

DRIVE MOTOR REQUIREMENTS

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Robot Total Weight Calculation

Component	Weight
Lipo Batteries – 200g x 2	400g
Arduino mega	40g
12V motors – 200g x 2	400g
Arduino nano	7g
OLED Display	15 g
Dangaya Motor Controller	75g
Servo motors – 20g x 3	60g
Color Sensors – 15g x 2	30g
ToF and Gyro meter	20g
Wheels, Spaces, Nuts	80g
Raykha Sensor	25g
Perspex floors	100g
Wires and other	50g
Body Cover	100g
Total Weight (Worst case)	1500g

Motor Specification Calculation

According to the path that robot is going to follow, the highest current and the torque will be needed at the ramp sub-task. Worst-case scenario will be, robot stopping at the ramp-start and trying to climb it. This case will require the highest torque and current.

We do the calculations for starting the ramp at zero speed and accelerating to 6cms^{-1} in 2s. Then climb the rest with that constant speed.

$$\text{Accelerated distance} = \frac{(V+U) \times 2}{2} = 6\text{cm}$$

Then, we can do the ramp climb in $2 + 38/6 = 8.3\text{s}$.

$$\text{Acceleration} = 6/2 = 3\text{cms}^{-2}$$

By applying $F = MA$ to the robot along the inclined plane.

$$\begin{aligned} \text{Total force needed by wheels} &= mgsin(20) + mA \\ &= 1.5 \times 9.8 \times sin(20) + 1.5 \times 3/100 \\ &= 5.077N \end{aligned}$$

$$\text{Force required by one wheel} = 5.077/2 = 2.54N$$

$$\text{Radius of the wheel} = 3\text{cm}$$

$$\begin{aligned} \text{Torque required from a wheel} &= Fd \\ &= 2.54 \times 3\text{Ncm} \\ &= 7.62\text{Ncm} \\ &= 0.777\text{kgcm} \end{aligned}$$

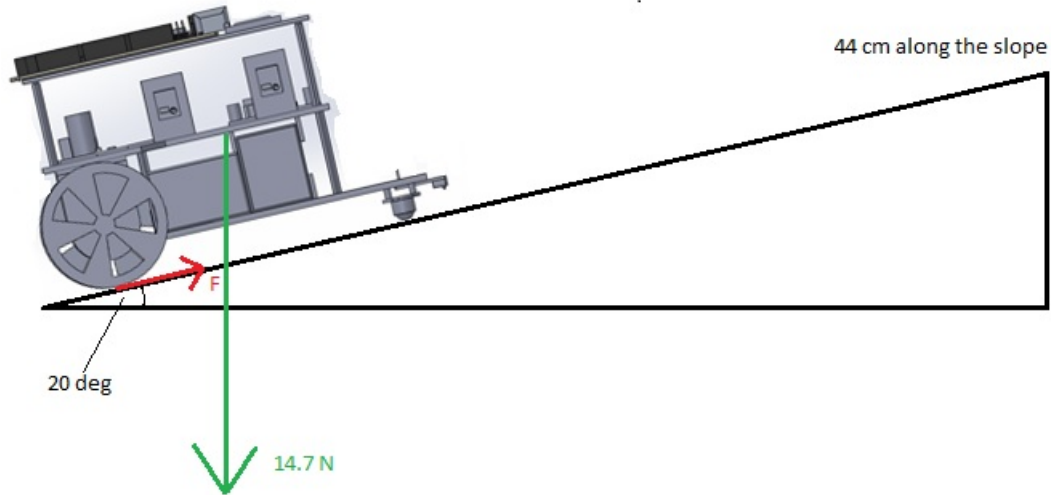


Figure 1: Free body diagram for robot on the ramp.(Only the forces which affect the ascend are marked here)

To leave a 25% space for any error (friction), We should use a motor with **1.036 kgcm** stall torque at least.

$$\begin{aligned}\text{Angular Velocity at the maximum speed in the ramp} &= 6\text{cms}^{-1}/3\text{cm} \\ &= 2\text{rads}^{-1} \\ &= 19.1\text{rpm}\end{aligned}$$

$$\begin{aligned}\text{Maximum power output of the motor (P)} &= \tau\omega \\ &= 7.6 \times 2/100\text{Nm} \\ &= 0.144\text{W}\end{aligned}$$

Descend from the Ramp

To maintain a constant speed, again motors should take the torque generated by weight.

$$\text{Torque} = \frac{1.5 \times 9.8 \times \sin(20) \times 3}{2} \text{ Ncm} = 7.54 \text{ Ncm} = 0.76 \text{ kgcm}$$

$$\omega = \frac{44\text{cm}}{10 \text{ s} \times 3 \text{ cm}} = 1.5 \text{ rads}^{-1}$$

$$\text{Power required during the descend} = \frac{7.54 \times 1.5}{100} = 0.11 \text{ W}$$

On flat ground

We are planning to complete the first line following part (approximately 250 cm) in 30 seconds and it will be the fastest run.

$$\text{Maximum RPM needed} = \frac{250 \times 60}{30 \times 2\pi \times 3} = 26.52 \text{ rpm}$$

Selected motor: Pololu 25D 12V high power 47:1 gear motor with encoders.

Stall Torque = 8.64 kgcm @9V

Stall Current = 4.2 A @9V