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.

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

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

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

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

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

Force required by one wheel $= 5.077/2 = 2.54N$

Radius of the wheel $= 3cm$

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

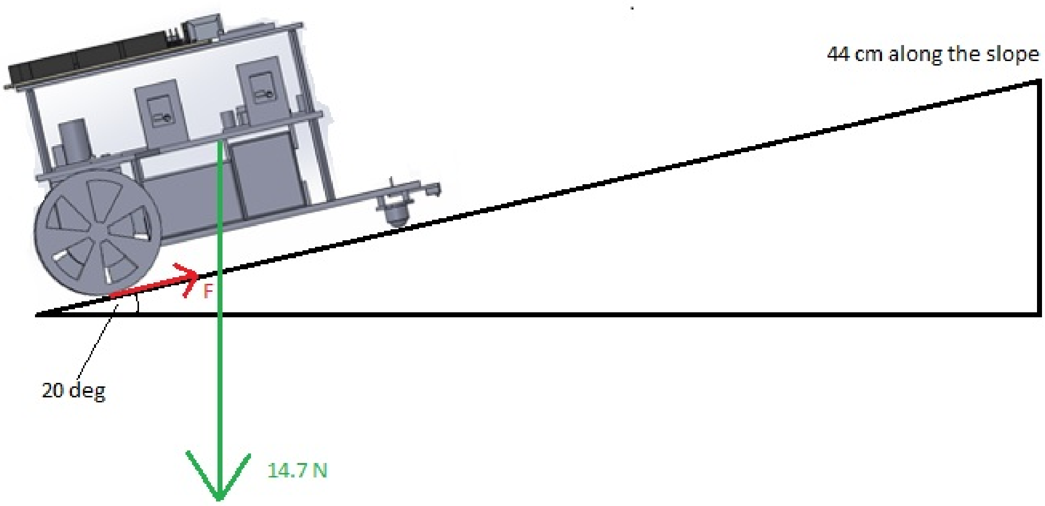

Figure 1: Free body diagram for robot on the ramp.(Only the forces which affect the ascend are marked here)

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

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

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

Descend from the Ramp

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

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

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

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

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.

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

Selected motor: Pololu 25D 12V high power 47:1 gear motor with encoders.
Stall Torque $= 8.64\ kgcm$ @$9V$
Stall Current $= 4.2\ A$ @$9V$