The Level of Abstraction, Information Density and Storage Capacity for 3D City Model Visualizations

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ABSTRACT

The growing availability of digital 3D city models has increased the access to the virtual world which is either photorealistic or non-photorealistic. Photorealistic city models are intended to represent the geometry along with the appearance of the reality as authentically as possible. Typically, photos are precisely mapped as texture information onto the geometric model, which then renders a photorealistic impression of the underlying environment. Due to the dense information of photorealistic representations, the user has to cope with information which not necessarily refers to his needs. Especially in mobile applications with constraints such as limited computing capability and display size, inappropriate information may confuse or distract the user, thus results in frustration. To avoid this drawback, we choose the non-photorealistic style which addresses illustrative and expressive visualization techniques to highlight geometric and semantic characteristics of 3D city objects. We investigate the correlation among the Level of Abstraction (LOA), Information Density (ID) and the needed storage capacity (SC) for the representation of 3D city model. Increasing the level of abstraction usually leads to the decrease of information density to be processed. Accordingly, the general storage capacity will decrease as well. Since a higher level of abstraction is less bound to photorealistic aspects, it may allow further semantic information to be accommodated in the visualization process. If the level of abstraction in a city model is increased in a controlled way so that the characteristic features are enhanced while non-relevant information is inhibited, the user's cognitive load during task completion may be reduced. This implies an increased efficiency of information communication. In our experiment, we treat the three concepts LOA, ID and SC as fundamental variables for the visualization of building facades. Using image segmentation algorithms, the elements within a facade per unit of area are successively reduced while preserving the characteristic structures within the image. The segmented image holds the sufficient information to be recognized in the environment. Additionally different regions are coloured with a medium colour value taken from the original image. The abstraction level of the image varies with the segmentation level. In our example different segmentation levels match different user needs. Image segmentation algorithms are used as a first attempt to reach an adequate level of abstraction. Since most segmentation algorithms work on given pixel values. They cannot sufficiently process the inherent semantic meanings of pictures. Therefore, it is a necessary task in our approach to elaborate the image segmentation with semantic enhancing algorithms. The elaboration allows the emphasis of certain characteristics in visualization such as a special entrance or windows of a building. Theoretically, a continuum from photorealistic to abstract non-photorealistic visualization can be created, which enables us to find a trade-off between a potential loss of information and the level of usage for various tasks.