Using Information Chunking for Spatial Learning based on Augmented Reality

by **JIONGYAN ZHANG**

Studying indoors is essential to people, as individuals are required to engage in some cognitive tasks within indoor environments without the assistance of other third-party devices [1]. The use of Augmented Reality devices for spatial learning has proven effective, as [2] demonstrates that AR virtual landmarks can capture human attention. However, an unsuitable and chaotic design of virtual landmarks can lead to confusion [3]. In this context, we employ a kind of spatial chunking approach, visualizing individual landmarks based on spatial categories and hierarchy, to design an indoor AR-assisted learning system. Meanwhile, we design a user study to evaluate the system's effectiveness.

OBJECTIVES

Our objectives are as follows: (1) to identify a method for spatial chunking that achieves a balance in information load; (2) to devise a visual guidance system to assist users in exploring potential relationships within the space to enhance memory; and (3) to design controlled experiments to validate the effectiveness of our proposed system and analyze its pros and cons.

CHUNKING METHODS

We employ a flexible chunking approach that is not bound by rigid segmentation. Initially, we categorize indoor landmarks and assign distinct colors to different categories to provide users with an initial impression of the spatial layout. Simultaneously, within each category, we select a primary landmark (typically considered semantically significant) and highlight it with a bright color, while other landmarks, categorized as secondary, are presented in a lighter shade. This approach enables users try to focus their attention on primary landmarks, reducing information load, while secondary landmarks can be memorized by those with more capacity for spatial learning. However, certain unimportant landmarks such as trash cans and fire extinguishers lack hierarchical information. Consequently, we assign a uniform color scheme to all different landmarks and also employ distinctive shapes based on their appearance to assist users in better comprehension and memory retention.

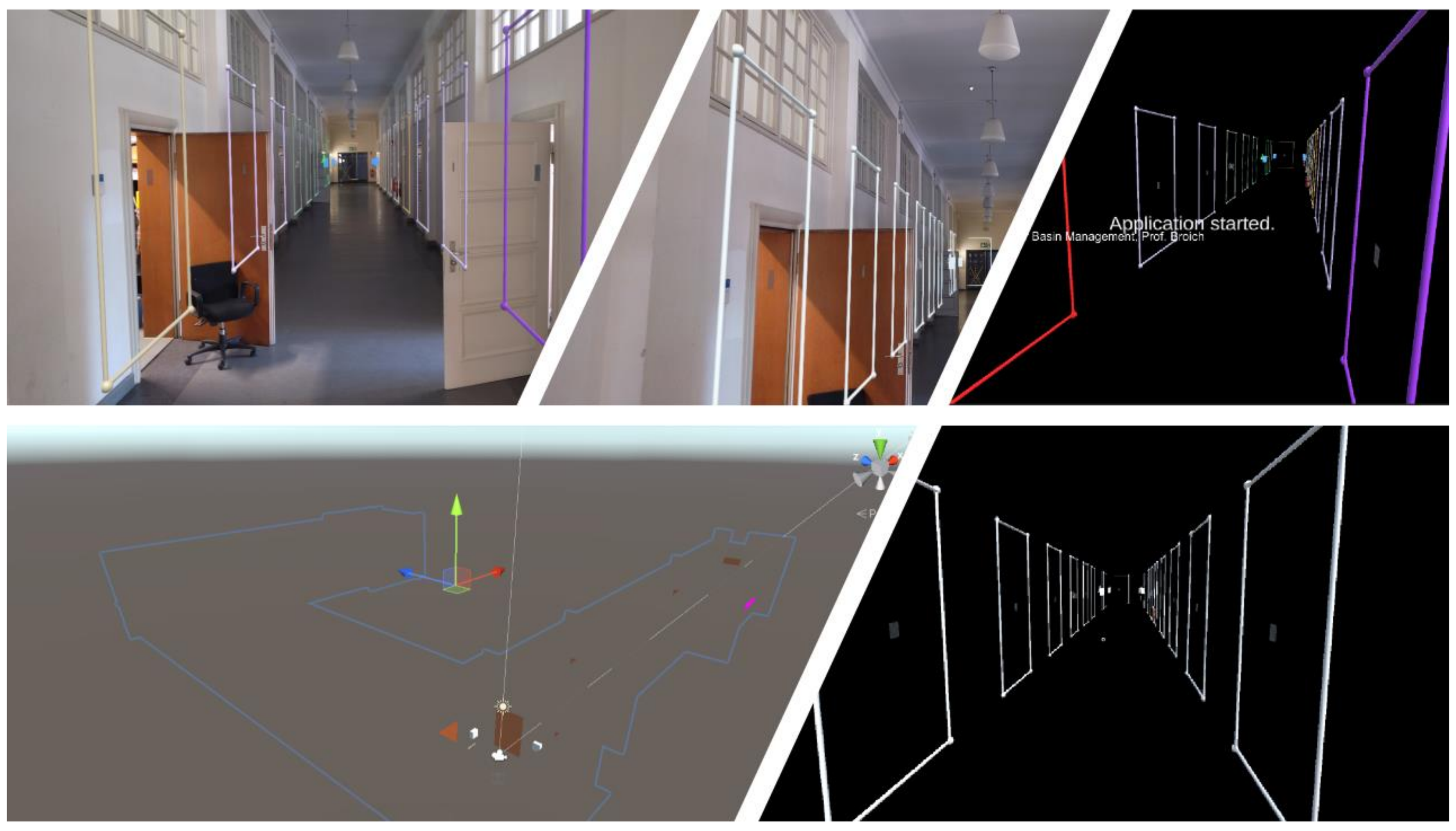

Fig. 2: System interface

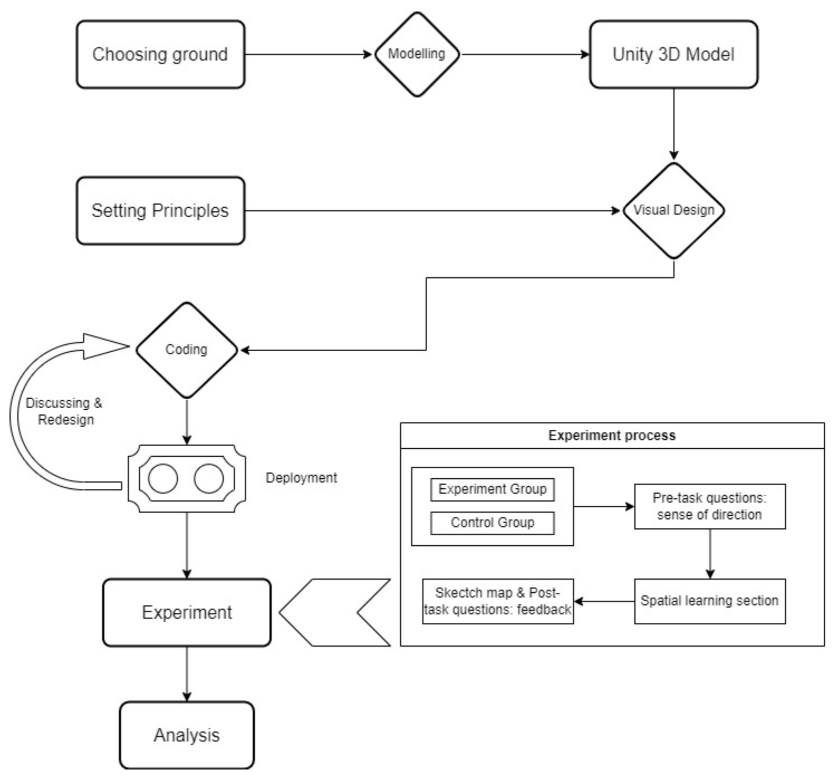

Fig. 1: Workflow

DESIGN

We employ the Unity 2020.3.15 platform and utilize the MRTK 3 framework to construct the current spatial model, along with coding for visual effects. The system is ultimately deployed onto the Hololens 2 device. Fig.2 showcases our designed Unity model, simulator effects, and real-world effects (with some deviation and color variation due to the use of external cameras attached to the Hololens 2 headset). Given the presence of a control group, all landmarks in the control group are configured as white landmarks.

USER STUDY

We recruit 38 volunteers to participate in the experiment (19 for experiment, 19 for control). Users need to finish a questionnaire to provide background information and give feedback after using the AR system. After that we conduct the data analysis to evaluate the system effect.

DATA ANALYSIS

We initially conduct differential tests to analyze the background information of the experimental and control groups in relation to the experiment. We find no significant differences in background information between the two groups. Then, we extract landmark memory quality scores and landmark memory topological edit distances from users' sketches to evaluate their memory performance. From various aspects, we demonstrate that the spatial learning performance of the experimental group surpasses that of the control group. Subsequent stress tests indicate that the experimental group experiences greater learning stress in the presence of information guidance compared to the control group. Finally, we conduct correlation examinations and find no significant relationship between users' backgrounds and their final assessment results, highlighting the system's broad applicability.

CONCLUSION

Our study introduces AR chunking for indoor spatial learning to overcome information overload. Using color-based visualization, we enhance efficiency while preserving detail. Experiments show better spatial learning, highlighting information organization's role in AR. Results are largely independent of user background. Despite limitations, our study provides insights for future research. We also encourage relative researchers to consider spatial chunking for better outcomes.

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