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# Non-realistic Visualization on an Autostereoscopic Display

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**Abstract**
This master's thesis researches non-realistic visualization methods for autostereoscopic displays. The thesis aims to evaluate how well non-realistic effects work on the Looking Glass Go display, focusing on the functionality of the effects, preservation of 3D depth, quality, and user-friendliness. To do so, an app for the Looking Glass Go display is created in the Unity Engine containing the implementation of over twenty effects, two scenes and user interface. The effects include edge detection, different types of dithering and shading methods, thresholding, distortion, and effects mimicking, for example, old movies, or night vision.

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## 1. Introduction

Non-realistic visualization is a crucial part of many industries, such as the movie industry, marketing, teaching, biology, and especially the video game industry. We can see many non-realistic effects being used in popular video games. Some of them are, for example, *Return of the Obra Dinn* [1], using the dithering effect, *My Voice Zoo* [2] containing edge detection and thresholding, or *The Wolf Among Us* [3] mimicking the look of a comics book. All three examples are shown in *Figure 1*.

But, how well do these effects work on an autostereoscopic holographic display, like the **Looking Glass Go** [4]? The questions this thesis aims to answer include the functionality and quality of the effects, preservation of 3D depth after the application of the effects, the difference between visualization in 2D and 3D, and user-friendliness (*Figure 1*).

This master's thesis follows up on the bachelor's thesis submitted by the same author in 2023, **"Non-photorealistic Rendering on Lume Pad"** [5]. The bachelor's thesis focuses on the holographic tablet Lume Pad and the methods of rendering non-realistic effects on this specific hardware. However, this tablet and its successor Lume Pad 2 have both been declared obsolete by Leia Inc. in 2025 [6]. Hence, this work uses the Looking Glass Go display instead of the Lume Pad tablet and continues the research of non-realistic visualization.

## 2. App Design and Shaders

For the purpose of user testing, an app was developed in the **Unity Engine**, version 6 [7]. The app contains the implementation of twenty-four non-realistic effects (shaders), twenty-two of which are then used for user testing.

The app gives the user the ability to look at the shaders at two different scenes, and move freely in one of them. The user interface includes a feature to adjust the intensity of the applied shader, switch between 2D and 3D mode, and a canvas with the name of the effect and the current intensity.

All user inputs are provided via the keyboard to ensure the lowest amount of disturbing items on the actual screen of the display, since the size of the display is only six inches diagonally. The app uses the *Universal Render Pipeline* because the Looking Glass Plugin for Unity [8] works best with this pipeline.

### 2.1 The Shaders

The effects are implemented as full-screen **post-processing shaders**. They are developed either in code with the HLSL programming language, or with Unity's Shader Graph visual shader programming tool. Eight of the twenty-two shaders are taken from the bachelor's thesis, and were only edited to work with the Looking Glass Go display.

Some of the other shaders are inspired by, or taken from different online and book sources. From the effects shown in *Figure 2*, it is namely, *Shadertoy* [9], the

*Learning Shaders with Char* online tutorial by the Looking Glass company [10], and the *Unity 6 Shaders and Effects Cookbook* by John P. Doran [11].

## 3. User Testing

User testing consists of **six different tests**. They focus on the preservation of 3D depth after the application of a shader, user-friendliness and *comfort* of viewing the shader, the differences between the shader in 3D and 2D mode, and possible artifacts in the scene after the shader is applied (including the disappearance of objects etc.). The tests also use the app feature to change the intensity of the shader to analyze at which value the 3D depth is strongest.

Every user testing session is conducted in person, and takes between forty-five minutes to an hour to complete. Users are selected from different age groups and have different occupations to obtain a wide range of answers. By the date of the publication of this paper, seven people have contributed to the user testing.

### 3.1 The Tests

The six different tests are done for each of the twenty-two effects, and are as follows:

- *Test 1:* At which intensity value is the 3D depth strongest?
- *Test 2:* At which intensity value is the 3D depth strongest *while still keeping the artistic style of the effect clearly visible*?
- *Test 3:* Does the effect improve the 3D depth compared to the scene without any effects?
- *Test 4:* Number of artifacts the user can see in the scene, especially objects, or details that disappear.
- *Test 5:* The rating of similarity of the effect in 2D and 3D mode.
- *Test 6:* The rating of (eye) comfort of viewing the effect.

## 4. Conclusions

This thesis implemented and evaluated twenty-two non-realistic effects on the Looking Glass Go autostereoscopic display. Preliminary user testing with seven users provided some early results. Data from *Test 5* shows a relatively high (average rating of 3.5 out of 5) similarity between the effects in 2D and 3D modes, indicating that the artistic intent of the shaders is preserved on the Looking Glass Go display. However, early results of *Test 6* show a relatively low comfort level among users (around 2.6 out of 5).

Results for other tests remain quite subjective and vary among users. Further testing is required to gather a larger dataset, which could lead to more definitive conclusions about the 3D depth preservation, or artifacts.


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