Micromouse Abstract

Team ID 222079

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Overview

Micromouse is a small autonomous micro controlled robot vehicle that has to navigate its way through an unknown maze. The main challenge for the contestant is to impart to the micromouse an adaptive intelligence to explore different maze configurations and to work out the optimum route for the shortest travel time from start to finish.

The basic function of a micromouse is to travel from the start square to the destination square. This is called a run. The time it takes is called the run time. Travelling from the destination square back to the start square is not considered a run. The total time from the first activation of the micromouse until the start of each run is also measured. This is called the maze time.

Components Used

1. **MCU:** STM32F103C6T6
2. **Motors:** N20 Brushed motors with encoders, 12V, 300RPM
3. **Encoders:** 3 pulse per rotation
4. **Motor Driver:** DRV8833 Dual H-Bridge motor driver
5. **IMU:** MPU6050 Gyroscope+Accelerometer
6. **IR Sensor:** TCRT5000L
7. **Battery:** 3S Li-Po Battery
8. **Wheels:** 44mm diameter, 18mm wide
9. **Buck Converter:** LM2596

Working Principle

Wall Detection: The emitter is an IR LED and the detector is an IR phototransistor. The IR phototransistor is sensitive to the IR light emitted by an IR LED. The photo-diode's resistance and output voltage change in proportion to the IR light received. This is the underlying working principle of the IR sensor. Hence it can easily detect the wall and move accordingly

Maze solving:

- **Algorithm**- Flood Fill. We define a 16*16 2-D array, each cell represents some number. We assign zero to the four destination cells, 1 to the cell which is immediately accessible by the destination cells, 2 to the cells next and so on.
- **Traversal (Dry run)**
    1. Find the values of its neighbouring cells.
    2. Travels to the neighbouring cell with the least value.
    3. Detects the wall to its left, right and front.
    4. Updates the newly found walls in the maze array
    5. Perform the flood fill for the entire flood array
    6. Back to step 1, and continue until the bot moves to the desired position
- **Actual run**

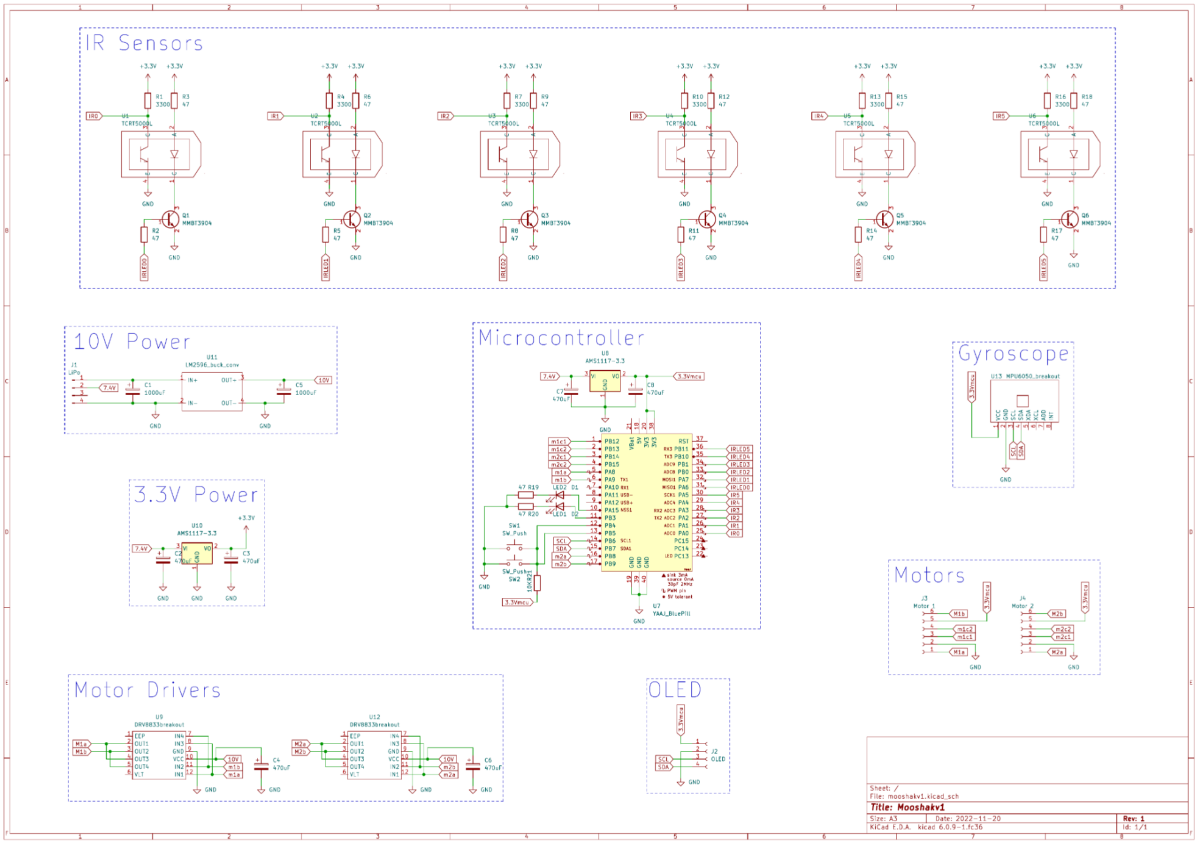
    Once we decide that the mouse has discovered enough cells to find an optimum path, bring the mouse back to the starting square, and do the fast run.

    1. Find the value of its neighbouring cells.
    2. Travel to the neighbouring cells whose value is 1 less than the present cell.
    3. Back to step 1, until the bot moves to the desired position.

Design Choices

1. Two wheel micromouse, instead of four wheels. We found that two wheel mice have better turning ability.
2. Encoder motors used, as precise odometry is absolutely essential to solve the maze.
3. SMD parts used wherever possible to reduce PCB size.
4. 6 IR sensors used for effective wall detection. Sensors mounted at an angle to detect walls early.
5. 3S Li-Po used instead of 2S for greater power and higher top speed
6. Length of the bot is restricted to 11cm, otherwise a U turn becomes infeasible
7. Wheels are mounted in the centre, to align the rotation centre with the geometric centre of the micromouse.
8. Battery voltage drop compensation added in software to combat drop in speed due to lower battery voltage of a drained battery. We have used a potential divider with appropriate values to reduce the 12.6V of the 3S lipo to 3.3V compatible with the STM32.
9. Transistors are used to turn the IR LEDs on or off, as the STM32 cannot supply enough current on its own.
10. DRV8833 was chosen because it has the same capabilities as the common L293D motor driver, but is more compact.

Schematics


IR Sensors
+3.3V
R1 3300
R3 47
IR0
U1 TCRT5000L
Q1 MMBT3904
R2 47
IRLED0
R4 3300
R6 47
IR1
U2 TCRT5000L
Q2 MMBT3904
R5 47
IRLED1
R7 3300
R9 47
IR2
U3 TCRT5000L
Q3 MMBT3904
R8 47
IRLED2
R10 3300
R12 47
IR3
U4 TCRT5000L
Q4 MMBT3904
R11 47
IRLED3
R13 3300
R15 47
IR4
U5 TCRT5000L
Q5 MMBT3904
R14 47
IRLED4
R16 3300
R18 47
IR5
U6 TCRT5000L
Q6 MMBT3904
R17 47
IRLED5
GND
10V Power
J1 LiPo
7.4V
C1 1000uF
U11 LM2596_buck_conv
IN+
IN−
OUT+
OUT−
C5 1000uF
10V
3.3V Power
U10 AMS1117-3.3
C2 470uF
C3 470uF
+3.3V
Microcontroller
U8 AMS1117-3.3
7.4V
VI
VO
C7 470uF
C8 470uF
3.3Vmcu
m1c1
m1c2
m2c1
m2c2
m1a
m1b
47 R19
47 R20
LED2 D1
LED1 D2
SW1 SW_Push
SW_Push SW2
10KR21
3.3Vmcu
SCL
SDA
m2a
m2b
PB12
PB13
PB14
PB15
PA8
PA9 TX1
PA10 RX1
PA11 USB−
PA12 USB+
PA15 NSS1
PB3
PB4
PB5
PB6 SCL1
PB7 SDA1
PB8
PB9
VBat
5V
3V3
RST
RX3 PB11
TX3 PB10
ADC9 PB1
ADC8 PB0
MOSI1 PA7
MISO1 PA6
SCK1 PA5
ADC4 PA4
RX2 ADC3 PA3
TX2 ADC2 PA2
ADC1 PA1
ADC0 PA0
PC15
PC14
LED PC13
IRLED5
IRLED4
IRLED3
IRLED2
IRLED1
IRLED0
IR5
IR4
IR3
IR2
IR1
IR0
▲ sink 3mA source 0mA 30pF 2MHz
PWM pin
● 5V tolerant
U7 YAAJ_BluePill
Gyroscope
3.3Vmcu
U13 MPU6050_breakout
VCC
GND
SCL
SDA
XDA
XCL
ADD
INT
Motors
J3 Motor 1
M1b
m1c2
m1c1
M1a
J4 Motor 2
M2b
m2c2
m2c1
M2a
Motor Drivers
U9 DRV8833breakout
EEP
OUT1
OUT2
OUT3
OUT4
VLT
IN4
IN3
GND
VCC
IN2
IN1
M1a
M1b
10V
m1b
m1a
C4 470uF
U12 DRV8833breakout
M2a
M2b
m2b
m2a
C6 470uF
OLED
3.3Vmcu
SCL
SDA
J2 OLED
Sheet: /
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Size: A3
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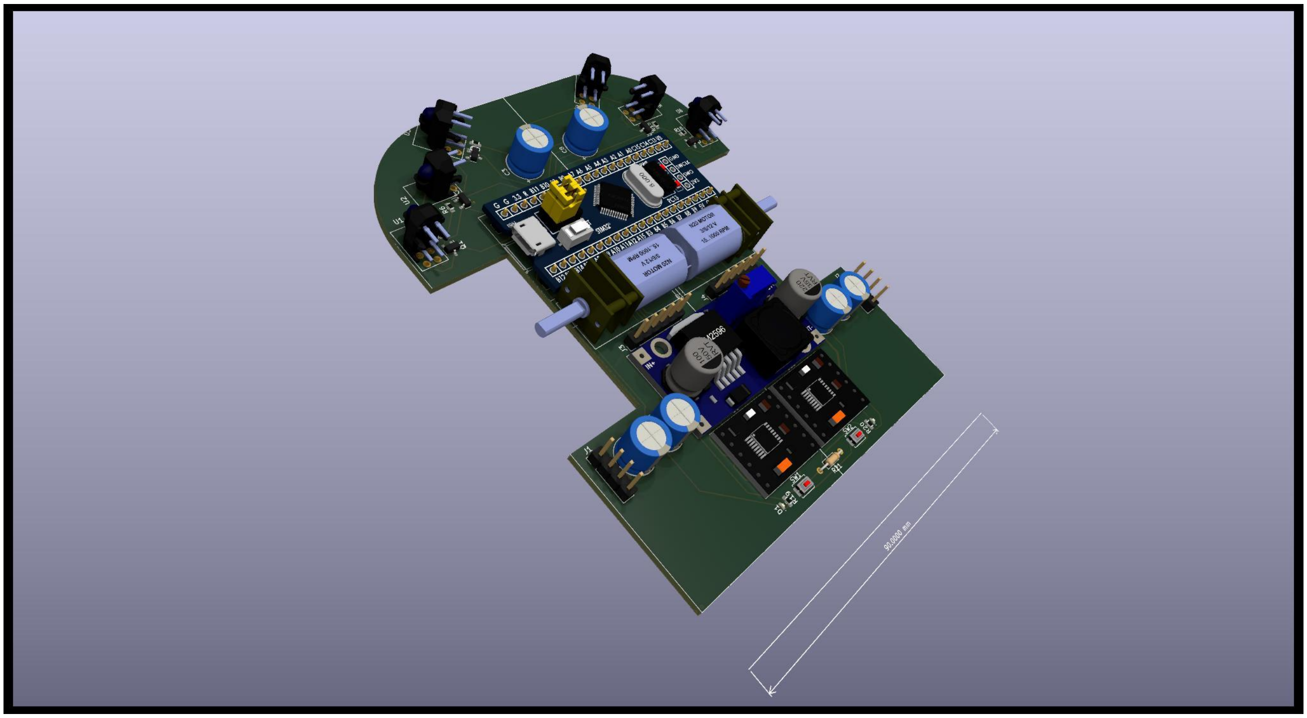
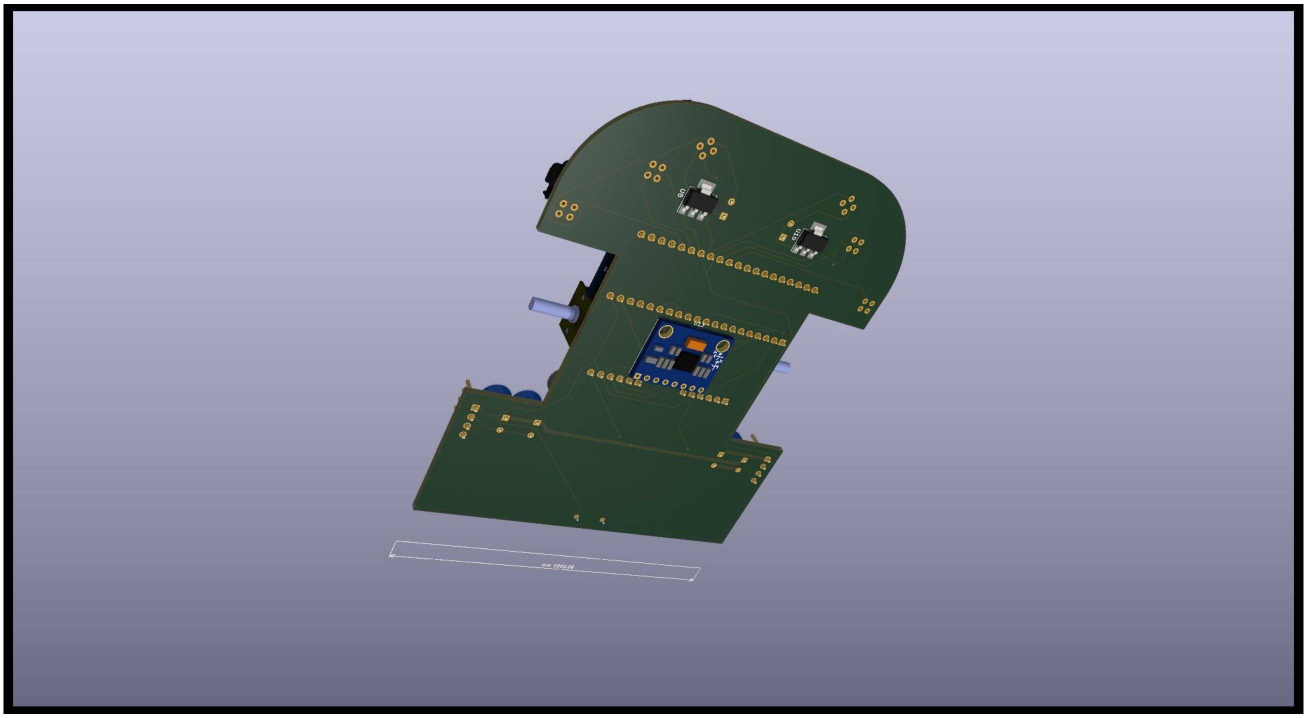
Rev: 1
KiCad E.D.A. kicad 6.0.9-1.fc36
Id: 1/1

3D Renders





Progress Pictures