A DISTRIBUTED SYNCHRONOUS DESIGN MEETING PROCESS USING CLOUD-VR SKETCH FUNCTION

（VR-Cloud® を用いた遠隔デザイン会議プロセス）

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1. Introduction

In recent years, architectural and urban design meetings using VR to share 3D images have been held in a single room and at a certain scheduled time at practical level.

Virtual Design Studios (VDS) have been constructed exploiting new computing and communication technologies (Wojtowicz 1994, Maher 1999, Kvan 2000, Matsumoto 2006). VDS system developments and design trials of an asynchronous distributed type are mostly used allowing stakeholders to participate in the design process at various places and at different times.

Mobility of people's activities and cloud computing technologies have progressed rapidly in the period of information and globalization.

1. Introduction

In this research, we defined the following research questions:

"How can a design team advance their design study in a distributed synchronously type of environment by using the cloud computing type of VR (cloud-VR) and its annotation function – allowing freehand sketching in a 3D virtual environment?"

A synchronous distributed type in Time and Space Matrix

		TIME	
		Same (synchronous)	**Different (asynchronous)**
SPACE	**Same (face to face)**	Same time, Same place • Electronic meeting system • Group decision support systems	Different time, Same place • Digital Kiosk
	Different (distribution)	Same time, Different places • Video conference • Telephone	Different times, Different places • E-mail • Bulletin Boards • SNS (Blog)

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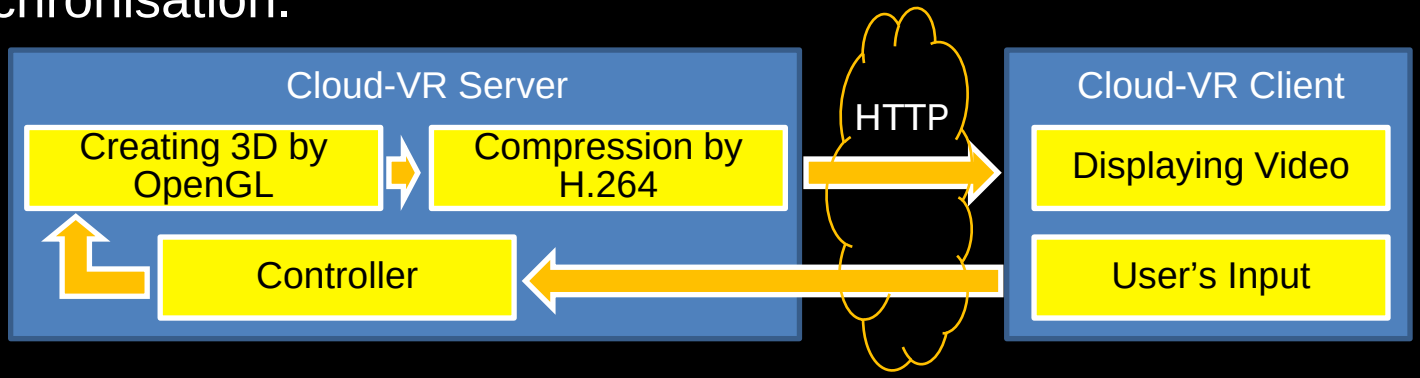
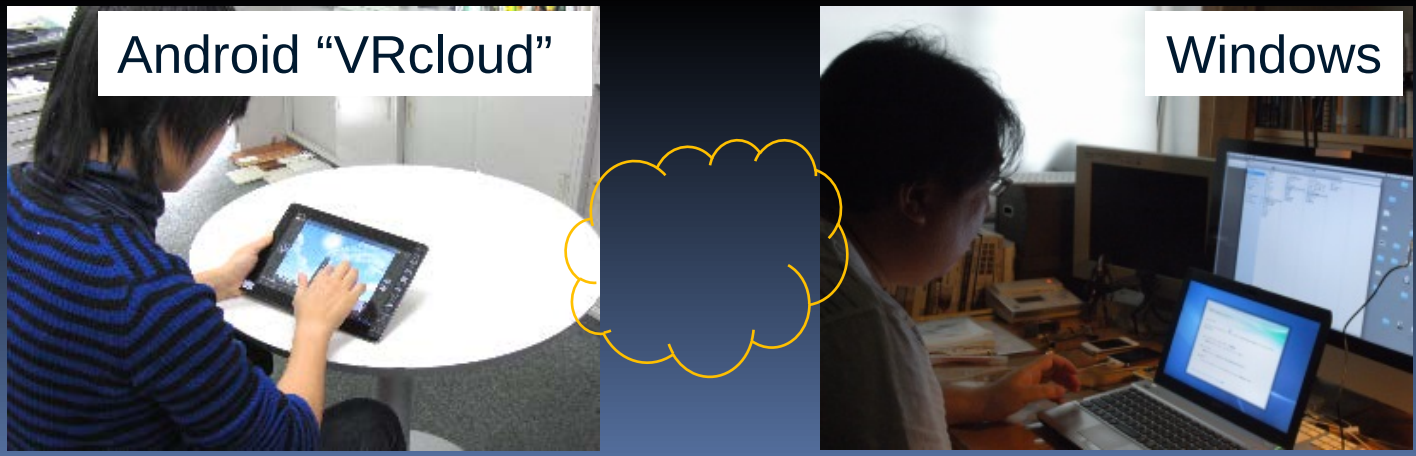
2.1. Annotation Function of Cloud-VR

3D-VR contents are transmitted by the video compression technique of the H.264 standard from the cloud-VR server.

Real-time 3D rendering in the server is quickly transmitted and do not require a well-GPU-equipped computer for client. More than 10 participants can share a viewpoint, alternatives, or the VR setup in synchronisation.





2.1. Annotation Function of Cloud-VR

When using 3D virtual space to study design approaches, stakeholders expect to be able to draw sketches and add figures and memos on the 3D virtual space. The annotation function has been developed and presented to realize this requirement (Sun 2013).

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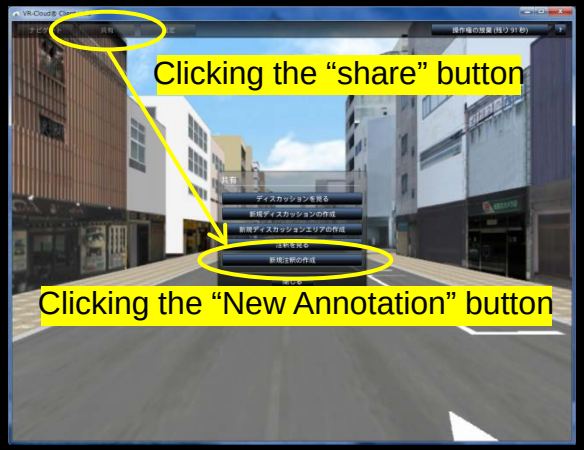

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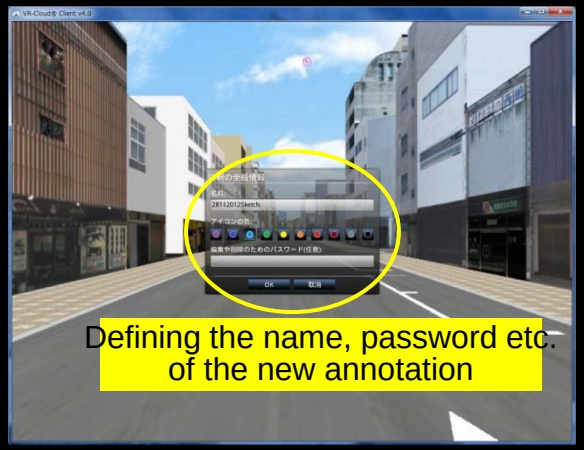

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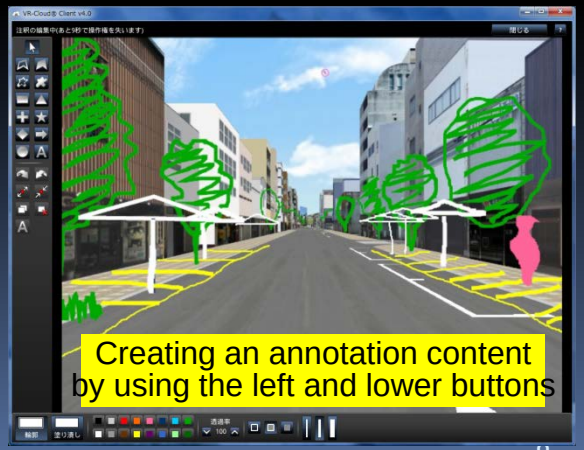

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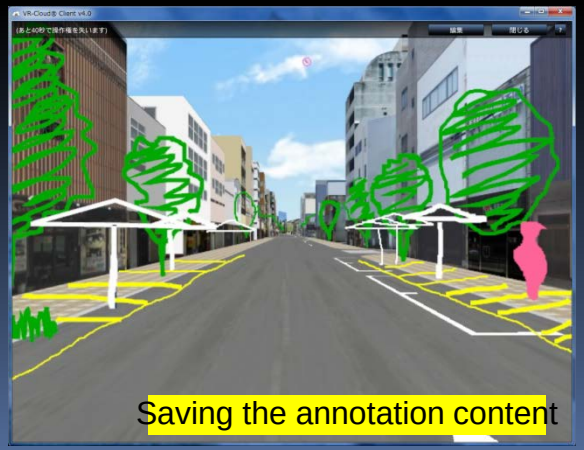

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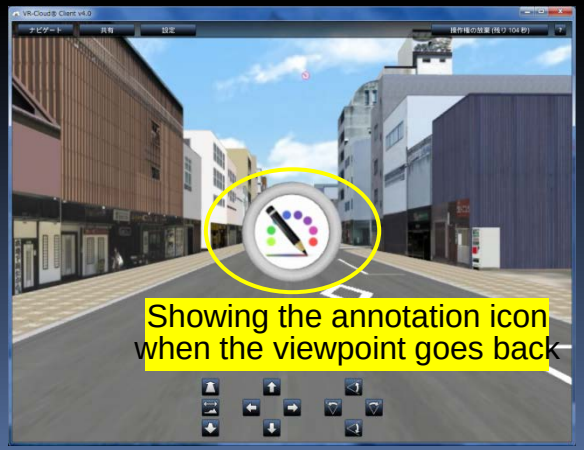

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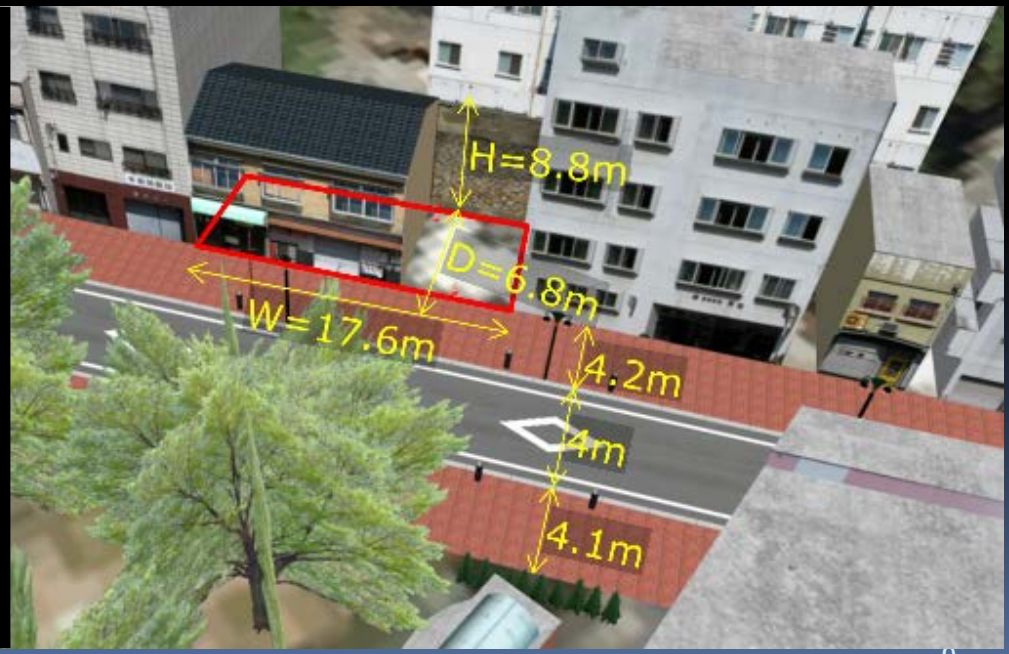
2.2. Experimental Plan

To consider the case of a collaborative architectural design meeting, we assumed an early design stage project to reconstruct a low layer residence which had become obsolete due to collective housing developments.

Conditions for the target site:

- 17.6m in building width, 6.8m in building depth, 12m in road width
- Building coverage ratio: 80%
- Floor area ratio: 600%
- A business district, a fire protection zone



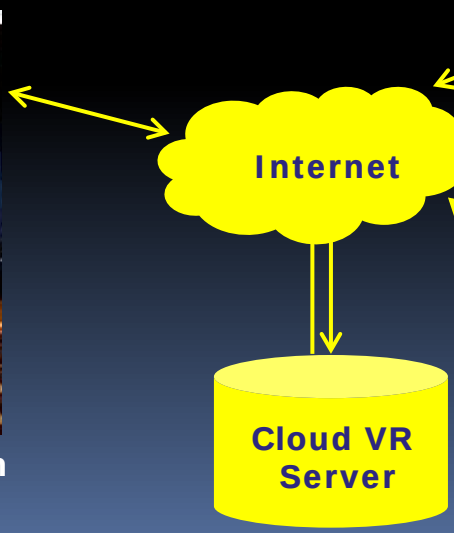
2.2. Experimental Plan

Three designers who were in different locations, used Windows PCs on which were installed cloud-VR and Google Hangouts as a video conference system.

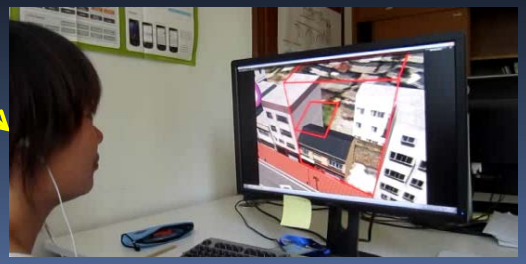
- Designer 1 in Chiba, Japan: Architect with practical experience and created an architectural plan.
- Designer 2 in Osaka, Japan: Good skills in VR operation and understood the current situation of the target site well.
- Designer 3 in Heidelberg in Germany: Documented the experimentation.

Experimentation: July 2013, 2Days

Designer1 @ Chiba, Japan



Designer2 @ Osaka, Japan



Designer3 @ Heidelberg, Germany

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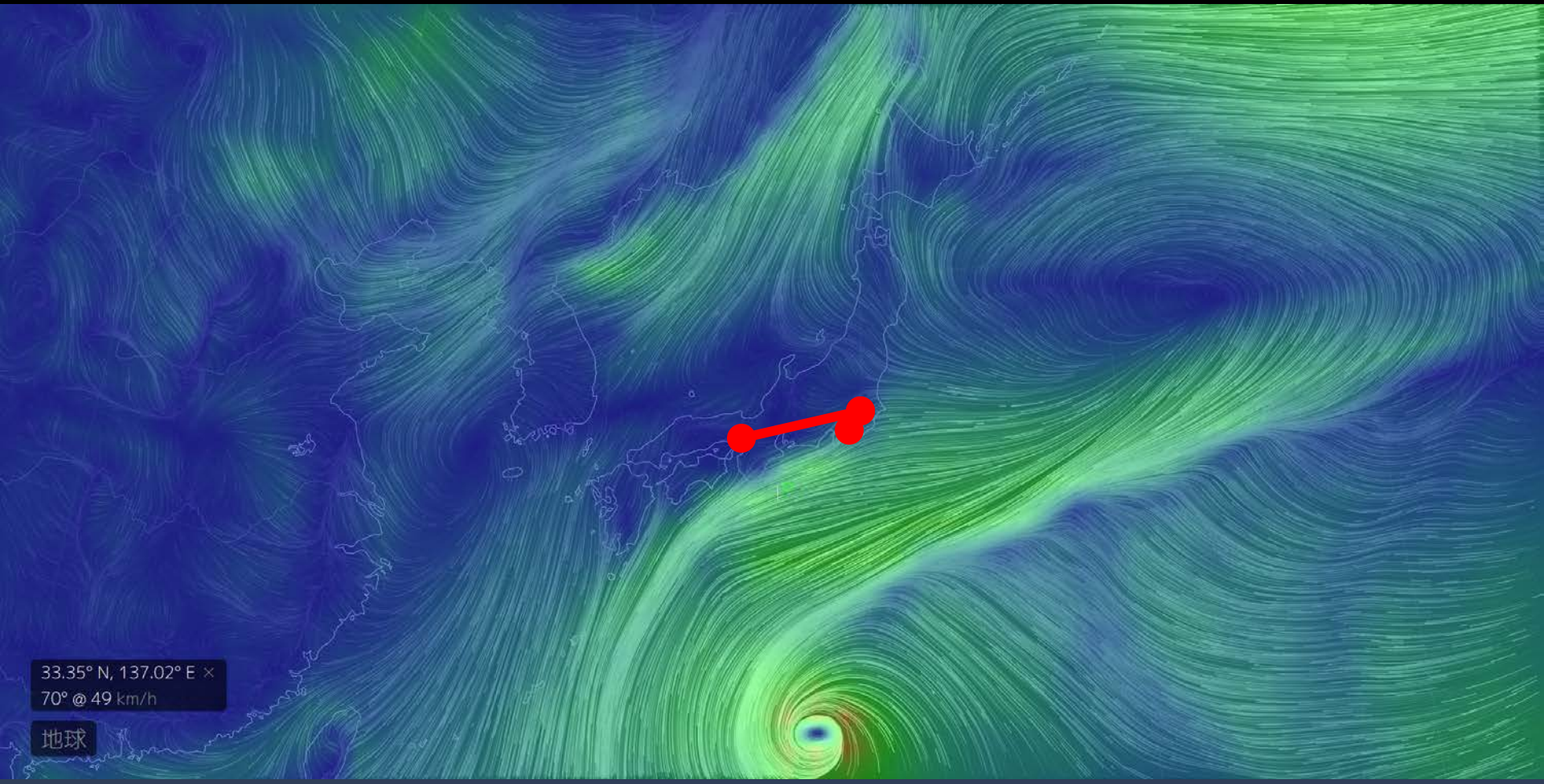
3.1. Reappearance Design Process by Real-time Short Demo



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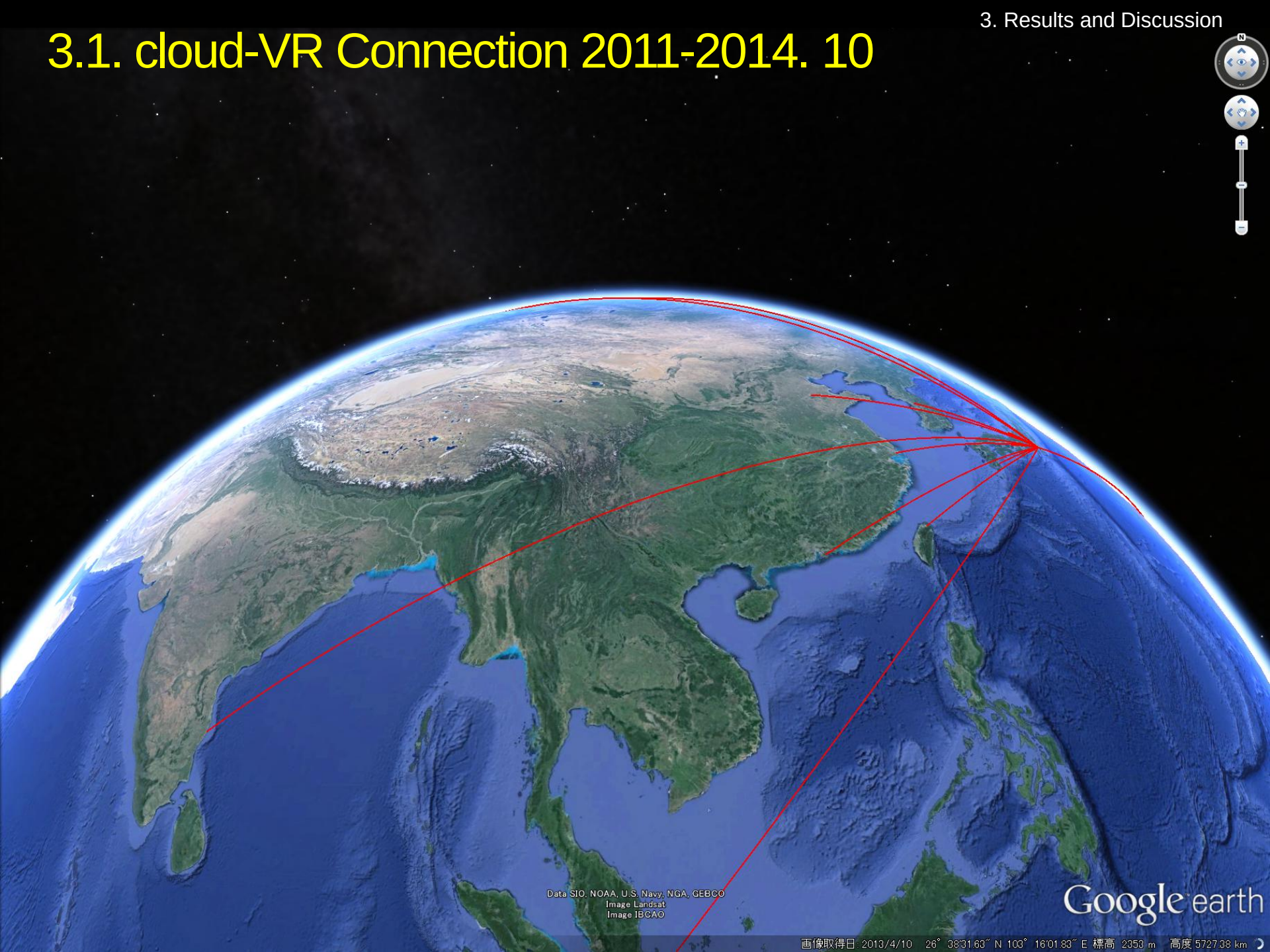
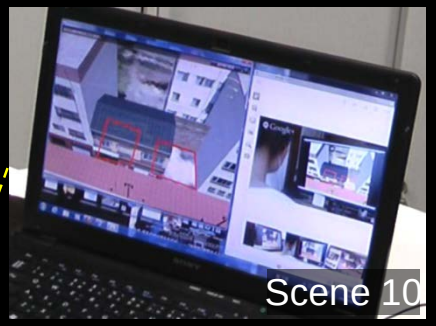
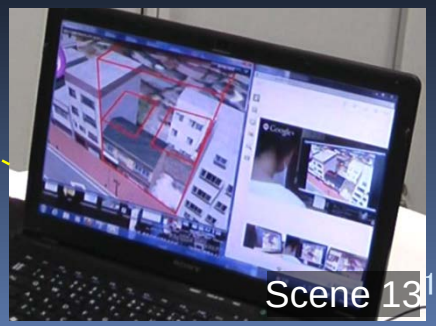
3.1. cloud-VR Connection 2011-2014. 10



3.1. Results: Design Process DAY 1

ID	Time(m:s)	Cloud-VR operation	Main speaker	Typical conversational content
01	0:00		Designer 2	Purpose of the design meeting was explained.
02	2:00	Designer 2	Designer 2	Designer 2 acquired the operation authority and explained the current situation of the target city.
03	3:45	Designer 2	Designer 2	Designer 2 explained the target building site.
04 *	4:05	Designer 2	Designer 2	On Designer 1's request, Designer 2 marked the target building site using the annotation function. The dimensions of the site and the status of the surrounding terrain were confirmed.
05	5:45	Designer 2	Designer 1	The construction condition were confirmed.
06	6:45	Designer 2	Designer 1	On Designer 1's request, Designer 2 operated VR to check access from the railway station and views of the building site.
07	9:50	Designer 2	Designer 1	The buildable construction volume was confirmed.
08	12:20	Designer 2	Designer 1	The buildable area per floor was confirmed. An entrance to the rental housing, and a store were planned on the first floor. Rental housing was planned from the second to the 7th floor.
09	14:00	Designer 1	Designer 1	The operation authority was changed to Designer 1.
10 *	14:25	Designer 1	Designer 1	Using the annotation function, from a bird's-eye view of the site, Designer 1 sketched the planar shape of the first floor of the building.
11 *	15:05	Designer 1	Designer 1	Using the annotation function, from a bird's-eye view of the site, Designer 1 sketched the common areas of the first floor level (plan 1). A concept of plan 1 was presented.
12 *	16:05	Designer 1	Designer 1	Designer 1 sketched the common areas of the first floor level (plan 2). A concept of plan 2 was presented.
13 *	18:30	Designer 1	Designer 1	From a bird's-eye view that was closer to the building site, using the annotation function, Designer 1 sketched the volume of the planning building.
14	21:55	Designer 2	Designer 2	The operation authority was changed to Designer 2. The scenery seen from the window of the planned building was reviewed.
15	27:20	Designer 2	Designer 1	The content of the next meeting was confirmed.





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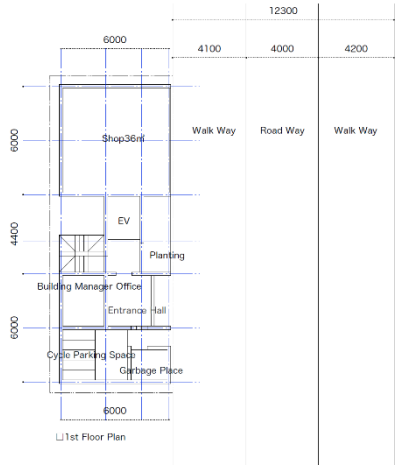
04 *	4:05	Designer 2	Designer 2	On Designer 1's request, Designer 2 marked the target building site using the annotation function. The dimensions of the site and the status of the surrounding terrain were confirmed.
05	5:45	Designer 2	Designer 1	The construction condition were confirmed.
06	6:45	Designer 2	Designer 1	On Designer 1's request, Designer 2 operated VR to check access from the railway station and views of the building site.
07	9:50	Designer 2	Designer 1	The buildable construction volume was confirmed.
08	12:20	Designer 2	Designer 1	The buildable area per floor was confirmed. An entrance to the rental housing, and a store were planned on the first floor. Rental housing was planned from the second to the 7th floor.
09	14:00	Designer 1	Designer 1	The operation authority was changed to Designer 1.
10 *	14:25	Designer 1	Designer 1	Using the annotation function, from a bird's-eye view of the site, Designer 1 sketched the planar shape of the first floor of the building.
11 *	15:05	Designer 1	Designer 1	Using the annotation function, from a bird's-eye view of the site, Designer 1 sketched the common areas of the first floor level (plan 1). A concept of plan 1 was presented.
12 *	16:05	Designer 1	Designer 1	Designer 1 sketched the common areas of the first floor level (plan 2). A concept of plan 2 was presented.
13 *	18:30	Designer 1	Designer 1	From a bird's-eye view that was closer to the building site, using the annotation function, Designer 1 sketched the volume of the planning building.
14	21:55	Designer 2	Designer 2	The operation authority was changed to Designer 2. The scenery seen from the window of the planned building was reviewed.
15	27:20	Designer 2	Designer 1	The content of the next meeting was confirmed.

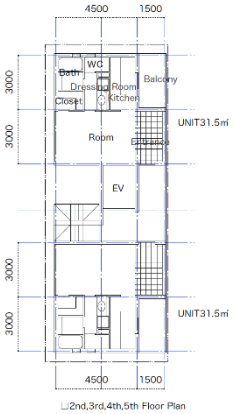
Three designers made themselves familiar with the conditions and the present situation of the site using fly-through and walk-through operations in the 3D virtual space of the cloud-VR.

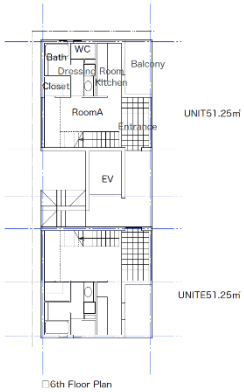
Designer 1 examined the building volume to determine the design conditions by building coverage and floor area ratio.
As a result, it was decided that a seven-storey building could be built.

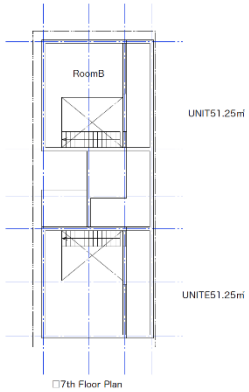
3.1. Results: Between DAY 1 and DAY 2

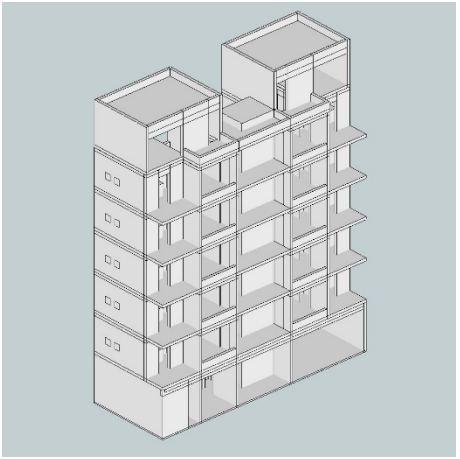
Designer 1 created the drawing in the schematic design phase based on the initial sketches made on DAY 1. Then, Designer 2 created a 3D virtual model of the building by using SketchUP and imported this to the cloud-VR server.

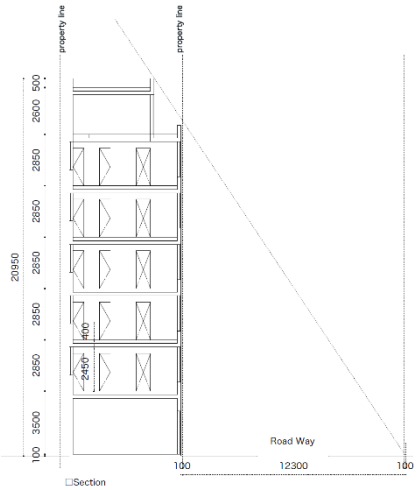








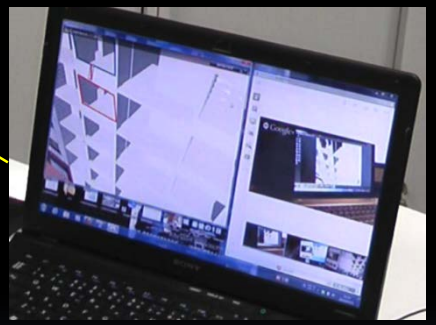




3.1. Results: Design Process DAY 2

ID	Time (m:s)	Cloud-VR operation	Main speaker	Typical conversational content
01	0:00		Designer 2	The purpose of the design meeting was explained.
02	0:30	Designer 2	Designer 2	Designer 2 acquired the operation authority and displayed the 3D building model created based on the meeting of DAY 1 in the 3D virtual space.
03	1:03	Designer 1	Designer 1	The operation authority was changed to Designer 1.
04 *	1:33	Designer 1	Designer 1	While overlaying the sketch on the 3D models, Designer 1 presented the zoning of the space using the annotation function.
05	4:20	Designer 1	Designer 1	Designer 1 presented the concept of space design. Both the 6th and 7th floors are designed as one dwelling unit. The forms were considered from a sky exposure plan of the front road.
06 *	7:00	Designer 1	Designer 1	From bird's-eye view that was closer to the building site, using the annotation function, Designer 1 explained the elongation of the windows necessary in order for the structure to be used for residential housing with a fire protection system.
07	10:55	Designer 2	Designer 2	The operation authority was changed to Designer 2. After entering the building interior, Designer 2 moved the building interior space via a walk-through. Designers 2 and 3 reviewed the view from inside the building and the window.
08	16:00	Designer 2	Designer 2	Designers 2 and 3 reviewed the view from the 5-7th floors and common areas.
09	23:00	Designer 2	Designer 2	Designers 2 and 3 reviewed the building façade from outside the building.
10 *	29:15	Designer 1	Designer 1	The operation authority was changed to Designer 1. While sketching using the annotation function, Designer 1 studied the sash and balcony of the building.
11 *	33:45	Designer 2	Designer 2	The operation authority was changed to Designer 2. Designer 2 proposed the façade design.
12 *	35:15	Designer 1	Designer 1	The operation authority was changed to Designer 1. While sketching using the annotation function, Designer 1 studied the building facade.

A more detailed design examination was carried out.



3.2. Discussion

Through the collaborative design work over two days, the synchronously and remotely cloud-VR meetings with freehand sketching function were finished as we expected. The annotation function was used effectively when Designer 1 drew the zone shapes of space composition, the volume shape of the planned building etc. in the schematic design phase.

Using the annotation function, a designer can draw directly by overlapping the sketch in 3D virtual space. Design activity has traditionally been carried out only in the imagination of the designer. Owing to the annotation function, design participants could share a concrete design image and could study the design interactively.

On the other hand, in an actual design work, it is hard for a designer to study a design only by using the screen of a VR perspective drawing. For an accurate understanding of the scale, orthographic drawing are also required.

3.2. Discussion

Technical problems with the annotation function were found:

- When a designer will draw sketches, the operation authority must be passed from the designer who previously had the operation authority. In order to pass the operation authority, it is necessary to terminate the annotation function once after saving. During the meeting, this operation interrupted the designers' conversation and thinking.
- During a designer drawing a sketch using the annotation function, the viewpoint of the 3D virtual space could not be moved. In the experiment, the designer who was sketching requested a function to zoom in/out on the design object more.
- If the 2D sketch drawn was converted into a 3D model automatically, a quicker study from various viewpoints can be possible.

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4. Conclusion

This research investigated the possibilities for synchronously distributed cloud-VR meetings in an architectural design process.

The experimentation of collaborative design work at the early stage of a housing renovation project was executed. The synchronously distributed cloud-VR meetings with freehand sketching function were finished by three designers in two days. The proposed system to share a 3D virtual space in regard to viewpoint, plan, sketch and other information synchronously and remotely was examined.

The annotation function was used effectively when designers drew the zone shapes of space composition, volume shape of the planning building and so on.

Through the experiment, some problems of the proposed design environment and the annotation function were clarified. Future work should attempt to solve the problems.

Acknowledgements and References

Acknowledgements

We would like to thank FORUM8 Co., Ltd. for the technical support.

References

- Dorta T., Kalay Y., Lesage, A., Perez, E.: 2011, Comparing Immersion in Remote and Local Collaborative Ideation through Sketches: A Case Study, *CAADFutures2011*, 25-39.
- Kvan T.: 2000, Collaborative design: what is it?, *Automation in Construction*, 9(4), 409-415.
- Maher M. L., Simoff S.: 1999, Variations on a Virtual Design Studio, *Proceedings of Fourth International Workshop on CSCW in Design*, 159-165.
- Matsumoto Y., et al.: 2006, Supporting Process Guidance for Collaborative Design Learning on the Web; Development of "Plan-Do-See cycle" based Design Pinup Board, *CAADRIA2006*, 72-80.
- Shen, Z. and Kawakami, M.: 2010, An online visualization tool for Internet-based local town-scape design, Computers, Environment and Urban Systems, 34(2), 104-116.
- Sun, L., et al.: 2013, A Synchronous Distributed VR Meeting with Annotation and Discussion Functions, *CAADRIA2013,* 447-456.
- Wojtowicz J.: 1994, Virtual Design Studio, *Hong Kong University Press*, Hong Kong.

Publication about this topic

- Lei Sun, Tomohiro Fukuda, Bernd Resch: A synchronous distributed cloud-based virtual reality meeting system for architectural and urban design, *Frontiers of Architectural Research*, Available online 25 June 2014.
- Tomohiro Fukuda, Lei Sun and Keisuke Mori: A Synchronous Distributed Design Study Meeting Process with Annotation Function, *Proceedings of the 19th International Conference on Computer-Aided Architectural Design Research in Asia (CAADRIA 2014)*, pp. 749–758, 2013.5, (full paper review).