Interim Design Report

Micro-mouse Sensing Subsystem

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Date

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Chapter 1

Introduction

1.1 Problem Description

The problem at hand was design and build a micro-mouse. A micro-mouse is a maze solving robot. The problem was split up in to three different parts: The motherboard, the sensing subsystem and the power subsystem.

The motherboard connects all the PCBs together. It also houses the processor which is the brain of the robot. The motherboard also house the connections that ensure all subsystem connect to to the processor. The wheels and motor are attached to the motherboard.

The sensing subsystem is the eyes of the micro-mouse. It locates walls and the maze and relays the information to the processor. The Processor then sends the necessary information to the power subsystem in order ti avoid the walls.

The power subsystem sends the necessary amount of power to the motors so the robot can move and stop when necessary. It also charges the battery that powers the micro-mouse.

This report focuses on the design of the sensing subsystem. As stated above the the main problem when designing this subsystem is to find a way to see when there are walls and where there are no walls.

1.2 Scope and Limitations

The scope of the project includes the design of a PCB that can sense when it nearby an obstacle and when there is no obstacle while interfacing with the other two subsystems mentioned in 1.1. Some code must be written to prove that the sensor is detecting either a wall in front, on the left or to the right of the robot.

The limitations to the design of the sensing subsystem include a way of limiting current so that the battery does not die before the maze is solved. The PCB must have 2x8 (2.54mm pin pitch) pin headers to connect to the motherboard. Additionally, the board must fit on the motherboard and between the wheels of the micro-mouse while still allowing for the micro-mouse to turn within the confines of the maze. Therefore, the sensing PCB can be no larger than 80mm by 20.5mm. The hardware of the sensing system was limited to parts that were in stock at JLCPCB and had to have a total cost of no less than $30.

1.3 GitHub Link

Click here to be redirected to GitHub.

Chapter 2

Requirements Analysis

2.1 Requirements

The requirements for a micro-mouse sensing module are described in Table 2.1.

Table 2.1: User and functional requirements of the power subsystem.

Requirement ID	Description
REQ01	Production cost of the PCB must be within the budget
REQ02	Pin headers need to be connected
REQ03	Subsystem needs to save power when not in use.
REQ04	Subsystem needs to prove that it works
REQ05	Subsystem needs to detect walls in front of the device
REQ06	Subsystem needs to detect walls to the right of the device
REQ07	Subsystem needs to detect walls to the left of the device
REQ08	Subsystem needs to draw a limited amount of current
REQ09	Sensing PCB needs to fit on the micro-mouse

2.2 Specifications

The specifications, refined from the requirements in Table 2.1, for the micro-mouse Sensing module are described in Table 2.2.

Table 2.2: Specifications of the sensing subsystem derived from the requirements in Table 2.1.

Specification ID	Description
SP01	PCB production must cost less than 30$
SP02	2x8 (2.54mm pin pitch) pin header to connect to the motherboard
SP03	Subsystem needs to switch off when not in use
SP04	Subsystem needs indicate when it senses the wall via three LEDs on the motherboards
SP05	PCB needs to house sensing hardware on the front
SP06	PCB needs to house sensing hardware on the right side
SP07	PCB needs to sensing hardware on the left side
SP08	The subsystem must draw < 400mA when in use
SP09	The Board can be no larger than 80mm by 20.5mm

2.3 Testing Procedures

A summary of the testing procedures detailed in chapter 4 is given in Table 2.3.

Table 2.3: CAPTION

Acceptance Test ID	**Description**
AT01	Powers on
AT02	IR LEDs turn on and off
AT03	Module detects walls in front of it
AT04	Module detects walls to the right of it
AT05	Module detects walls to the left of it
AT06	Subsystem does not draw over 400mA
AT07	LEDs on motherboard switch on at the appropriate time

2.4 Traceability Analysis

The show how the requirements, specifications and testing procedures all link, Table 2.4 is provided.

Table 2.4: Requirements Traceability Matrix

#	Requirements	Specifications	Acceptance Test
1	REQ03	SP03	AT02
2	REQ04	SP04	AT07
3	REQ05	SP05	AT03
4	REQ06	SP06	AT04
5	REQ07	SP07	AT05
6	REQ08	SP08	AT06

2.4.1 Traceability Analysis 1

2.4.2 Traceability Analysis 2

Chapter 3

Subsystem Design

3.1 Design Decisions

Multiple designs and configurations of hardware were tested. The initial design made use of a QRD1114. This seemed a great fit initially as it emitted infrared light and detected it in one device but upon further testing the device failed to act as needed when light was reflected from a very close distance. The next design utilised a combination of a TSAL6100 IR emitting diode and SFH205 photodiode. This design was further improved by adding more IR emitters and photodiodes that further increased accuracy and decreased current draw.

3.1.1 Final Design

The following design describes the final schematic of the sensing subsystem. Firstly, the TSAL6100 and the SFH205 were replaced as they were not available on JLCPCB and instead the TSAL6200 and the SFH213 were used as they operate in a similar fashion to the aforementioned parts. The IR sensor configuration was repeated three times; Once for the front, the right and the left hand side of the PCB. Each IR LED connects to a BJT (specifically the MMBT551) that switches on and off intermittently dues to a signal received from the motherboard. All resistors fitted are couple with open solder jumpers with varying size resistors to ensure the correct amount of current is drawn.

Each BJT is connected to a single IR LED on each of the sides that need sensing in the event that one fails. Photodiodes are connected in reverse bias in order to detect the intensity of light. Each photodiode has multiple resisistors connected in series paired with solder jumpers to ensure that great range of voltages are recorded with drawing too much current,

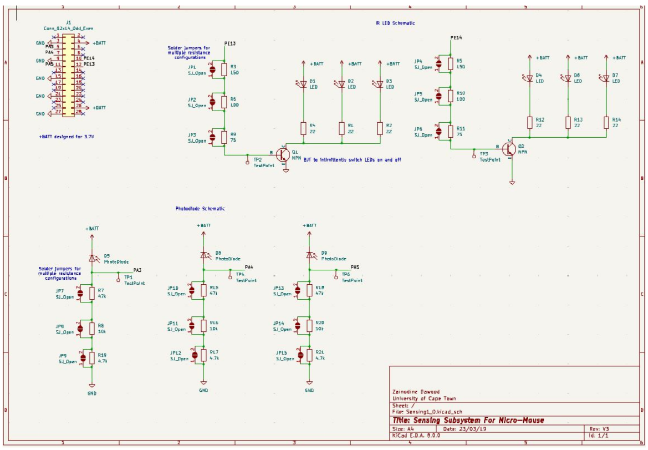
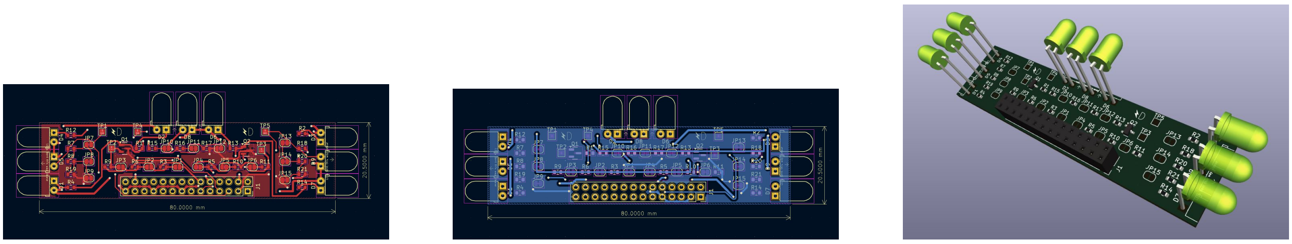


Figure 3.1: Schematic



(a) Front PCB (b) Back PCB (c) 3D PCB

Figure 3.2: PCB

3.2 Failure Management

Table 3.1: CAPTION

Name	Description
Redundancy	multiple resistors used with solder jumpers have been added
Design for Testing	Multiple test points have been added
Modulation	IR LEDs have been split in to two in case one fails

3.3 System Integration and Interfacing

To integrate the subsystem with the rest of the system ....

Table 3.2: Interfacing specifications

Interface	Description	Pins/Output
I001	Power subsystem to sensing subsystem	• BATT+: Power to sensing; P4 and P26
I002	Sensing subsystem to ADC	• Output P5 to STM PA3 • Output P7 to STM PA4 • Output P11 to PA5
I003	Signal from processor to sensing subsystem	• STM PE13 to P12 • STM PE14 to P10

Chapter 4

Acceptance Testing

4.1 Tests

Table 4.1: Subsystem acceptance tests

Test ID	Description	Testing Procedure	Pass/Fail Criteria
AT01	Powers on	• •	
		• •	

4.2 Critical Analysis of Testing

Table 4.2: Subsystem acceptance test results

Test ID	Description	Result
AT01	Powers on	

4.2.1 AT01

This worked, this did not work. I suspect that is because of x y and z.

Chapter 5

Conclusion

5.1 Recommendations

Bibliography

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