Non-Photorealistic Rendering in Stereoscopic 3D Visualization

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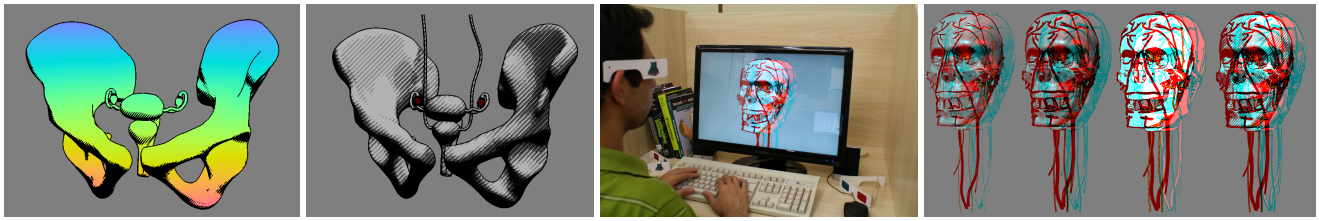

(a) first NPR style (b) second NPR style (c) VIDA system in anaglyph (d) The four styles used in the test

Figure 1: *Actual Results.*

CR Categories: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Color, shading, shadowing, and texture;

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1 Introduction

Spatial visualization of virtual contents appears to be, with the appearance of stereoscopic displays, the next step for increasing immersion in visual output. This kind of visualization can be used to facilitate the understanding of complex informations, like anatomic structures. One approach currently adopted for this purpose is the use of non-photorealisitic rendering (NPR), like proposed by Tietjen, Isenberg and Preim [2005]. However, this NPR style, which conventionally tries to simulate a 2D illustration, fused with the the stereoscopic 3D visualization can break the 3D perception of the virtual contents. This work aims to study the 3D perception of virtual contents represented using NPR techniques, in order to evaluate the influence of NPR in the 3D perception when used with stereoscopic information visualization. The stereoscopic NPR visualization was applied in VIDA, a system for the study of anatomic structures that enables the stereoscopic visualization and interaction with virtual objects [Tori et al. 2009], in order to proceed the user tests, the figure 1c show the system used in the test.

2 System Prototype and Initial User Tests

The 2D illustration-like NPR style was generated using diagonal black stripes to represents the light shading effect and applying silhouettes lines to the object. The colors of the object were set to be the material diffuse value or variate according the global y position. To generate these stripes the global position, of each pixel rendered, was used with GLSL shader. Figure 1a illustrates this non-photorealistic style. Figure 1b illustrates another non-photorealistic style created for the user test that increases the object shading effect, repeating the same approach that generated Figure 1a two or more times with different stripes thickness values and different illumination values.

Preliminary user tests were done to verify the 3D perception of the stylized objects. In this test, users were asked to compare the 3D perception of the different styles (the conventional rendering through OpenGL without and with object silhouettes and the two NPR styles previously described; all the styles are presented with anaglyph rendering in figure 1d) two by two. After that, the styles were ordered according the users comparison. This test was applied to 14 users including students of computer engineering and design college. The results indicate that the 3D perception was worse in the two NPR styles than the conventional OpenGL render. Moreover, 50% of the users noticed a difference of 3D perception between the conventional OpenGL render with and without silhouette, and all of these users claimed that the perception was better without silhouette, althought they commented they were not distracted by silhouette of the object.

3 Discussion and Conclusion

The preliminary user tests give us strong evidence that our hypothesis, that NPR can break the 3D perception, is true. A possible explanation of this fact is that the abstraction of the object surface, created by the NPR, decreases the number of visual cues presented to the user to estimate the spatial information. However, this hypothesis does not match with the results of the comparison between the conventional render with and without silhouette. So, another hypothesis is that 3D perception of a rendered object is directly proportional to its photorealism. However, this hypothesis can not be validated with the current results, since many users reported that there is no difference between the two rendering techniques, and all the users did not complain about the silhouette. Future works include tests with other NPR techniques, like hatching, that give more clues of the object surface, formal user tests with different stereoscopic techniques, to verify the hypotheses raised in this work and use of the results obtained in this work in interactive user interface design.

References

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