ME210 Team 27 Documentation

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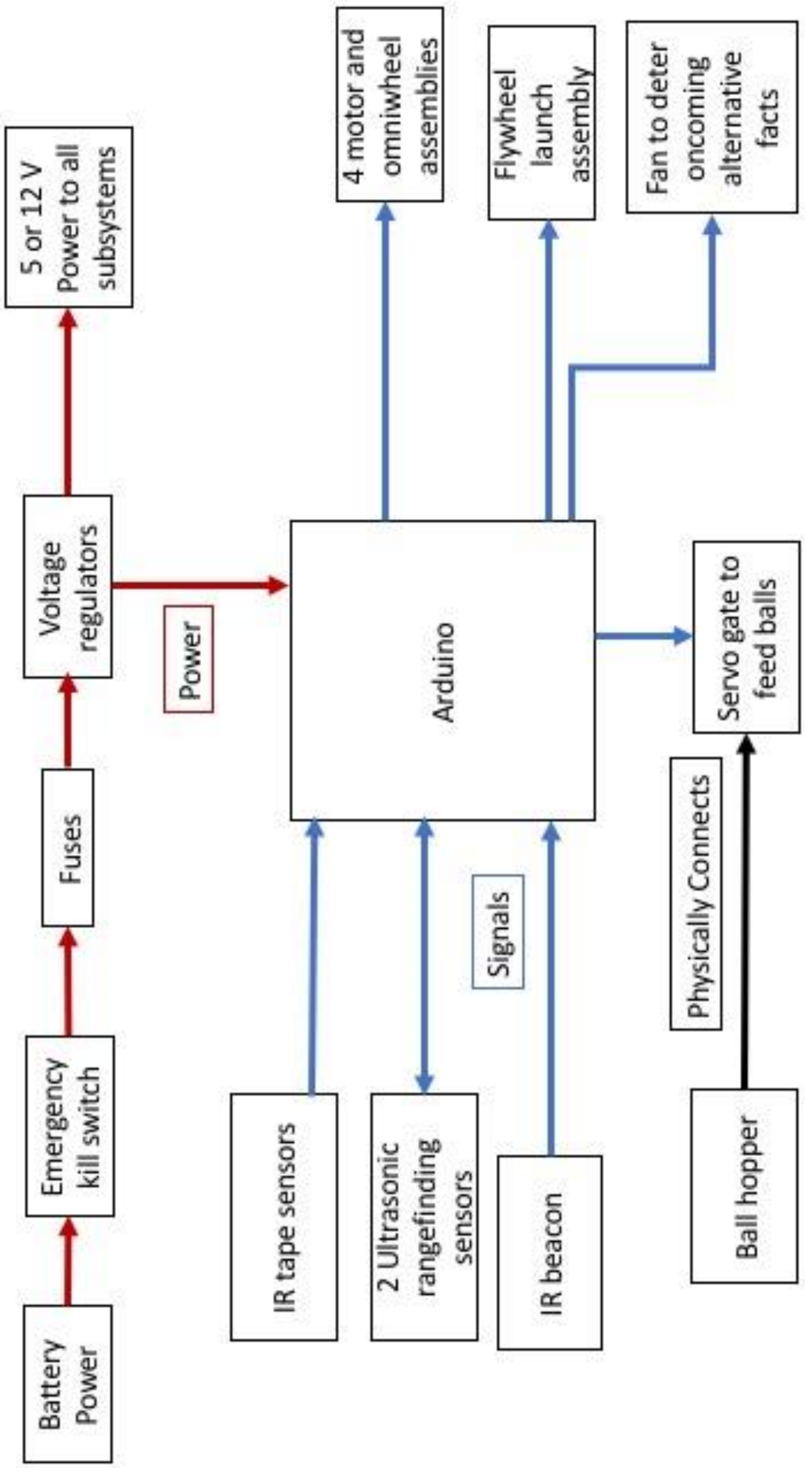
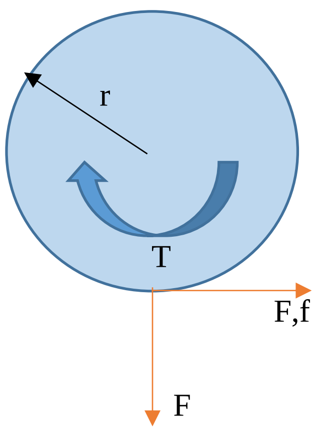
1 System Block Diagram



2 Calculations

2.1 Motor Spec Calculation

Static coefficient of friction (Rubber)	u,s	~1
Dynamic coefficient of friction	u,k	~0.5
Wheel diameter	d	60 mm
Total weight	m	3 kg
Number of wheels	n	4



r = d/2 = 60/2 = 30 mm = 0.03 m
F = m*g/4 = (3)(9.81)/4 = 7.36 N

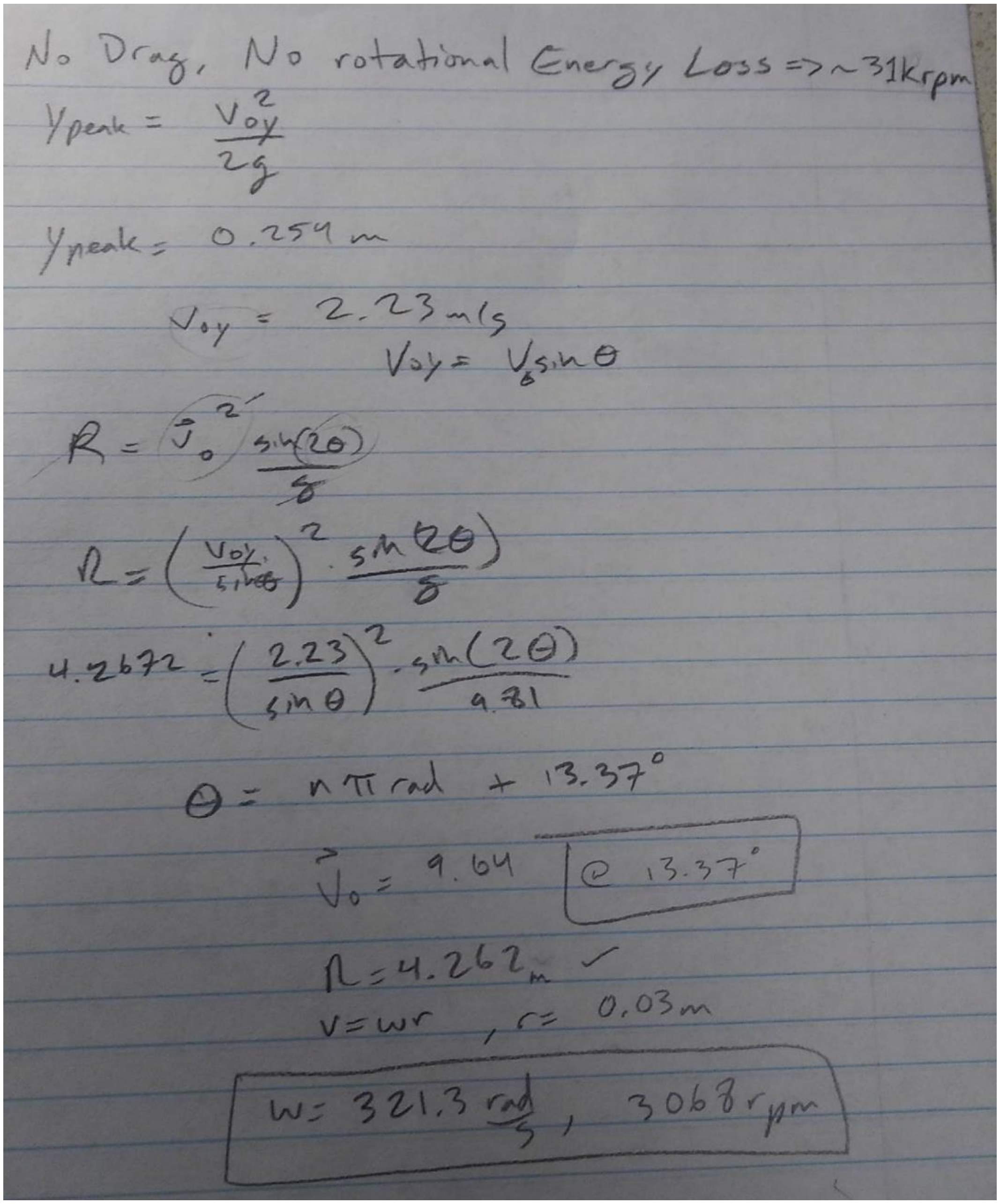
Max Torque	Continuous Torque
F,f = u,s*F = (1)(7.36) = 7.36 N T,max = F,f*r = (7.36)(0.03) = 0.211 Nm	F,f = u,k*F = (0.5)(7.36) = 3.68 N T,continuous = F,f*r = (3.68)(0.03) = 0.110 Nm

<u>ZGB37RG Gear DC Motor</u>
At 12V

Stall Torque:	228 mNm	>	Max Torque (211 mNm)
Max Efficiency Torque:	114 mNm	>	Continuous Torque (110 mNm)
Max Efficiency Speed:	269 rpm		
Max Efficiency Current:	1.32 A		

Therefore, this motor will successfully drive the robot at 269 rpm, if given 12V and 1.32A.

2.2 Trajectory Calculation



- Calculations assumed shot was taken from lower “T” tape.
- Results: to make shot at peak of flight, a 13.37 degree angle is needed with a ball velocity of 9.64 m/s. Assuming the wheels shoot the ball with no rotation, a rotational speed of about 31krpm is needed. According to the test data, this minimum speed is achievable.

2.3 Power Calculation

Part	**Voltage / Current**	**Power**	**Quantity**	**Total Power**
ZGB37RG DC Motor	12 V 1.32 A	15.84 W	4	63.36 W
Flywheel Motor	6 V 300 mA	1.8 W	2	3.2 W
HS-322 HD Servo Motor	6 V 200 mA	1.2 W	1	1.2 W
Ultrasonic Sensor HC-SR04	5 V 15 mA	0.075 W	2	0.15 W
Reflective Sensor OPB704WZ	5 V 40 mA	0.2 W	2	0.4 W
Arduino Uno	12 V 50 mA	0.6 W	1	0.6 W
Photo-Transistor LTR-3208E	5V 4 mA	0.018 W	1	0.018 W
			Total Current	6244 mA
			Total Power	68.93 W

Tower Hobbies NiMH 2000 Battery

Capacity: 2000 mAh
Quantity: 2

Total Capacity: 4000 mAh

Minimum Operating Time:

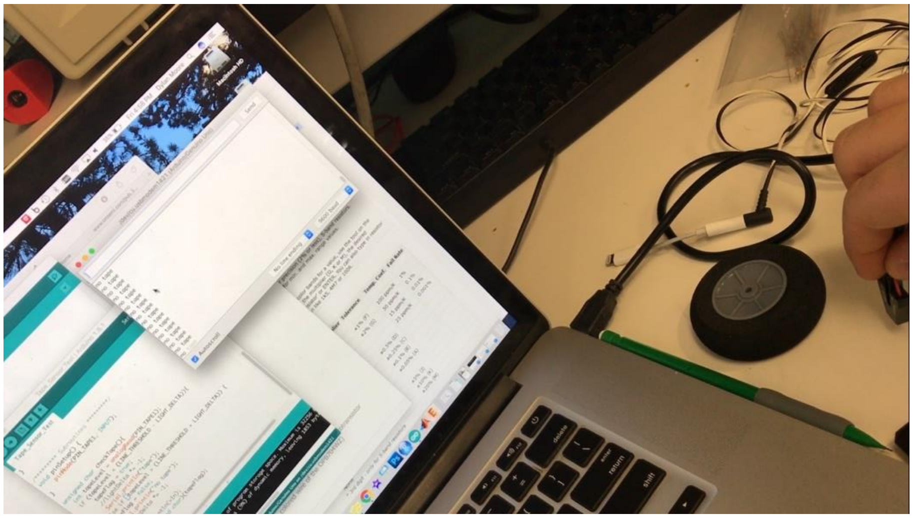
Assuming all parts are operating at all time,

t = 4000 mAh / 6244 mA = 0.64 h = 38.4 min

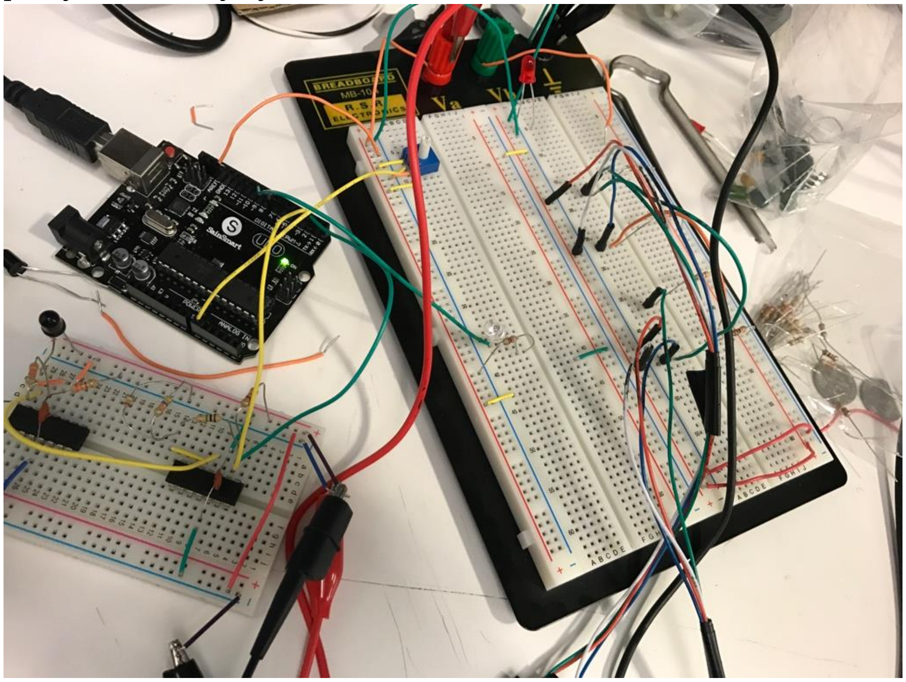
3 Preliminary Testing Results

3.1 Infrared Tape and Beacon Sensor

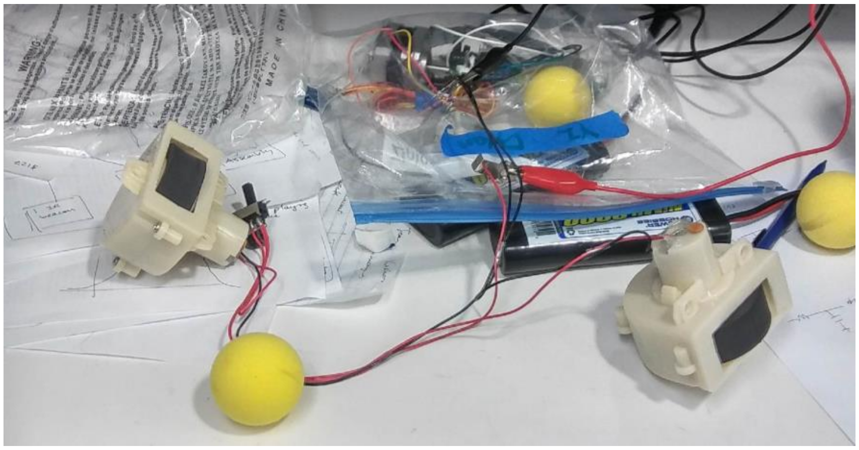
We connected two OPB704WZ IR tape sensors to the Arduino and reliably detected light and dark underneath with hysteresis. Short functions were written to check the status of the sensors and return “true” or “false” if tape was detected.

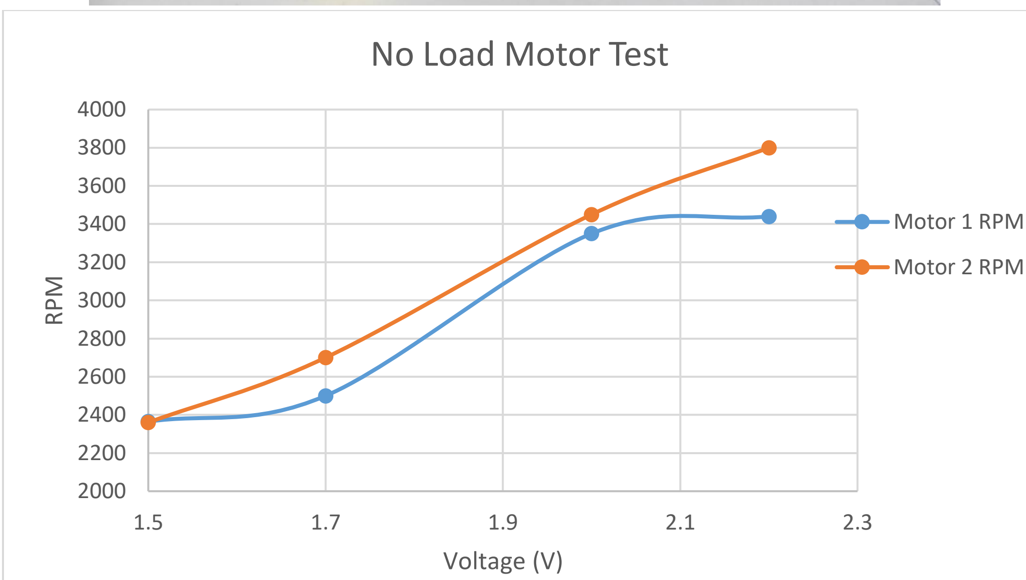


We also prototyped the beacon sensor using the same circuit as Lab 1, but using the Arduino to calculate the frequency and duty cycle. We successfully detected the 1 kHz beacon using interrupts on Pin 2 for the frequency. We have the pwm time from another interrupt on Pin 3 as a proxy for the duty cycle.



3.2 Launcher

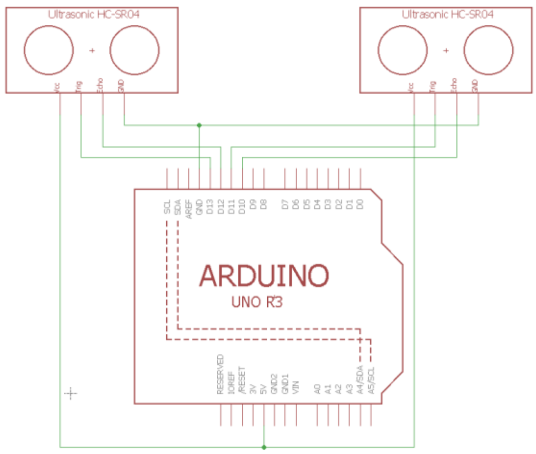


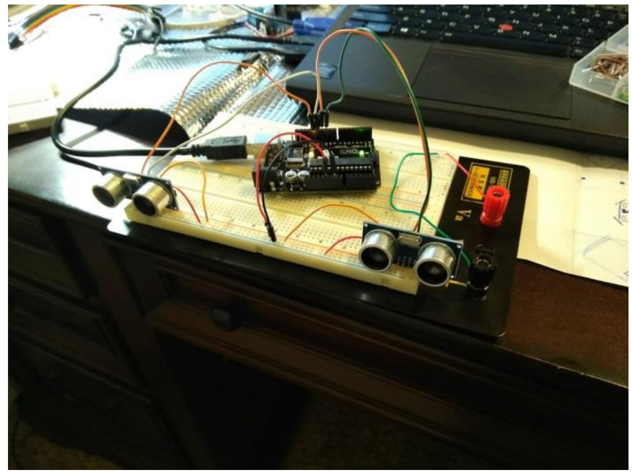


Voltage	Motor 1 RPM	Motor 2 RPM	Current	Stall Current
1.5	2365	2360	0.4	1.03
1.7	2500	2700	0.42	1.25
2	3350	3450	0.47	1.31
2.2	3440	3800	0.5	no test

- RPMs drop about 5 per second. A feedback loop may be needed to keep RPMs stable.
- Tests were performed with both motors running simultaneously.

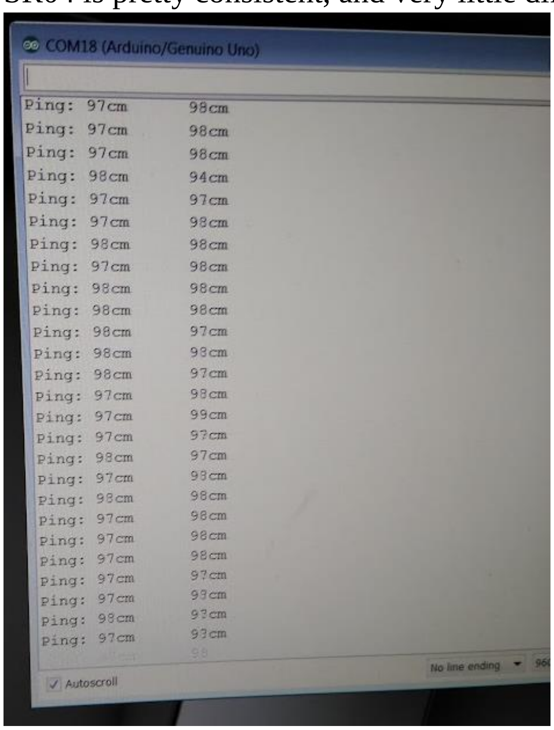
3.3 Ultrasonic Sonar Sensor SR04





Purpose:
The two SR04 sensors are used to keep the robot always parallel to the safe space edge of the game field. They are mounted at the two corner of the robot along the same edge, so that the robot will constantly adjust its position.

Preliminary test data:
Used the "NewPing" library file from the Arduino community, and seems like the data out of the SR04 is pretty consistent, and very little difference between the two sensors.



Considerations:

1. The two SR04 will take up 4 digital I/O pins on the Arduino UNO, which is quite expensive. There's an alternative of using the SRF06, which can short the trigger & echo pins together, to achieve the same result. However, the SRF06 is $10-15 each, so it is quite expensive too. The other solution is just go with the SR04 and use a second Arduino UNO.
2. There seems to be some small lag from the sensor, especially when it is moved very fast. Noticed some strange "0" reads from the sensor. This might be ok, since the robot does not have sudden changes, but if it brings problem later, we may need to modify the library. If the error is too high, we may also need extra tape sensors.