Virtual Reality Applications for Building Indoor Engineering: Circulation Way-Finding

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Abstract : Circulation paths and indoor connection network of the building play an important role both in the daily operation of the building and during evacuation in emergency situations. The degree of legibility of the paths for navigation inside the building has a deep connection with the perceptive and cognitive system of human, and the way the surrounding environment is being perceived. Human perception of the space is based on the sensory systems in a three-dimensional environment, and non-linearly, so it is necessary to avoid reducing its representations in architectural design as a two-dimensional and linear issue. Today, the advances in the field of virtual reality (VR) technology have led to various applications, and architecture and building science can benefit greatly from these capabilities. Especially in cases where the design solution requires a detailed and complete understanding of the human perception of the environment and the behavioral response, special attention to VR technologies could be a priority. Way-finding in the indoor circulation network is a proper example for such application. Success in way-finding could be achieved if human perception of the route and the behavioral reaction have been considered in advance and reflected in the architectural design. This paper discusses the VR technology applications for the way-finding improvements in indoor engineering of the building. In a systematic review, with a database consisting of numerous studies, firstly, four categories for VR applications for circulation way-finding have been identified: 1) data collection of key parameters, 2) comparison of the effect of each parameter in virtual environment versus real world (in order to improve the design), 3) comparing experiment results in the application of different VR devices/ methods with each other or with the results of building simulation, and 4) training and planning. Since the costs of technical equipment and knowledge required to use VR tools lead to the limitation of its use for all design projects, priority buildings for the use of VR during design are introduced based on case-studies analysis. The results indicate that VR technology provides opportunities for designers to solve complex buildings design challenges in an effective and efficient manner. Then environmental parameters and the architecture of the circulation routes (indicators such as route configuration, topology, signs, structural and non-structural components, etc.) and the characteristics of each (metrics such as dimensions, proportions, color, transparency, texture, etc.) are classified for the VR way-finding experiments. Then, according to human behavior and reaction in the movement-related issues, the necessity of scenario-based and experiment design for using VR technology to improve the design and receive feedback from the test participants has been described. The parameters related to the scenario design are presented in a flowchart in the form of test design, data determination and interpretation, recording results, analysis, errors, validation and reporting. Also, the experiment environment design is discussed for equipment selection according to the scenario, parameters under study as well as creating the sense of illusion in the terms of place illusion, plausibility and illusion of body ownership.

Keywords : virtual reality (VR), way-finding, indoor, circulation, design