Ben Morehead
Personal Project Portfolio

Up to date as of October 4th, 2019

1. Table Top Arcade Basketball

November 2019

1.1 Motivation:

In the fall semester of 2018, I was taking a digital systems course and my partner Lisa and I were tasked with designing a custom project that uses the DE1-SOC FPGA Board (the main tool used within the class). Being a fan of basketball, I saw a way in which a small scale basketball arcade game could be implemented using the FPGA Board, leading to a functioning game that incorporates some basic electronics, digital game logic, and display output.

1.2 Design Details:

The project itself was split into 3 parts:

1. The physical structure which included the actual basketball elements as well as the ball sensor
2. The FPGA-implemented game logic
3. VGA FPGA-output

1.2.1 Physical Structure

The physical game was made out of some scrap 2x2s and thin plywood. The frame exists as a slanted box so that after every shot the ball can roll back to the player unprompted. The hoop was purchased from the local dollar store and attached to the wood base, and some masonite and wood glue were used to create a compartment to limit the ball from bouncing too much outside of the box.

Attached from the back in the compartment is a photoresistor. This allowed us to actually track when a ball went effectively through the hoop, as the photoresistor would experience a darkened environment. The photoresistor was then attached to a simple mosfet circuit that allowed a strong signal to be sent to the GPIO port of the FPGA board, which in turn lead to a logic signal to increase the score.

1.2.2 FPGA-Game Logic

The game state-system was implemented with Verilog. With basic on board accessories such as the GPIO and on-system clock, we were able to create a time based game that would reset the score at the end of the timer, and update the high score respectively. The game was started with a button located on the side of the physical structure, that then fed a signal to the GPIO of the FPGA.

1.2.3 VGA Output

The VGA Output was implemented through a process we learned in class. The work involved creating bitmap representations of the different elements we'd want to show on screen. We then used those files in our pre-existing VGA output module to properly display information acquired from the sensor and timer.

1.3 Debugging:

1.3.1 Physical Structure

The major issues that arose with the physical structure surrounded tracking the ball. A score was initially tallied using a trip-wire style laser and photoresistor combo, but there were inconsistencies with where the ball would fall through the hoop, leading to no interruption of the photoresistor setup. To fix the consistency issue, I changed the environment of the photoresistor to be in a shaded box where the ball needed to fall, and as the ball passed by the resistor the circuit was able to detect that change in light.

1.3.2 FPGA-Game Logic

Game logic was fairly standard. An on-board timer determined how long the analog circuit would track the ball for, highscore was saved in local random access memory, and there would be a full reset on the completion of the game. Given the simplicity of the system there was not a lot of debugging to be done.

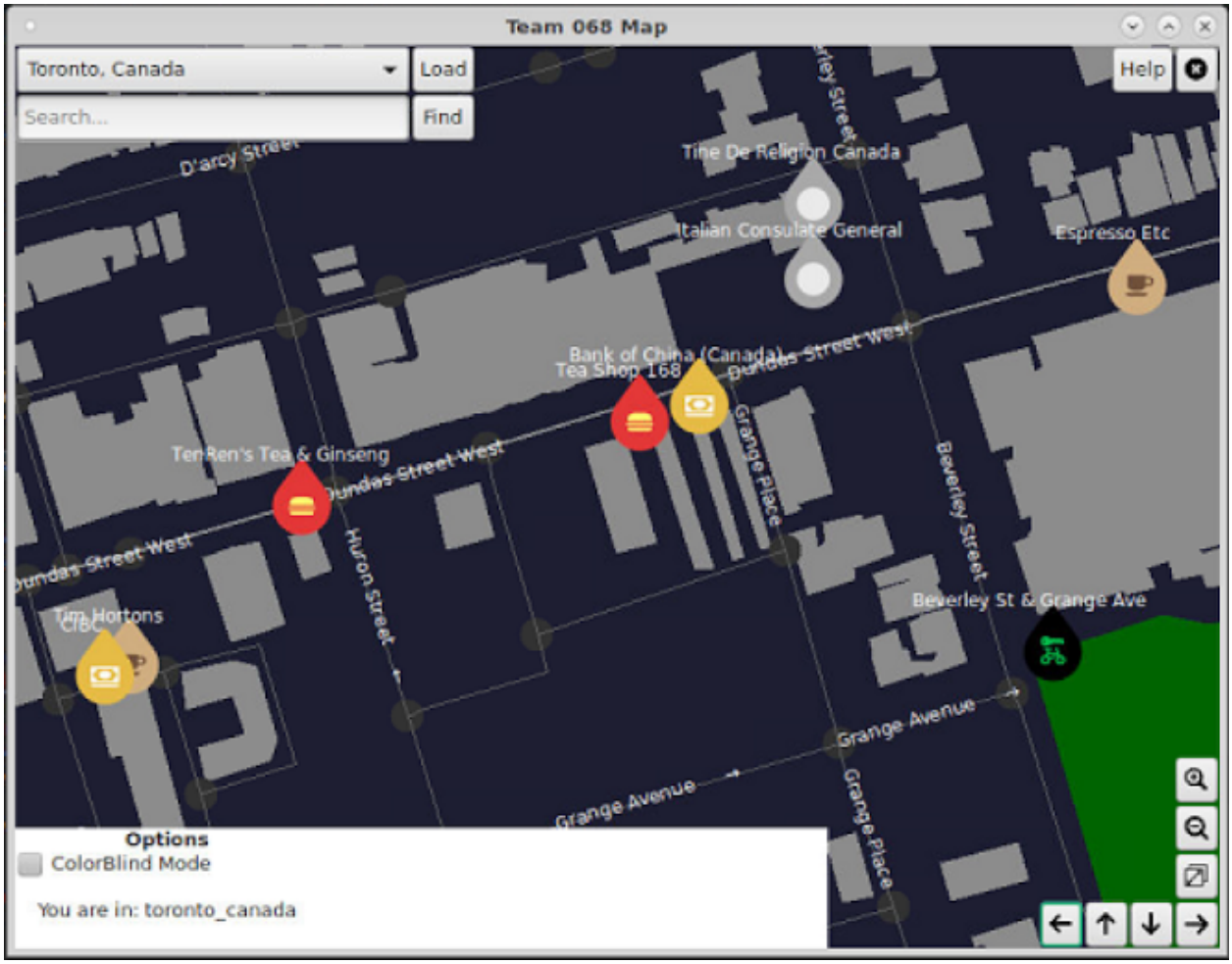
1.3.3 VGA Output

The VGA had limited bugs as it used a module acquired from the course.

1.4 Summary:

Summary Point	**Information**	**Notes**
Languages Used	Verilog	Was my first large project with Verilog, gained more experience later on in follow-up courses.
Equipment/Tools Used	DE1-SOC FPGA Board, Simple BJT circuit with Photoresistor, Basic woodworking	A lot of experimenting with the physical product, the software and logic was more straightforward.
Project Length	1 Month	Was the project for our digital systems course so a month of course time was allocated for it
Project Difficulty (1-10)	7	It was my first experience using very low-level digital hardware.

2. Custom GIS Software



Summary:

In a group of three, I helped create a custom Geographic Information System software that utilized C++ and the OpenGIS API to implement a custom user interface based on the existing information provided.

Two Floor Connect Four

Summary:

I designed and constructed, with the help of my peers, a multi-floor game of Connect Four. With fully functional piece input slide, and piece catching system. Due to the risk involved with this project, designing a foolproof mechanism for both catching and inserting the pieces was essential, as well as ensuring that the proper support system was in place to prevent any chance of the structure failing and hurting someone.

Stair Cascading Light Fixture
Basketball YoloV5 Player Tracker

Augmented Reality Climbing Wall