EN2532 - Robot Design and Competition

# DC MOTOR SELECTION FOR THE MOBILE ROBOT


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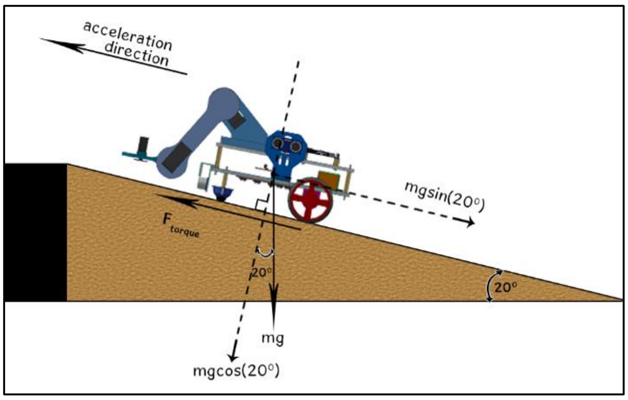
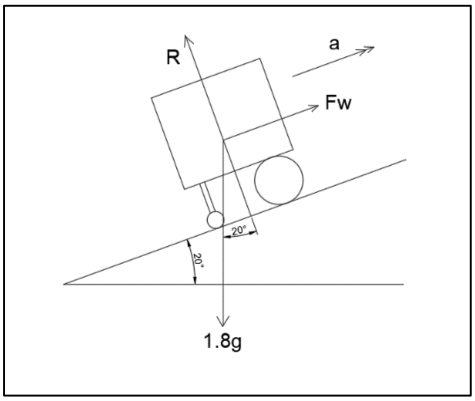
**What is a DC motor?**

A DC motor is a mechanically commutated electric motor powered by "direct current". This converts direct current electrical energy into mechanical energy. There are two main types of DC motor based on existing commutating mechanism. They are brush DC motors and Brushless DC motors. These motors are comprised of six main components; permanent magnets, a spinning armature called a rotor, an axle, a commutator, field magnets, and brushes (optional). Using magnetism, they can create rotational motion.

## Free Force Diagram




## Calculations




- Maximum speed = 0.12ms$^{-1}$
- Radius of wheel = 3.25cm

*Note: For all the calculations the weight of the robot is approximated as 1.8 Kg while velocity of the robot is decided to be nearly 0.21 meters per second depending on some critical parameters.*

Let's assume we need to achieve maximum velocity within 1s,

$$v = u + at$$

$$0.12 = 0 + a(0)$$

$$\therefore a = 0.12ms^{-2}$$

Assume that there is no friction between the robot and surface.

$$F = ma$$

$$F_w - mg\sin 20° = ma$$

$$F_w = m(a + g\sin 20°)$$

$$F_w = 1.8(0.12 + 9.8\sin 20°)$$

$$F_w = 6.2492\ N$$

Torque needed from both motors;

$$\tau = F_w.r = 3.25 \times 6.2492 \times 10^{-2}$$

$$\tau = 0.203\ Nm$$

Therefore torque required from both of the motors in $oz - in$.

$$\tau = 0.203\ Nm$$

$$\tau = 28.7472\ oz - in$$

Torque required from one motor;

$$\tau = \frac{28.7472}{2}\ oz - in$$

$$\tau = 14.3736\ oz - in$$

RPM of the motor;

$$RPM = \frac{0.12ms^{-1} \times 60}{2\pi r} = \frac{0.12 \times 60}{2\pi \times 3.25 \times 10^{-2}}$$

$$RPM = 35.2589\ revmin^{-1}$$

Angular velocity of motor;

$$\omega = \frac{35.2589\ rev}{min} \times \frac{2\pi}{60} rads^{-1}$$

$$= 3.6923\ rads^{-1}$$

Power required to be supplied by the 2 motor;

$$P = \tau\omega$$

$$P = 0.7495\, W$$

Power needed to be supplied by one motor;

$$P = \frac{0.7495}{2} W = 0.3745W$$

# Comparisons

- Required torque from the motor = $14.3736\, oz - in$
- Required RPM from the motor = $35.2589\, RPM$

These values correspond to the ideal world. But in practice, many losses are applied. Therefore, assuming that the losses are 50% or greater than the ideal values, we should at least double our requirements. Then,

- Required torque from one motor = $14.3736 * 2 = 28.7472\, oz - in$

Now, we need to consider the provided motor specifications to check whether or not the motor is suitable for our work. Consider the Toque vs. Speed and Torque vs. Current graph for Pololu Metal Gear motor 25Dx67L mm HP 12V with 48 CPR Encoder.

According to the graph, for the 28.7472 $oz - in$ torque (nearly$30\, oz - in$), we can get nearly 215 RPM by this motor. It would give the robot plenty of speed. Furthermore, we can see that to achieve this we have to give nearly 1600 mA to the motor. So, we can reduce the voltage and decrease RPM of the motor to desired values. In our calculations, we didn't consider the frictional and other losses. So, considering those conditions, this motor (Pololu 25D*67L mm HP) is a good fit and we chose it for our work.