# Motor Justification

Tuesday, December 14, 2021 8:16 PM

When taking another look at the motors that I previously requested, I realized that the advertised speed of the motors was actually the no-load speed. Due to this, it is necessar to select different motors that will be able to achieve the speed we desire when loaded.

When searching for the right motor, I took several factors into account. Nominal voltage expected robot weight, desired speed, desired acceleration, maximum incline, and wheel radius were factors that I considered when calculating the required parameters of our motors.

Through research I was able to find the equation I would need to use

$$T = (100/e) * \frac{(a + g * \sin(\theta)) * M * R}{N}$$

The derivation for this equation can be found at

https://www.robotshop.com/community/blog/show/drive-motor-sizing-tutorial

In the equation above, *e* represents system efficiency, *a* represents acceleration of our robot, *g* represents the acceleration due to gravity, *theta* represents maximum incline, *M* represents the mass of the robot in kilograms, *R* represents the wheel radius, and *N* represents the number of motors. The weight estimate of the robot can be found below.

| | |
|---|---|
| **Motors x4** | **1.65 lbs** |
| **All Controllers/Sensors** | **Approx 0.5 lbs** |
| **Shooting Mechanism** | **Approx 2 lbs** |

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|---|---|
| **All Controllers/Sensors** | **Approx 0.5 lbs** |
| **Shooting Mechanism** | **Approx 2 lbs** |
| **Wheels x4** | **0.5 lbs** |
| **Battery** | **Approx 1.1 lbs** |
| **Robotic Arm** | **Approx 2 lbs** |
| **Acrylic Chassis** | **2.5 lbs** |
| **Turntable** | **Approx 1 lb** |
| **Total** | **11.25 lbs** |

Our parameters include 0.4572 m/s^2 for acceleration, 15 degrees for maximum incline (although the board is expected to be relatively level), 5.1 kg for M, and 4 for number of motors. E accounts for total system efficiency, which is a bit harder to estimate, but I believe a value of 50% is a fair approximation. Many websites use a standard of 65%, but I subtracted an additional 15% to be safe.

When entering the above parameters, I come to a result of 2.03 kgf-cm. Additionally, considering our wheel radius of 0.026 m, we will need to achieve an rpm value of 168 rev/m.

Considering the parameters listed hitherto, I believe that the motor at the following link is ideal for our application:
https://www.pololu.com/product/4743/specs

The rated specification of the motor are as follows:

| | |
|---|---|
| **Max efficiency @ 12V:** | 51 % |
| **Speed at max efficiency:** | 180 rpm |
| **Torque at max efficiency:** | 2.2 kg·cm |

| | |
|---|---|
| **Current at max efficiency:** | 0.66 A |
| **Output power at max efficiency:** | 4.0 W |

The rated specifications of this motor match our applications needs, which will allow us to reach our desired speed.

I would also like to purchase this set of screws for mounting the motors to the acrylic chassis:
https://www.pololu.com/product/1075

We plan to leave holes in the acrylic specifically to mount the motors.

The new motors are rated very similarly to the original motors in terms of torque and current. The main difference is the rated speed. The updated schematic of the drivetrain is as follows: