Interactive access of cellular structure using virtual reality technology

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Introduction. Confocal imaging provides a powerful tool for visualizing individual cellular structure by a combination of series stacked 2-dimensional images. As an emerging technology, virtual reality (VR) has been applied for various fields from engineering design to military simulation. We are developing VR technology for cell biology application. In this paper, we present a VR system for interactive access of the cellular structure. A large screen image is used to produce high-resolution structural data of cellular structures in 3D space. Virtual gloves are incorporated into the system allowing users to interactively manipulate cellular structures. The system is able to provide an intuitive tool to access the complicated structure thus enabling quantitative analysis for cell biology and clinical research.

Methods. An Olympus FluoView™ 500 confocal microscope is used for capturing of confocal images. The images are served as inputs to the VR system. Various formats including conventional TIFF are acceptable with the system for RGB color images input. Up to 512X512 image resolution is allowed with the system to achieve a real time VR processing with the aid of graphics hardware. A database is developed to store both 3D image information and biochemistry knowledge. Stereo-graphics techniques are developed with the system to visualize the 3D reconstructed cellular model. Users can access the 3D virtual cell structure and appreciate its depth information by wearing a pair of stereo glasses. This is further enhanced by a reach-in interaction using virtual gloves.

Results and Summary. Selected samples of actin expression (in GFP vector) in human cervical cancer cell HeLa are demonstrated in the VR environment (Figure 1). Users can interact visually the intercellular structure of the individual component of the cells. The stereoscopic vision enables users to assess the size of an object based on the human eye stereo viewing principle. It shows the feasibility of using stacked 2D images obtained with a confocal microscope for 3D reconstruction and subsequent volume rendering. 3D VR-enhanced image processing techniques are being developed to improve the quality of imaging due to the problem caused by photo bleaching effects during the scanning of the 3D stacked images.

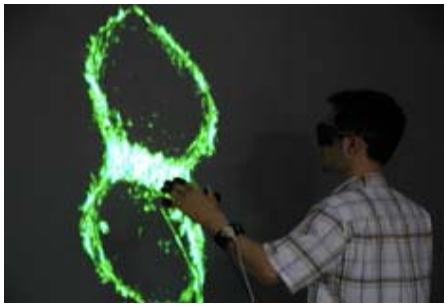

Figure 1. Interaction with the cellular structure in a VR environment