Concept Generation and Selection

Holo-video Monitor

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INTRODUCTION

OVERVIEW

This document defines the initial design specifications of an improved holo-video monitor as it builds off of previous models. The purpose of this new design is to enhance the quality of the holo-video monitor and solidify the building process. The process of enhancing the previous design consists of determining the customer requirements, evaluating the current design of the monitor, and deciding on which aspects of the design we want to improve. We make these decisions based on a time budget, engineering expertise, and cost.

PURPOSE

The purpose of this document is to lay out our decision process for how we will complete the most difficult part of our project. Most of our project is taken directly from the designs previously designed and tested by the Electro-Holography Laboratory (EHL) at BYU; meaning there are not many design decisions that we are currently making. We will be modifying that design in the second half of the semester after we have learned more about the monitor and how to construct it. The most difficult part of the project is the Arduino Shield. The Arduino shield is the interface between the hardware and software and controls the mirrors, pulse lasers, infrared lasers and many other systems. Because it does this, it is an incredibly complex design. We would like to discuss different options for this scanner shield and see if we can improve the design.

PROCEDURE

For this decision, we have outlined several different concept options that could improve or change the design of the scanner shield. We discussed many options and metrics that were important to us and the EHL in general. We assigned weights to each of the metrics which reflects the importance that we place on each metric. Then we created a design matrix to score each of the concepts per the metric. We will then explain why we have chosen to implement the design that we have.

BODY OF FACTS

SPECIFICATIONS AND FACTS

Create a holo-video monitor which can:

- View images in a realistic 3D representation
- Operate at a low cost
- Be powered by an AC outlet common in homes
- Fit in a reasonable space
- Receive image data from a video card
- Be run from a regular PC
- Operate with low noise levels

We interpret that to mean:

- Use principles of occlusion, parallax, and accommodation to construct a monitor.
- Create monitor using cheaper materials with easier fabrication.
- The monitor should have a power supply that draws power from a 120V AC outlet.
- Use lasers of different color to give the image color.
- Use smaller parts and do not duplicate functionality.
- Build a custom board that is capable of logic on the video signals that come from the computer.
- Use smaller parts that do not require large fans to cool.

CRITICAL ASSUMPTIONS

- We assume that the designs given to us by the EHL work and can be trusted
- Hardware will work per specifications
- AOM has been tested and performs proper function

PRODUCT DESIGN

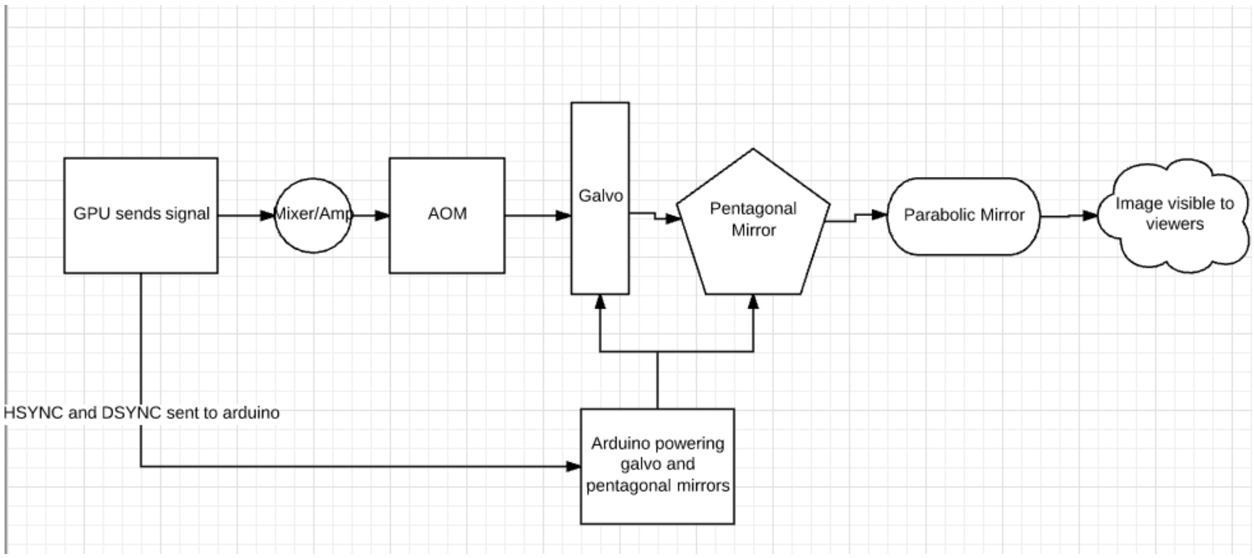

Figure 1. The current design for our holo-monitor.

Hardware

The GPU in a computer will send the signals into the system. The AOM, Galvanometer, and pentagonal mirror will then steer the light from a laser in the depth, vertical, and horizontal directions respectively. The light is then reflected onto a parabolic mirror which makes the image available for the viewers.

Software

The GPU sends the HSYNC and DSYNC signals into the Arduino shield. That shield then controls the Galvanometer and the pentagonal mirror. It controls the spinning rate of each of these mirrors, which will then control the angle at which the light comes out. The holographic image is created by different beams of light intersecting at points and so this function is crucial and extremely complicated. This Arduino shield is placed on top of and into the pins of the Arduino. We will now discuss different options for improving this part of the process.

CONCEPT SELECTION AND SCORING

DESIGN EVALUTION METRICS AND WEIGHTING

Concept Possibilities ---

Current Design: This is our benchmark design which is currently used. This design involves a lot of soldering, including sensitive surface mount soldering. This soldering can be very complex and with everything that it needs to do, there are a lot of parts to be tested and many places for problems in the board to arise which can be difficult to find and solve. But when the board has been fixed, it runs smoothly and does everything that is needed of it very well

Outsourcing: This method would involve sending out the completed files and design to a company to fabricate. This has the advantage of potentially taking less time but at a higher monetary cost. This would be a lot simpler for everyone in our team and in the research group. The downside is that the EHL is a research group and so the design changes frequently and there some quirks in the design that would need to be worked out before it would be ready to outsource. We also have the downside of only needing a few boards (4/year) and so the fabrication would be higher than if we needed more (100/year)

FPGA: When this project started, the research group was working with a few different systems that have now been combined into the Scanner shield. The engineers decided that hardware was easier to debug than software at the point. Now that the bugs have been mostly worked out, we could implement the entire design in a digital hardware form that would be easier to maintain and change. There would be minimal maintenance in the long term but it would take quite a few programmer hours initially to accomplish this major design shift.

Metrics and Weights – Based on 8 boards over two years

Cost of Materials: We decided that this should have a weight of 15% because one of our specifications is low cost. Values are expressed in $US.

Initial Time: Weight of 25% because time is very important to the students who would be developing the boards. Values are expressed in hours to complete the first board

Long term Time: Weight of 25% and values are expressed in hours to complete the remaining 7 boards over 2 years.

Cost of Labor: Cost is important and so again it has a weight of 15%. The cost is determined as cost in $US to pay an engineer during the hours in which he completes 8 boards over 2 years.

Pay for an undergraduate is about $6 per hour assuming half of the students are paid and half of the students are volunteer

Hardware Complexity: This is our estimate of how complex the hardware of the board would be. On a scale of 1-10 multiplied by 100. Weight of 10%

Software Complexity: This is our estimate of how complex the software of the board would be. On a scale of 1-10 multiplied by 10. Weight of 10%

DESIGN FUNCTION MATRIX

		Current Scanner Shield		**Outsourced Scanner**		**FPGA**	
For 8 Boards over 2 years	*Weight*	*Score*	*Weighted*	*Score*	*Weighted*	*Score*	*Weighted*
Cost of materials	0.15	480	72	480	72	1600	240
Initial time	0.25	20	5	40	10	40	10
Long term time	0.25	140	35	7	1.75	7	1.75
Cost of Labor	0.15	960	144	1000	150	35.25	5.2875
Hardware complexity (1-10)	0.1	100	10	50	5	20	2
Software Complexity (1-10)	0.1	30	3	30	3	80	8
Total	**1**	**269**		**241.75**		**267.0375**	

RESULTS

Our results show that outsourcing the scanner should be the best option for us. That would be a great decision if we were working in industry and this was a real project. Because we are a research based university project, the design changes too quickly and students have such low salaries that we are choosing to continue with the current design. The overhead of changing the procedure would be too much. As a compromise, we are working with the research team to develop a stencil for the surface mount soldering components which brings down the complexity of the scanner shield considerably.

Conclusion

Because of our decision matrix, we as a team have come to be more united. We had some discord about the amount of time that we were spending on the current design and its importance in the project. By working through and weighing all of the options, we are now united as a team to finish the scanner shield and the project in the way outlined. We will have to change our schedule to move the scanner shield to the end of our design process so that it does not slow us down considerably. This design decision was crucial for our success and we look forward to implementing it and creating our first holo-video monitor.