論　文　要　旨
Thesis Abstract

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※報告番号	甲第３１７号	氏　名 (Name)	FAUZAN ALFI AGIRACHMAN

主論文題名　（Title）

Affordance-based Design Review Method using Virtual Reality

内容の要旨　（Abstract）

In the architectural design process, the architect visualizes his works to communicate their ideas to project stakeholders. So they can understand what the architect's ideas are. The media technology used by an architect for visualization is developed and more sophisticated from time to time. One of them is immersive virtual reality (IVR) technology. It helps architects to develop spatial elements by intensifying spatial experiences that can be perceived by human senses in an immersive way, unlike other visualization media. Due to its spatial advantages and re-emerging in recent years, researchers in the architecture field explored VR technology for various purposes in the architectural design process. One of them is in the design review process. Unfortunately, most studies tended to utilize qualitative boolean responses only, such as good or bad. There is a need to adopt an approach that treats user perceptions in the design process. So, we adapt the affordance concept from ecological psychology study for a design review process.

This study aims to develop an affordance-based design review method in architectural design by utilizing immersive VR technology. It is at the intersection of architecture design, VR, and affordance study. This study was designed to develop an affordance-based review method framework, develop a VR system that supports the method, test out both method and VR system and evaluate the effectivity of VR system as the companion system for affordance-based design method process. The study was conducted in the scope of architectural education settings only and used a third-year architectural design studio course as a case study.

There are eight chapters in this study. Chapter 1 serves as the introduction to the study, including its background, motivations, problem statement, goals, objectives, scope, and structure. Chapter 2 presents the literature review for the study. It covers the virtual reality

technology and affordance study in architecture. Chapter 3 covers how the affordance-based design review process is defined and works from defining the affordances into Affordance Structure Matrix (ASM) to data analysis processes, including the proposed Present-Disappear-Stagnant (PDS) Process.

Chapter 4 conducted a pilot study for a VR system as a proof of concept. It explored the user interaction inside a virtual environment (VE) with a Building Information Modeling (BIM) model as a digital entity connected to a cloud-based database. Chapter 5 extended the prototype and brought its basic interaction model as the foundation of Virtual Reality Design Reviewer (VRDR) development. VRDR was designed to help students review their design works in the nuance of the architectural design studio course.

Chapter 6 exercised a simulation by utilizing VRDR in performing an affordance-based design review method to design works from a third-year architectural design studio course. In the simulation, three sets of data analysis were performed to find which design components of the reviewed design works achieved the studio objectives and which components must be improved, which affordances that are easy to be perceived with the non-VR and VR system, and the effectivity of VR system for performing design review process in terms of affordance ability to be perceived.

Chapter 7 extended the exercise of VRDR utilization by performing two parts of the study. Part 1 implemented VRDR in an ongoing design studio course with a student and a supervisor. Part 2 performed a confirmation study to affirm the result of Part 1. In conclusion, this study confirms that the affordance-based design review method using virtual reality helps students improve their design work by revealing the presence of positive and negative affordances in his work. It also reveals the differences between a student and supervisor in perceiving the affordances for reviewing design works. The comparison of media effectivity also confirmed the obligation of physical properties for perceiving affordances by users. Further discussion on practical workflow of the design review method and the advancement compared to other VR systems were explored in Chapter 8.

In the end, at Chapter 9, this study developed a framework of affordance-based design method using VR technology. It describes how the affordance-based design method is implemented in stages. Since it was tested only in educational settings, a future study may be performed to find the method’s effectiveness in professional settings.