



## A study of user perceptions of the relationship between bump-mapped and non-bump-mapped materials, and lighting intensity in a real-time virtual environment

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The video and computer games industry has taken full advantage of the human sense of vision by producing games that utilize complex high-resolution textures and materials, and lighting technique. This results to the creation of an almost life-like real-time 3D virtual environment that can immerse the end-users. One of the visual techniques used is real-time display of bump-mapped materials. However, this sense of visual phenomenon has yet to be fully utilized for 3D design visualization in the architecture and construction domain. Virtual environments developed in the architecture and construction domain are often basic and use low-resolution images, which under represent the real physical environment. Such virtual environment is seen as being non-realistic to the user resulting in a misconception of the actual potential of it as a tool for 3D design visualization. A study was conducted to evaluate whether subjects can see the difference between bump-mapped and non-bump-mapped materials in different lighting conditions. The study utilized a real-time 3D virtual environment that was created using a custom-developed software application tool called BuildITC4. BuildITC4 was developed based upon the C4Engine which is classified as a next-generation 3D Game Engine. A total of thirty-five subjects were exposed to the virtual environment and were asked to compare the various types of material in different lighting conditions. The number of lights activated, the lighting intensity, and the materials used in the virtual environment were all interactive and changeable in real-time. The goal is to study how subjects perceived bump-mapped and non-bump mapped materials, and how different lighting conditions affect realistic representation. Results from this study indicate that subjects could tell the difference between the bump-mapped and non-bump mapped materials, and how different material reacts to different lighting condition.

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