Project Daltonismo

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1 Introduction

Suffers of Color Vision Deficiency (CVD), commonly known as colorblindness, have a reduced ability to perceive colors when compared to non-sufferers. Many videogames rely on users ability to perceive color, which leaves users who suffer from CVD at a disadvantage. Project Daltonismo offers CVD compensation by running daltonization on a video signal in real time. daltonization is a popular CVD compensation algorithm. The video signals both in and out are HDMI. The daltonization is running on one FPGA in parallel with both HDMI decoding and encoding, unlike the more typical implementation of using dedicated HDMI decoding and encoding hardware. When all is said and done, this design offers a large degree of flexibility in types of CVD to compensate for and a very low amount of latency between signal input and output.

2 Daltonization

At a basic level, Daltonization works in 3 main steps.

1. CVD is simulated on the input color.
2. The output of the last operation is subtracted from the original input color.
3. This resulting difference is then added back to the original color.

This results in the difference in colors being amplified and brings them into a more perceptible state for sufferers of CVD. The only thing that has to be done to change the type of CVD being compensated for is to change the values modeling the type of CVD in the first step. The rest of the algorithm is identical from there on out. What this allows for is the manual input of mathematical models for atypical CVD types, or just one's personal vision type. For this manual input, the device does not need to be reprogrammed and it can be done instantly in real time.

3 FPGA

Project Daltonismo gains a lot from being run on an FPGA. The ability for an FPGA to run many, many pieces of logic allows for many operations to be completed simultaneously, as opposed to sequentially as they would have to be done on a CPU. A GPU implementation would allow for all pixels of a frame to be operated on simultaneously, but in several sequential steps, similar to how a CPU would, but in the case of a GPU in order to take advantage of the parallel nature, a whole frame of delay would have to be added to the video signal. Currently, Project Daltonismo is running with around 100 pixels delay between pixel input and pixel output, which at a 1080p 60Hz resolution comes out to less then 1.5 µs, compared to the approximately 16.7 ms delay of waiting for a whole frame.

4 HDMI

To input an HDMI signal is challenging, first the signal is delayed to align it to the sampling times, then the symbol bit alignment needs to take place. Our method of doing this is to try each delay time and alignment until one is found that works. This only takes around one quarter of a second and is done once per usage session.

5 Conclusion

Project Daltonismo met all of the required metrics for the device. Qualitative results demonstrated that users who suffer from CVD noticed little to no difference between an unaltered images and images with simulated colorblindness. Additionally, the implemented daltonization aided CVD sufferers tell the difference between colors which in an unaltered image seemed to them to be similar or identical. The HDMI signal was also able to hit target resolution and frame rate with no noticeable delay or issues.