Three-Dimensional LED Display

Project Proposal
Senior Design 1
EEL4914

April 25, 2014

Team Number:	15
Project Members:	Luke Ausley
	Joshua Moyerman
	Andrew Smith
Sponsors:	Stellascapes (Pending)

1 Project Description

The 3D LED Display is born from the desire to design and build a high quality RGB LED Cube. A cube comprised of RGB LEDs will allow users to display a broader color palette. The 3D LED Display not only encompasses the physical cube itself, but the creation of a user friendly interface for animating and modifying the content displayed on the cube. The user interface will consist of a wireless enabled tablet device communicating to a wireless computer within the LED cube. The communication will allow the display of both static and interactive graphics and animations.

In addition to presenting static and dynamic graphics, the 3D LED Display will also be capable to respond to external stimuli such as physical human interaction, gestures, button presses, etc. The cube will have a visual recording device capable of tracking and responding to human movements for the usage of controlling, and interacting with the cube. The operator will have dynamic control of the 3D LED Display by utilizing these different control mechanisms; from a wireless device such as a tablet or a smartphone, to interactive gesture control. These unique methods of communicating with the display with allow the user to accomplish a variety of tasks with the 3D LED Display such as presenting text, interactive graphics, or even video games in 3D.

2 Motivation

The 3D LED Display is of particular interest to the group due to the desire to experiment with novel ways of driving and interacting with large RGB LED cube displays. Given the fascination of the group members with the topics of both LED matrices and LED cubes, we chose our Senior Design project vectors to explore the concepts related to the operation of 3D LED cubes, improving upon methods used in the past while incorporating new and unexplored elements to the technology. The 3D LED display includes a variety of design aspects that appeal specifically to each group member. The electrical design, embedded system development, and software development provide well-defined areas of interest to each group member.

3 Project Specifications and Requirements

- Cube Resolution of 16x16x16
- Cube Size of 65x65x65cm
- Overall Size of 70x70x100cm
- Minimum Refresh Rate of 100Hz
- Minimum Animation Frame Rate of 25FPS
- 24 bit RGB Color Space
- Nominal Operating Voltage: 120V
- Maximum Operating Current: 10A

- Maximum Wireless Communication Distance: 10M

4 Project Architecture

The following diagrams detail the architecture of 3D LED Display. Blocks shown in green represent items the team must acquire, while blocks in blue represent items the team must research, design, and implement.

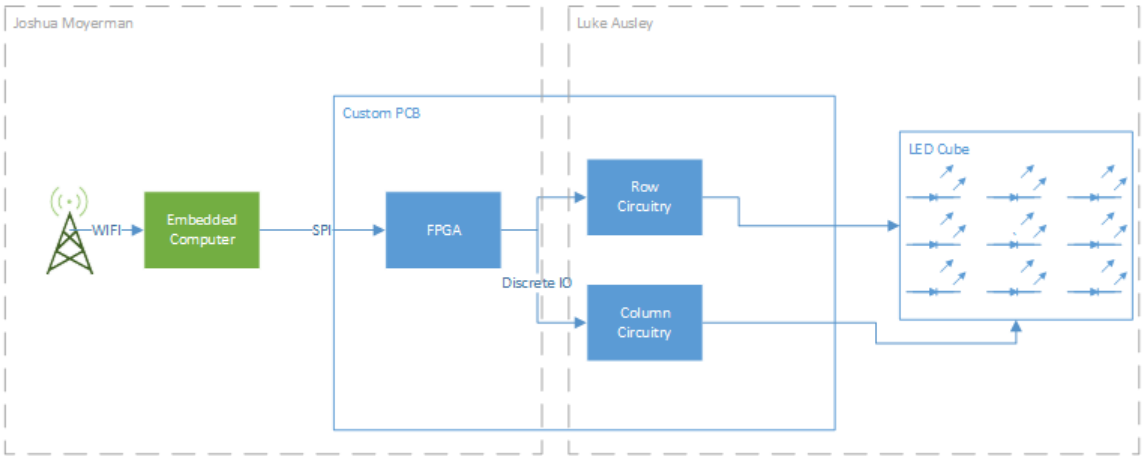

Figure 1: 3D LED Display Hardware Block Diagram

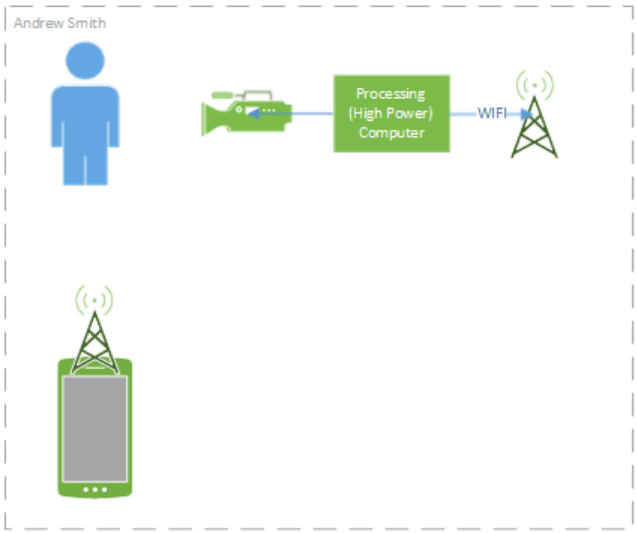

Figure 2: 3D LED Display Hardware Block Diagram

Figure 1 details the hardware necessary, as well as the proper input/output path for the operation of the 3D LED display. Figure 2 shows the user interfaces available to interact with the display. The software running on the wireless device will provide an interface to

the user in order to program LED patterns and sequences, push sequences to the 3D LED display, and select from preprogrammed sequences. A separate computer vision interface allows a user to interact with the 3D LED display through gesture recognition to execute preprogrammed actions and sequences.

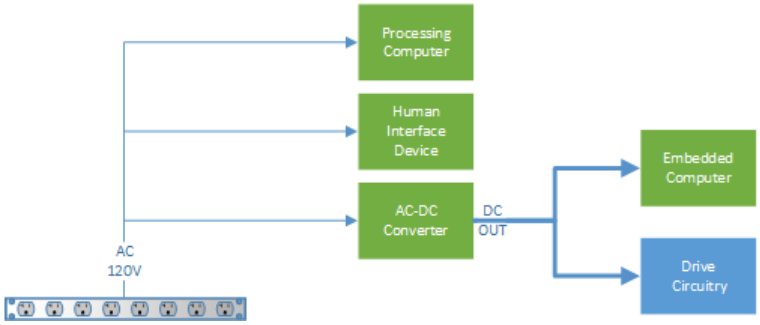

Figure 3: 3D LED Display Power Block Diagram

Figure 3 details the power flow from a wall output to each individual component in the 3D LED Display.

Item	Description
Embedded Computer	Handles processing of instructions
WiFi	Used to communicate between the user (Tablet or Processing computer) and LED Cube
Serial Peripheral Interface (SPI)	Used to communicate between Embedded Computer and FPGA
Field Programmable Gate Array (FPGA)	Used to control the multiplexing of the Row and Column Circuitry
Discrete Input/Output	Used to communicate between FPGA and Row/Column Circuitry
Custom Printed Circuit Board (PCB)	Design layout including FPGA/Circuitry
Row Circuitry	Circuit to control/power each row of the LED cube
Column Circuitry	Circuit to control/power each column of the LED cube
Light Emitting Diode (LED) Cube	Structure containing the LEDs that comprise the display
Processing Computer	Computer to handle all vision algorithms
Tablet/Smartphone	Used to collect input from the user
Camera	Used to detect user gestures
User	Used to create input
Wall Output	Power Source
AC	Alternating current, from wall source
DC	Direct current, converted to use for embedded computer and circuitry
AC/DC Converter	Alternating current to direct current converter

Table 1: Diagram Legend

5 Project Budget

The 3D LED Display is approximated to cost $775. A pending a sponsorship by Stellascapes will cover the cost of LEDs, which will reduce the out of pocket cost to the group. Group member Joshua Moyerman will provide the balance of the project expenditures, up to an amount of an additional $1,000, due to interest in owning the project after its completion. The group members will evenly distribute any additional costs necessary for the completion of the project amongst themselves.

Item	Cost
LEDs	$350
Wire	$50
Embedded Computer	$50
PCB	$50
Driver Circuitry	$75
Power Supply	$50
Camera Device	$50
Processing Computer	Group Owned
Frame & Case	$100
Subtotal	$775
Sponsored	($350)
Total	$375

Table 2: Project Budget

Note: The values listed above are rough estimates given the group's current knowledge of current prices.

6 Project Milestones

ID	Task Name	Duration	Start	Finish
1	**Project Report**	**50 days**	**Mon 9/23/13**	**Fri 11/29/13**
2	First Draft	30 days	Mon 9/23/13	Fri 11/1/13
3	Proofreading & Edits	21 days	Fri 11/1/13	Fri 11/29/13
4	Final Draft	0 days	Fri 11/29/13	Fri 11/29/13
5	**Software**	**136 days?**	**Mon 9/23/13**	**Tue 4/1/14**
6	**Embedded Computer**	**136 days?**	**Mon 9/23/13**	**Tue 4/1/14**
7	Initial Design	50 days?	Mon 9/23/13	Fri 11/29/13
8	Programming	65 days	Mon 12/2/13	Fri 2/28/14
9	Testing	21 days	Mon 3/3/14	Mon 3/31/14
10	Integration with FPGA	0 days	Tue 4/1/14	Tue 4/1/14
11	Integration with Wireless Control	0 days	Tue 4/1/14	Tue 4/1/14
12	**GUI**	**136 days?**	**Mon 9/23/13**	**Tue 4/1/14**
13	Initial Design	50 days?	Mon 9/23/13	Fri 11/29/13
14	Programming	65 days?	Mon 12/2/13	Fri 2/28/14
15	Testing	21 days?	Mon 3/3/14	Mon 3/31/14
16	Integration with Embedded Computer	0 days	Tue 4/1/14	Tue 4/1/14
17	**Vision Control System**	**136 days?**	**Mon 9/23/13**	**Tue 4/1/14**
18	Initial Design	50 days?	Mon 9/23/13	Fri 11/29/13
19	Programming	65 days?	Mon 12/2/13	Fri 2/28/14
20	Testing	21 days?	Mon 3/3/14	Mon 3/31/14
21	Integration with Embedded Computer	0 days	Tue 4/1/14	Tue 4/1/14
22	**Firmware**	**136 days?**	**Mon 9/23/13**	**Tue 4/1/14**
23	Initial Design	50 days?	Mon 9/23/13	Fri 11/29/13
24	Programming	65 days?	Mon 12/2/13	Fri 2/28/14
25	Testing	21 days?	Mon 3/3/14	Mon 3/31/14
26	Integration with Embedded Computer	0 days	Tue 4/1/14	Tue 4/1/14
27	Integration with Drive Circuitry	0 days	Tue 4/1/14	Tue 4/1/14
28	**PCB**	**115 days?**	**Mon 9/23/13**	**Fri 2/28/14**
29	Initial Design	50 days?	Mon 9/23/13	Fri 11/29/13
30	Schematic Rev 1	23 days	Mon 12/2/13	Wed 1/1/14
31	PCB Rev 1	10 days	Wed 1/1/14	Tue 1/14/14
32	PCB Testing	11 days	Sat 2/15/14	Fri 2/28/14
33	**Physical Assembly**	**115 days?**	**Mon 9/23/13**	**Sat 3/1/14**
34	Initial Design	50 days?	Mon 9/23/13	Fri 11/29/13
35	Cube Assembly	23 days	Mon 12/2/13	Wed 1/1/14
36	Base Assembly	44 days	Wed 1/1/14	Sat 3/1/14
37	Final Assembly Complete	0 days	Sat 3/1/14	Sat 3/1/14