Energy Consumption difference for NXT robots with varying mobile platforms

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Abstract:

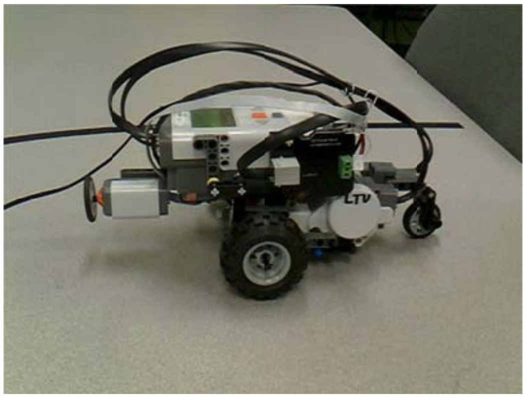
In the construction of robots many wheels or sliders can be used in different lay outs to produce many different mobile platforms for specified purposes. However, some of these mobile platforms may be less energy efficient than others.

Equipment:

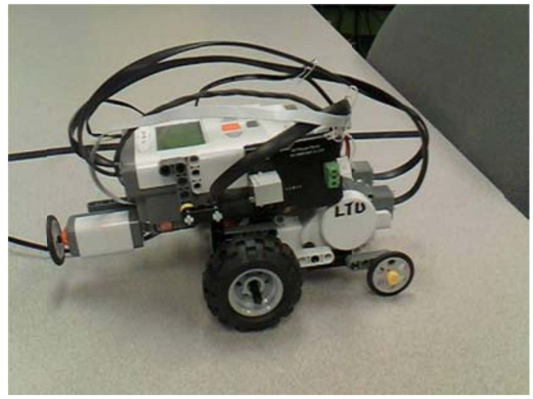
An NXT robot was used in combination with a NXT power meter sensor by mindsensors.com. This power meter sensor was attached to the robot and it measured current and voltage of the battery pack around 22 times a second. The energy was calculated for that time step and added with all the others to find the overall energy consumed. The reading resolution for Amps is 1 mA, and for Volts is 12 mV. The accuracy however is not as good it had an averaged measured difference off of the actual of about 200 mV and 7 mA.

Introduction:

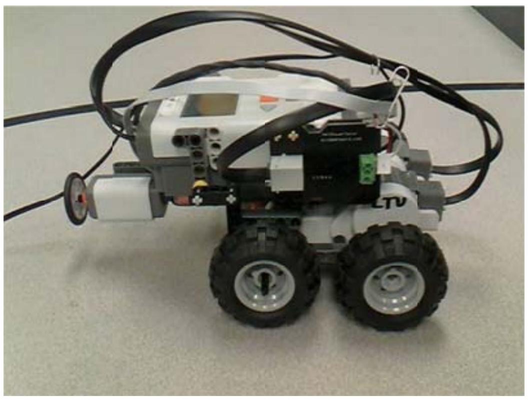
A straight line test was used for this experiment; a set distance was measured between the front of the robot and a fixed box at the end of the track, exactly 0.11 ± 0.005 meters. The robot had a button at the front so that when the robot reached the end of the track it would immediately stop recording data and display the results. The motors were run at full power with their axles locked in sync. The surface which the robot drove on was a hard laminate desktop surface. The wheels of the robot were kept to the same size because different sizes would change the time it took to reach the end of the track which is the biggest factor in determining the amount of energy used in a run. The weight of the robot was kept constant at 801 ± 1 grams. Each robot was run five times and the results were averaged to find the energy used per run.



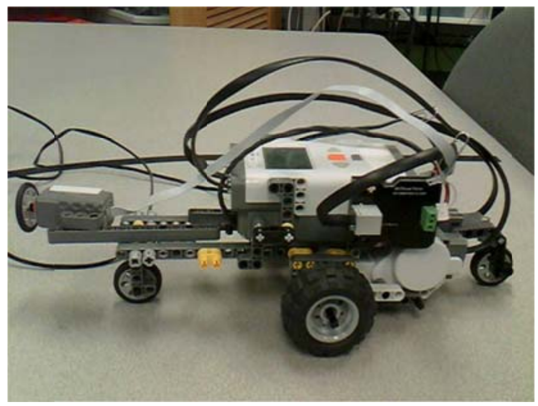
Robot A: Rear swivel wheel.



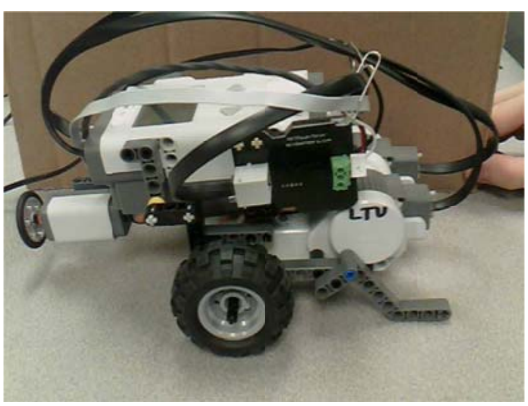
Robot B: Rear non-swivel wheels.



Robot C: Double wheels (only one set is powered).



Robot D: Double swivel wheel.



Robot E: Rear sliders.

Results:

Robot	Energy Consumption mJ
Robot A	6285
Robot B	6405
Robot C	6063
Robot D	6394
Robot E	6693

Analysis of Results:

Despite the larger wheel with higher moment inertia, Robot C seems to be the most efficient robot of the five. Robot A seems to be the next most efficient. Robots B and D are in the middle of energy efficiency. Robot E with the sliders seems to be the least efficient.

Limitations:

In the non averaged results the deviation was up to 500 mJ averaged around 200 mJ which is unexplainably large considering that the time and processer loops that it took before it reached the end of the track were identical. Also the experiment only tests the application were the robot would be traveling straight. More experiments would be needed to test the efficiency with rotation and a mixture of the two. Also if the axles were unlocked some robots may gain more curvature in the path to the box. Another factor that may of skew the results was that the weight partitioned onto the drive wheels may not be the same for every robot.

Further Research:

This experiment only tested the energy efficiencies of the robot traveling forward. More experiments could be done to find out the efficiencies of turning. For determining an overall energy efficiency an averaged result may be taken, weighted on the expected turning and forward travel in a robotic application.

Raw Data: The follow list is the raw data collected in the testing.

Bot A

Energy mJ	Mass kg	Time sec	Distance m	Velocity m/s	loops	Motor speed	Voltage Initial mV
6457	0.801	2.731	0.11	0.040278286	60	100	8276
6296	0.801	2.799	0.11	0.03929975	60	100	8276
5817	0.801	2.732	0.11	0.040263543	60	100	8289
6546	0.801	2.731	0.11	0.040278286	60	100	8289
6481	0.801	2.731	0.11	0.040278286	60	100	8289
6285	0.801	2.7448	0.11	0.04007963	60	100	8283.8

Bot B

Energy mJ	Mass kg	Time sec	Distance m	Velocity m/s	loops	Motor speed	Voltage Initial mV
6256	0.802	2.731	0.11	0.040278286	60	100	8302
6375	0.802	2.732	0.11	0.040263543	60	100	8302
6460	0.802	2.732	0.11	0.040263543	60	100	8289
6511	0.802	2.732	0.11	0.040263543	60	100	8289
6424	0.802	2.734	0.11	0.040234089	60	100	8289
6405.2	0.802	2.7322	0.11	0.040260601	60	100	8294.2

Bot C

Energy mJ	Mass kg	Time sec	Distance m	Velocity m/s	loops	Motor speed	Voltage Initial
5664	0.8	2.732	0.11	0.040263543	60	100	8302
5894	0.8	2.731	0.11	0.040278286	60	100	8315
6341	0.8	2.732	0.11	0.040263543	60	100	8302
6245	0.8	2.731	0.11	0.040278286	60	100	8315
6170	0.8	2.731	0.11	0.040278286	60	100	8302
6062.8	0.8	2.7314	0.11	0.040272389	60	100	8307.2

Bot D

Energy mJ	Mass kg	Time sec	Distance m	Velocity m/s	loops	Motor speed	Voltage Initial
6268	0.801	2.73	0.11	0.04029304	60	100	8315
6030	0.801	2.731	0.11	0.040278286	60	100	8315
6507	0.801	2.733	0.11	0.040248811	60	100	8315
6570	0.801	2.732	0.11	0.040263543	60	100	8315
6597	0.801	2.731	0.11	0.040278286	60	100	8315
6394.4	0.801	2.7314	0.11	0.040272393	60	100	8315

Bot E

Energy mJ	Mass kg	Time sec	Distance m	Velocity m/s	loops	Motor speed	Voltage Initial
6567	0.801	2.716	0.11	0.040500736	60	100	8315
6704	0.801	2.731	0.11	0.040278286	60	100	8315
6596	0.801	2.731	0.11	0.040278286	60	100	8315
6863	0.801	2.731	0.11	0.040278286	60	100	8315
6738	0.801	2.733	0.11	0.040248811	60	100	8315
6693.6	0.801	2.7284	0.11	0.040316881	60	100	8315