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We used the issued power supply to separately measure the the power consumed by each of the three major components: Turtlebot, Servo, Solenoid.

For each, we repeated the experiment 2-3 times to reduce percentage error, as detailed in the tables in the following section.

#### Turtlebot Setup

We soldered a custom wire of 16AWG with a banana connector to the power supply and a T-plug connector to the Turtlebot3's openCR power jack.



Figure 1: Connected Power Supply to Turtlebot using custom wire. Figure 2: reading off the power supply

#### Servo Measure Setup

We connected the power supply directly to the Vcc of the servo to directly measure the power consumption, connecting the supply's negative wire to a common ground.

#### Solenoid Measure Setup

Potential difference was measured using a voltmeter. The current running through the solenoid was read off from the power supply.

#### Servo

Test Number	Power (W)
1	0.85
2	0.70
3	1.04
	Overall Avg Power:0.863

#### Solenoid

Test Number	Voltage(v)	Current(A)	Avg Power(W)

1	10.57	0.980	10.36
2	10.56	0.950	10.03
3	10.61	0.948	10.06
			Overall Avg Power:10.15

Power consumption of the turtlebot\* during (i) initial boot up, (ii) standby/idle and (iii) during operation.

#### Initial Boot Up

Test Number	Max Power (W)
1	9.2
2	9.19
	Overall Avg Power:9.2

#### Standby/Idle

Test Number	Min Power (W)	Max Power (W)	Avg Power (W)
1	5.65	5.852	5.75
2	5.63	5.86	5.75
			Overall Avg Power:5.75

#### During Operation

Test Number	Only ROSBU(W)	ROSBU + RTELEOP MAX velocity (W)	Avg Power (W)
1	7.58	9.20	8.39
2	7.53	9.37	8.45
			Overall Avg Power:8.42

#### Assumptions

- Out of all operation time, solenoid + servo only activates for a small amount of time. Assume negligible net power consumption by solenoid and servo.
- Robot is moving half the time at max velocity and idling with ROSBU ON the other half of the time.

The LiPo battery that comes with the Turtlebot is 11.1 nominal voltage and 1.800 mAh.

The capacity of the battery (in W h) is  $(11.1 \text{ V}) * (1800 \text{ mAh}) = 19.98 \text{ W h}$

Based on the above assumptions, the overall average power consumed is **8.42 W**

Therefore the expected operation duration for the Turtlebot is  $19.98 / 8.42 = 2.37 \text{ hrs}$