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Research paper

Taxonomizing Building Forms and Characteristics for Urban Scale Virtual Reality 3D Models

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Abstract

Virtual reality (VR) technology allows urban environments to be experienced through a full-scale digital immersion. However, as the virtual environment (VE) in VR is set to be in full-scale by default, what can be considered as adequate details for architectural operations in large VEs is therefore ambiguous. This paper aimed to taxonomize building forms and characteristics represented as level of details (LOD) in creating operational urban scale 3D models for VR. A total of *N*=96 respondents participated in a survey, in which they were requested to rank the building characteristics critical to be represented in an urban scale VE. A Principal Component Analysis (PCA) was then used to factorize these characteristics which resulted to 'geometric extrusion' and 'distinction'. These components were then used to define the taxonomy of urban scale 3D models for VR.

Keywords: *Use about five key words or phrases in alphabetical order, Separated by Semicolon*

1. Introduction

The renewed interest in making VR to be affordable to the masses has paved the way to the so-called 'second wave' of VR revolution, as their current hardware and software have improved rapidly (Stein, 2015; Halley-Prinable, 2013). New possibilities such as using VR in architectural operations are therefore ought to be researched for exploring their potentials. VR has already been used for urban planning and construction activities (Diao, Xu, Jia, & Liu, 2017), but to increase non-specialists' interest in VR, the current pipeline of model acquisitions via user input in architectural practice must also be observed. The notion of sufficient details for this process is still vague, therefore this paper attempted to contribute a proper taxonomy to define what is sufficient for a full-scale urban VE in VR.

2. Methodology

The discourse framework was set through literature reviews. A total of *N*=96 respondents participated in a survey, in which they were asked to rank the architectural characteristic items which they perceived as critical to be preserved in an urban scale VR 3D model, measured at an ordinal scale (Likert-type score) with scores ranging from 1 (highly unimportant) to 5 (highly important). The items were then factorized through a PCA in SPSS to reduce a larger set of variables into a smaller set of constructs.

3. Representations and scale

The operational use of models may vary depending on the scale and the LOD (Stavrić, 2013). For practical purposes, reducing the scale of models will typically increase the LOD and vice versa. There are no rules on dictating how salient a 3D building in a VE should be built. In the case of a full-scale VR 3D models, the concern of scale is silent thus the notion of details' adequacy becomes more apparent. Therefore, it is relevant to use architectural forms and characteristics to become the basis for our taxonomy.

4. Schematization of lod

LOD is a discipline within the interactive computer graphics bridging the complexity of 3D models and its performance by regulating several details used in the models (Luebke et al., 2002). Ideally, reducing the LOD in the sampling of the 3D objects will eventually reduce the rendering computation. This reduction often comes at the expense of the visual detail. The use of 3D graphics in regulating LOD is increased simply because it can be achieved now (Çöltekin, Lokka, & Zahner, 2016), but this overlooks the substantial essence of the 3D models itself, that the interest of achieving a pragmatic VE is ignored. This paper argues that architects may only need neces-