California State University, Channel Islands (CSUCI)
Department of Mechatronics

Smart City
Final Report

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Student Name: Travis Anger
Student ID: 003170238

Abstract

We were designated to create a ‘Smart City’ that consisted of 3D printed buildings, an electric train with tracks, railroad crossing guards, two sensors that detect the train, a stoplight, and a wooden base. The first sensor detects the train on the initial pass, before the crossing, once detected, the guards go down. The second sensor detects the pass of the final train car and then the guards rise up. Through the use of a Programmable Logic Circuit (PLC), the sensors send the appropriate signals to the crossing guards to rise or fall, and to turn the stoplight the appropriate color. PLC circuitry and programming proved to be the most difficult but allowed for the best addition to my engineering knowledge.

Introduction

The proposed problem with the ‘Smart City’ was having the crossing arms move when the train was either arriving or leaving the crossing area and having the stoplight change in relation to the proper signals. This translate into mechatronics in terms of a new learning environment with new variables that have never been seen before. For instance, with our use of PLC, that is a major cornerstone in engineering as of late and is insurmountable in the engineering ecosystem. 3D printing is another extremely useful product to be introduced recently. With how versatile 3D PLA material can be, there is an exponential amount of new possibilities that can be explored. Sometimes a project needs a new housing or socket that needs to be made in a short time period which can only be achieved with 3D printing. The future of the Mechatronics field will be full of new problems that require that high level of critical thinking to achieve the proper solutions, so with the new additions of PLC and 3D printing, the skills that have been learned will make us look extremely competitive to possible employers.

Literature Survey

Programmable Logic Circuit (PLC) is an industrial level computer controller that monitors the state of an input device and acts accordingly with an output program and device. A Central Processing Unit (CPU) takes in the PLC computer program, computed on computer program CCW, and operates with that specific program until a new one is uploaded via an ethernet cable. The CCW program operates with the programming language Ladder Logic, which is a graphical interface that simulated the opening and closing of particular relays or gates in real time once the program is running. Simple inputs on the PLC could be anything from buttons, switches or even sound, which is then outputted via lights, sounds, motors, etc. Given that PLC is an industrialized logic circuit, it is not engineered with the most memory possible so it has the hinderance of running slower than expected but could still meet the base requirements of the proposed engineered circuit.

Formal Description

Building the ‘Smart City’ proved to be more time consuming as expected. Starting with a wooden base, the group drew out the rough schematic of the city, shown in Figure 1, and began painting in the lake, park, roads, and sidewalks with paint [2]. The rough outlines on the base were direct outlines of the Black PLA 3D printed buildings, which consisted of four ‘skyscrapers’, six ‘town houses’, one clock tower, and one statue of a gorilla. The city, park with the statue, and LED stop light was set inside the train track perimeter while the town houses were outside the perimeter with the crossing guard being the only form of entry and exit to the city.

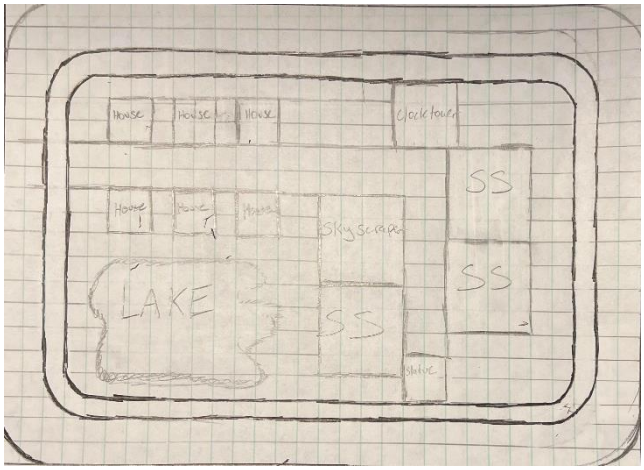

Figure 1 'Smart City' Schematic

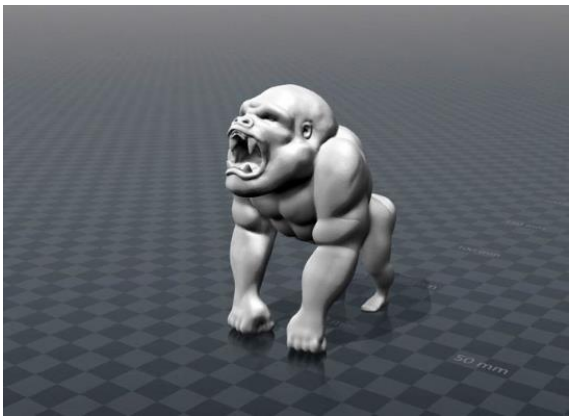
Figure 2 Gorilla Statue

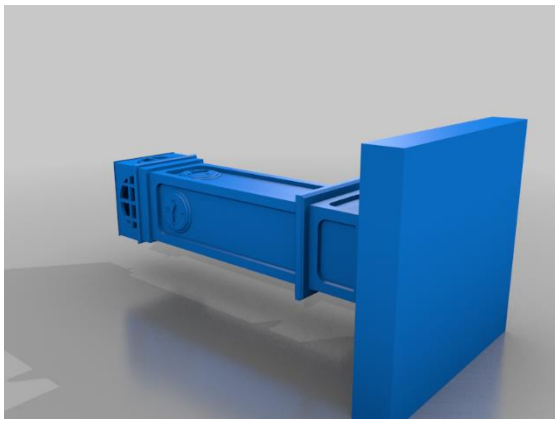
Figure 3 Clock Tower

My contribution to the project consisted of connecting the sensors and crossing guards’ outputs to the stoplight, where if sensor one detected the train, the guards would come down and the light would turn red and when sensor two detects the trains final car passing, the guard would raise up and then the light would turn green. In addition, I also painted parts of the base board for an aesthetically pleasing look.

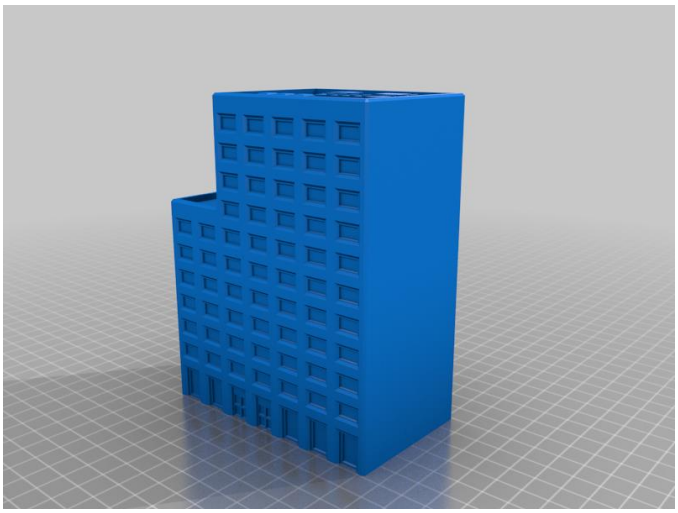

Figure 4 Skyscraper

Figure 5 Town House

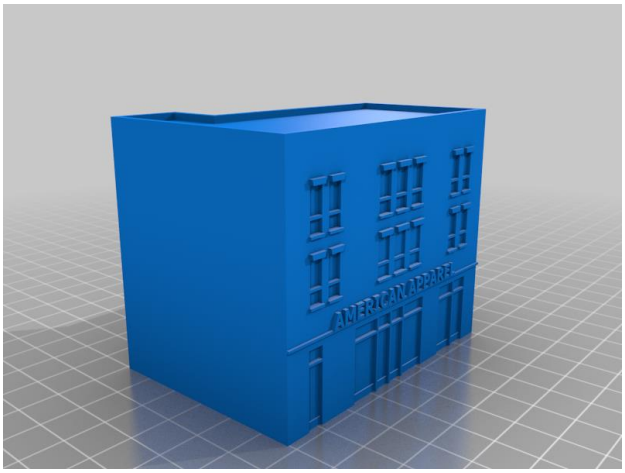

Figure 6 City Building

Conclusion

The project finished with only having a portion completed as seen in Figure 7. Given out time constraints with the other class activities like building a functioning PLC board and waiting for the 3D materials to be printed and glued gave way for not enough time for everything to be completed. The logic is completed but there was not enough time to implement the logic to the PLC and check if everything was working properly. I would say that given a few more weeks of time to work on the project that it could be fully realized and completed in that time frame with all of the ladder logic working correctly.

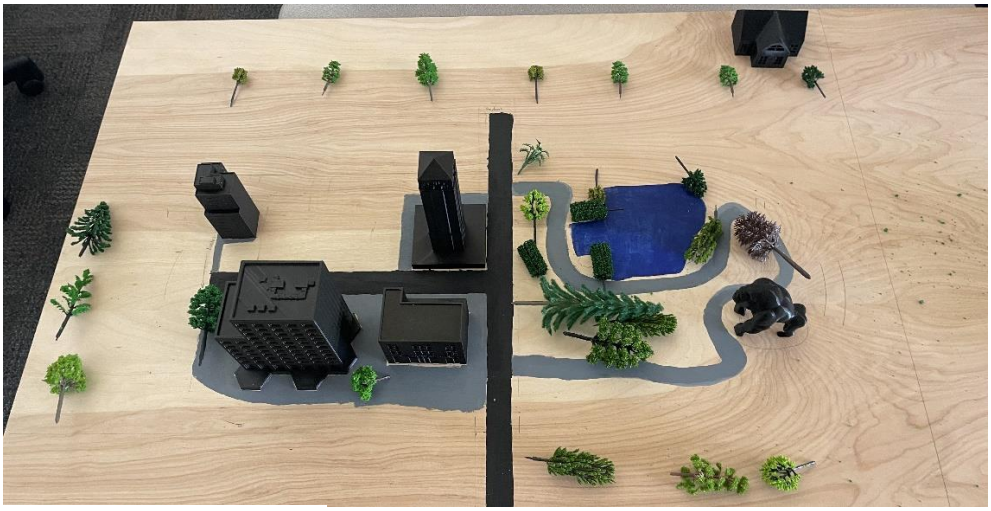

Figure 7 Completed 'Smart City'

Citations

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