USING IMMERSIVE VIRTUAL REALITY TO INVESTIGATE THE EXPERIENCE OF DAYLIT SPACES

Kynthia Chamilothori, Dipl. Ing. (Arch).
PhD advisers: Prof. Marilyne Andersen, Dr.-Ing. Jan Wienold

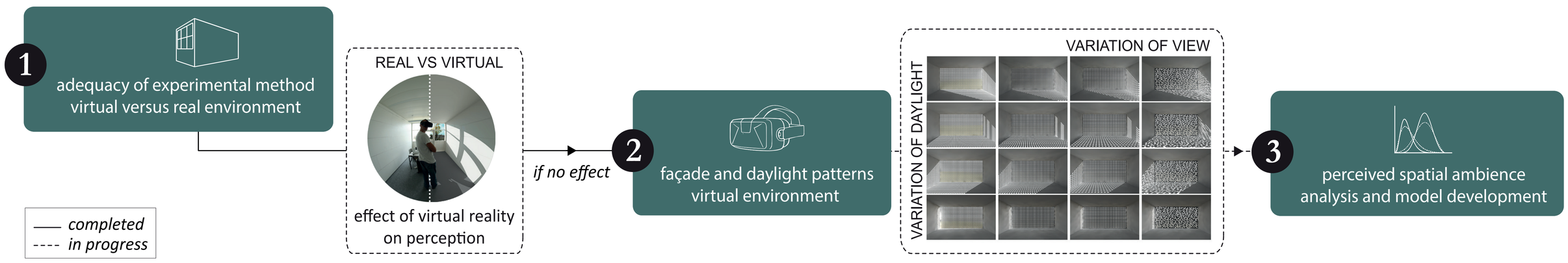
ABSTRACT:

Although daylighting research has produced established metrics regarding human comfort and the energy performance of daylight, we are left with an limited understanding of the perceptual aspect of luminous conditions. This shortcoming hinders the recognition of the positive impacts of daylight on our appraisal of space and the use of luminous effects as an intentional architectural outcome.

A considerable barrier in the acceleration of research in this subject is the difficulty of controlling the variation of luminous conditions in experimental studies. This thesis aims to overcome this barrier with the development and validation of a novel experimental method using a Virtual Reality (VR) Headset, providing a controlled immersive environment for the conduction of subjective assessments. Findings from experimental studies in the framework of this thesis, which compared the user perception of real environments and renderings in VR, as well as real environments and photographs in VR, are very promising for the adequacy of using the proposed method as a substitute for experiments in real space.

Following these positive results, we aim to assess a wide range of daylight and view conditions, primarily in virtual environments, and investigate relationships between the perceptual aspects of a scene, such as its ambience, and quantifiable characteristics of the façade and daylight patterns in the scene, such as its luminance distribution. Using the spatial context -the implied use of the space- as an additional variable, this thesis aims to broaden our understanding of human experience in daylit architectural spaces.

METHODOLOGY



1 ADEQUACY OF EXPERIMENTAL METHOD
PERCEPTUAL ACCURACY OF VIRTUAL REALITY

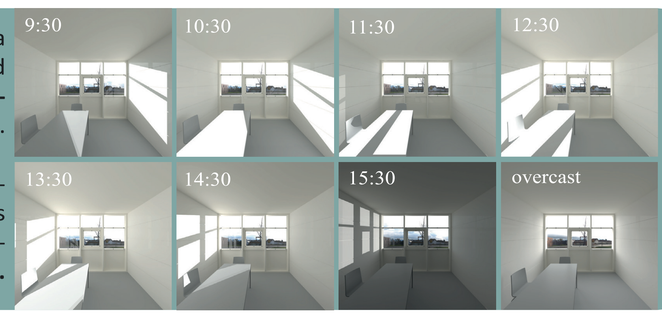
REAL SPACE

VIRTUAL SPACE

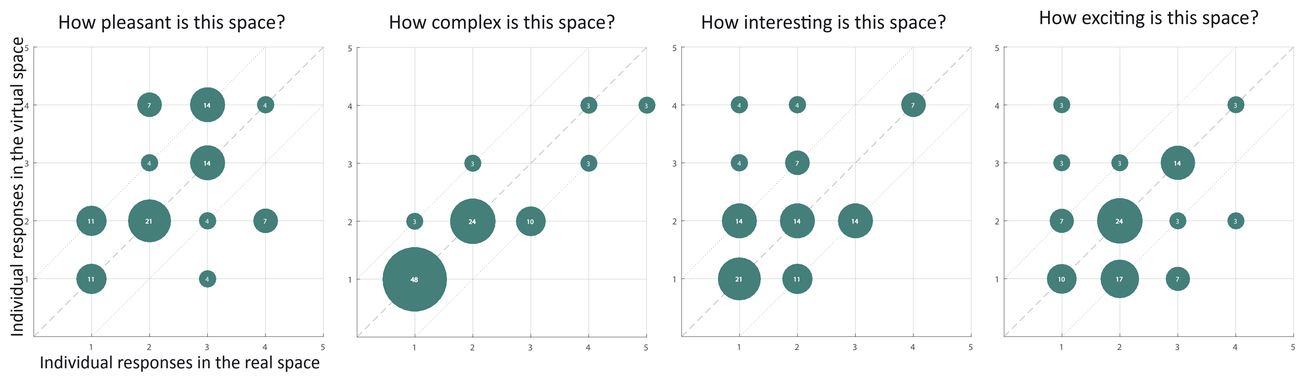
In this study, 29 participants saw in random order the real environment and the equivalent virtual environment in the Oculus Rift DK2 VR headset (*left*). The virtual space is based on Radiance renderings, creating a 360° immersive scene that can be explored from a static viewpoint (*right*).

As each participant saw both the real scene and a pre-rendered virtual scene (*left*) that best matched the real conditions in each session, we can **compare** their **evaluations in the two environments**.

The graphs below, along with the statistical analysis, show a **high level of agreement** in responses **between the real and virtual** scenes and are promising for the use of VR in **subjective experiments.**

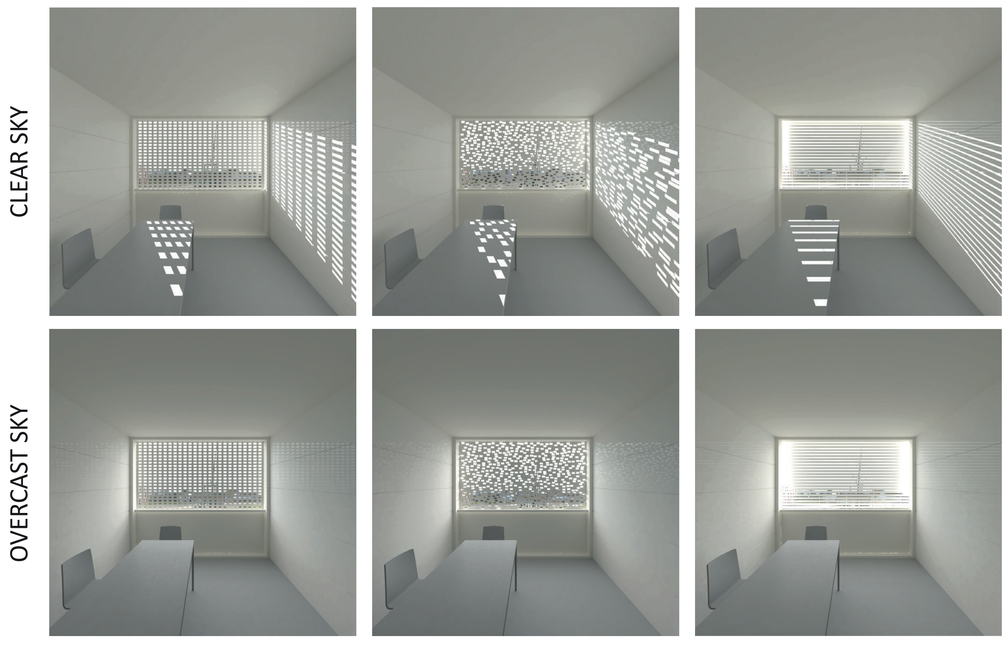


SUBJECTIVE RESPONSES



Distribution of individual paired responses (%) in the real and virtual environment.

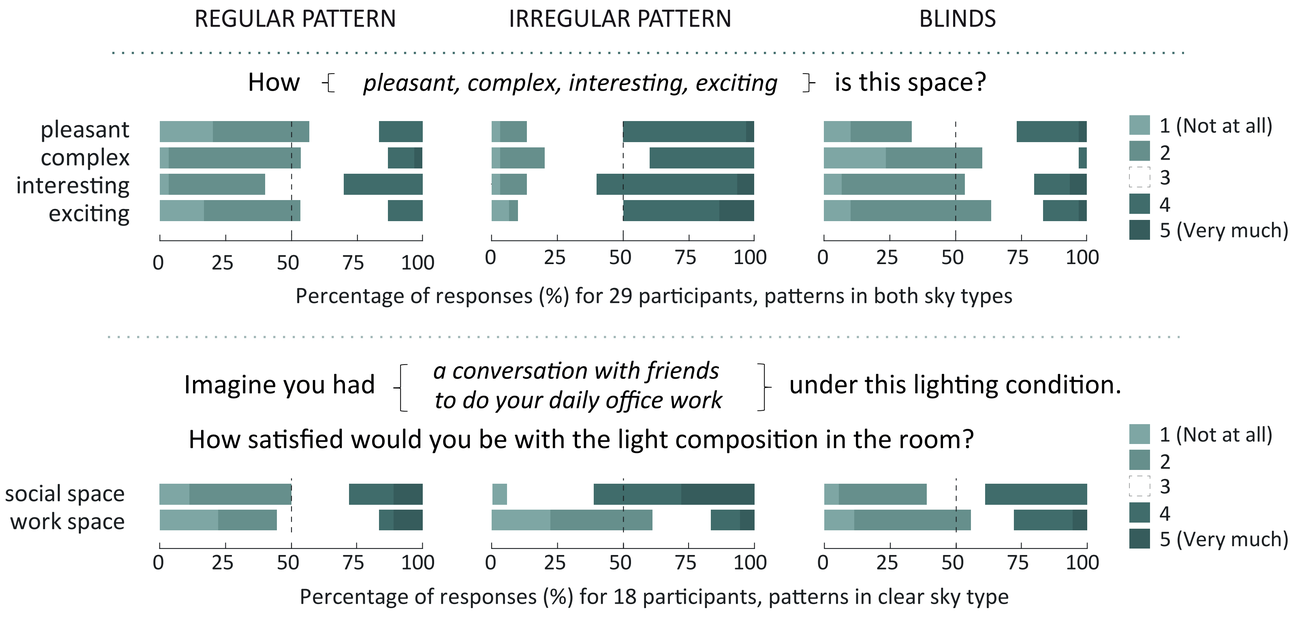
2 FAÇADE AND DAYLIGHT PATTERNS
EFFECT OF PATTERN IRREGULARITY



In this experiment in virtual reality, participants saw in random order the same scene with three different façade patterns under the same sky type and responded to the same questionnaire.

The responses on the **perception of space** show that the **irregular pattern** was evaluated **more positively** than the other two variations. Comparing the regular and irregular patterns, there was a significant **effect of irregularity** on how *pleasant*, *complex* and *exciting* the space was perceived.

Regarding people's **satisfaction with the light composition in the room** in different **scenarios of using the space**, the **irregular pattern** produced particularly **contrasting results** and was more **positively evaluated** than the other two façade patterns for a **social context** of space use.



KYNTHIA CHAMILOTHORI
kynthia.chamilothori@epfl.ch

Kynthia joined LIPID as a doctoral candidate in February 2015. She graduated with honors from the Technical University of Crete with a Master's degree (Dipl-Ing) in Architectural Engineering in 2014, receiving the Limmat Stiftung Excellence Award for her academic performance. Her research diploma project, "Memorigami", a prototype temperature-responsive shading system that integrates smart materials, received an innovation development grant from the 2013 University Student Entrepreneurship Project (UNISTEP). Before starting her doctoral studies, she collaborated with LIPID under the supervision of Dr. Boris Karamata for the development of a real scale prototype of an arabic-inspired adaptive shading system which responds passively to direct sunlight.

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