COMP207 - Report

Introduction

The aim of this project is to create a small maze solving robot that includes many different forms of digital prototyping techniques and that fits the constraints of the micromouse competition and to create a group attempt of the micromouse.

In this report I will highlight the ideation and design of the micromouse, the key digital prototyping techniques that I used to complete the project, the benefits of each and the reasons for why and how I used them,

Digital Prototyping Techniques

The digital prototyping techniques that I used:

- PCB Design
- 3D Printing
- 3D Scanning
- Laser Cutting
- Milling
- CAD (Assemblies, Renders, Animations etc)
- Vinyl Sticker Cutting

In order to incorporate these techniques in a meaningful way I needed to first think about the design of my micromouse. I took inspiration from Lightning McQueen from the movie Cars and wanted to make my micromouse resemble this character.

Once I had figured out what I wanted to make I needed to workout the best way to make it using each aspect. My first idea on how to use each of the prototyping techniques to complete my vision was this:

- PCB Design - Design a circuit board that can hold all the electronics to make the micromouse
- 3D Printing - Design the motor mounts and print them out and attach to the PCB

- 3D Scanning - Scan a model of the inspiration for the product to edit into motor mounts
- Laser cutting - Cut a lightweight piece of wood for the middle of the chassis to mount the board
- Milling - Mill a foam casing to dampen sound of a buzzer that will be attached
- CAD - Designing the different elements in Fusion 360 and using drawings, assemblies, renders and animations to see how it will all fit together
- Vinyl Sticker Cutting - Cut out some custom stickers for the theme of the micromouse

PCB Design

The first step was in designing the PCB for my micromouse.

Iteration 1

Initially we were provided a basic template for a PCB which utilised:

- Raspberry Pi Pico
- L293DN Motor Driver
- Three TCRT-5000 LDRs
- L7805CV Voltage Regulator

I then added an MFRC522 RFID Module and a Piezo Active Buzzer to the schematic so that I could turn the micromouse on and off with a specific RFID tag and play sound effects.

After getting my first PCB I noticed a few issues. The first being that the TCRT-5000s were wired the wrong way on the schematic. This meant I had to flip the TCRT-5000s around so that they would work.

When attempting to code the micromouse I found a further issue with the MFRC522. I was under the impression that the pins could have different GPIO pins however that is not the case as the MFRC522 makes use of SDA and SCK which is specific to the microcontroller you are using meaning my PCB would not work for the RFID scanner. Not only that but Arduino IDE does not have a library that supports use of MFRC522 with a Raspberry Pi Pico meaning I made the change to MicroPython.

Iteration 2

For my second iteration of my PCB I changed some key things:

- Replaced the TCRT-5000s with VL53L0X ToF sensors as they give more precise readings for distance.
- Changed the pins for the MFRC522 for the specific microcontroller so that it can be used
- Removed the extra jumper pins
- Changed the motor input so that the encoded motors can be utilised

I also found from soldering my first PCB that labelling each pin is extremely helpful in constructing the PCB once you get it and testing it.

For the second iteration I tested the component changes that I could before ordering the PCB to make sure that I would have a working PCB in time.

3D Scanning and 3D Printing

After I had created my PCB it was time to make the motor mounts. The first step was to take a 3D scan of a Lightning McQueen model I had. To do this I hot glued it onto the end of a screwdriver and used Polycam to do photogrammetry to make a model.

I then took this model and tried using two different software packages to turn it into motor mounts. Blender and Fusion 360. After testing out both software packages I went forward with Fusion 360 as I have more experience using it.

When modelling the motor mounts I went through a few iterations as my original plan was to have them on the side of the PCB however I then discovered that doing this would mean that the micromouse would be far too large to turn in the maze meaning it couldn’t compete. To fix this I remodeled the motor mounts to fit on the top of the PCB and had to make cuts in them so that the VL53L0x sensors wouldn’t be obscured. It was also at this point I decided to change from two wheel design to four wheel design as it would make the turning more centralised so that it is easier to go through the maze due to the size of my micromouse.

Computer Aided Design

CAD is essential to this project and I used it in every aspect to create all the distinct parts. To see how these parts would fit together I made an assembly which was specifically helpful in solving my size constraint problems to work out the dimensions of it. Once the final assembly was made I created some drawings, a render and an animation of it to help visualise the final creation.

Laser Cutting

Due to the fact I changed to four wheel drive I no longer had to worry about the stabilisation of the micromouse meaning I decided to incorporate laser cutting in a different way. With four wheel drive if the wheels you use have low friction it allows you to use skid steering which helps with maneuverability in tight spaces, perfect for the maze.

To make use of skid steers I decided to laser cut my wheels out of acrylic and etch on Lightning McQueens catch phrase on the wheels to emphasise the theme. When making the wheels due to the placement of the motors and how close they are to the VL53L0x sensors I made sure the wheels were the perfect size to clear the ground but not obscure the sensors.

Milling

Furthermore I decided to change my idea of what to mill as I wanted to make a battery holder with a nice finish that I could laser etch with so I milled a piece of resin board into a battery holder and cut away a small design of Lightning McQueen on the top. I did this by doing a flip cut. This is where you first screwed it down onto the bed then cut out the top part of the body. Then you make a rough cut and a finishing cut. After it did that cut I flipped the cut to do the bottom cut.

Vinyl Sticker Cutting

After I had assembled the micromouse to put the finishing touches I decided to cut some stickers off for it. However I found out that its hard to adhere vinyl stickers to PLA and due to how curved the side is of the motor mount its quite hard to stick it down securely.

MicroPython

As stated earlier I used MicroPython so that I could use my components. The main challenge with this was in setting up the laser sensors as they all utilised the I2C bus and had the same default address. Arduino luckily has a library for the VL53L0x sensor that has lots of documentation

Collaborative Work

We were also tasked with making a joint group robot, I took over as project lead. To start off I split up the project into the distinct tasks to complete it and gave everyone tasks specific to their skill set. I then set up a group GitHub repo, Fusion 360 folder and EasyEDA team so that we could make use of these cloud services tools for pair computing. I gave myself the job of programming the micromouse.

After giving everyone a job I set up a trello board so that we could keep track as a group of the jobs that need to be done.

To do this I looked at the EasyEDA schematic to see what components were in use then used MicroPython to write code as I found that the Raspberry Pi Pico works better using MicroPython than Arduino IDE.

Conclusion

By using all of these techniques I managed to find out the benefits of each and some jobs they are best suited to, to use in a significant and appropriate way to help bring my vision to life.

Improvements I would make is to put more time into coding my micromouse so that I have a more complex maze solving algorithm that used the frontier method and then a form of fastest route algorithm such as Dijkstra's or A*.

I also found that in collaborative work it’s better to stay on goal the faster you set up the AGILE practices so in future I will set up a trello board earlier and have more conventional sprints to keep everyone on track.