
Experimental Result:
Overlaying a Virtual Object

“大極殿(Daigokuden)”,
an old building of Nara capital was overlaid on old base of Daigokuden.

Discussion

- Airship was controlled automatically.
  - Some errors occurred by micro compass in the gyroscope.
- Augmented aerial images were produced.
  - Registration errors occurred in some frames.





Conclusion

We have proposed an Augmented Telepresence system which enables the user to change position and direction of view.

Problem

It's difficult for users to change position and posture of user's view to desired viewpoint.

Solution

- Autopilot airship is used to support users changing position of viewpoint easily.
- Omni-directional camera is used to change posture of view.

Future Work

- Improvement of automatic control
- Improvement of registration and image quality
  - Vision based registration methods for correcting errors
  - Adjustment of image quality
- Development of real-time Augmented Telepresence
  - Realizing real-time processing
    - Real-time transfer of omni-directional images
  - Implementation of user interface