**Robot Total Weight Calculation**

Lipo Batteries – 200g x 2 400g

Arduino mega - 40g

12V motors – 200g x 2 400g

Arduino nano – 7g

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**

According to the path that robot is going to follow, the highest current and the torque will be needed at the entry point of the ramp. 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 = (V+U)\*2 / 2

= 6 cm

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

Acceleration = 6/2 = 3cms-2

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

Total force needed by wheels = mg sin(20) + mA

= 1.5x9.8xsin(20) + 1.5x3/100

= 5.077 N

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

Radius of the wheel = 3cm

Torque required from a wheel = Fd

= 2.54x3 Ncm

**= 7.62 Ncm**

**= 0.777 kgcm**

To leave a 25% space for any error (friction),

**We should use a motor with 1.036 kgcm stall torque at least.**

Angular Velocity at the maximum speed in the ramp = 6 cms-1/ 3 cm

= 2 rads-1

= 19.1 rpm

In this moment, maximum power output of the motor (P) = τω

= 7.6 x 2 / 100 Nm

= 0.144 W

**Climb down the Ramp**

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

Torque = 1.5x9.8xsin(20) x 3/2 Ncm

= 7.54 Ncm

= 0.76 kgcm

‘Omega’ = 44cm/(10s x 3cm)

= 1.5rads-1

Power required during the descend = 7.54 \* 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.

**Maximum RPM needed = 250 x 60 / (30 x 2π x 3)**

**= 26.52 rpm**

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

**===Graph===**

The combined graph shows the relationship the speed of a \_\_\_\_DC motor (in rpm) vs Torque (in kgcm) and the Current drawn by the motor (x100mA) vs Torque (in kgcm). The stall current is about 4200 mA for a 9V supply, with stall Torque of 11.8 kgcm. Load free speed is 210rpm (22 rad/s).

Leaving a safety margin of 25%, the motor will be able to overcome a Torque of 8.8kgcm. If using this motor, the circuit components relating to one motor (such as motor driver) should be capable of handling 4A. For the current to be below 2A(the common limit of an L298), the task and design of the robot should be restricted below (2\*11.8/4.2) = 5.6kgcm.

Considering the case where the torque requirement is highest, (start of the ramp climb of 20 degrees)

Torque limit per motor = 5.6kgcm

Torque by two motors = 11.2kgcm

Force provided along the inclination = (3x11.2x9.8) =329N

Load it can support vertically = (329 sin (20) / 9.8) = 11.4kg.

The speed of motor at 5.6kgcm torque = (1- 2/4.2) \*22 = 11.5 rad/s, which gives a speed of 0.34m/s along the ramp.

Thus, if this motor is used at a load significantly less than 11.4kg, then we can be confident that currents of 2A will not be exceeded. A smaller load would reduce the torque required, current drawn will reduce, and higher speeds can be achieved.

Regulated Voltage supplied to the motor = 9V

Assuming voltage and current are nearly in phase during steady state,

**Maximum current needed at the ramp = P/V**

**= 0.144 / 9**

**= 0.016 A**

**Maximum current in climb down of the ramp = 0.0754\*1.5/9**

**= 0.013 A**

**With the losses within the motors and inefficiencies,**

**An upper limit for the current taken by the motor = 200mA**

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To allow the ability to train and test the robot, 2200mAh capacity is suitable for both baterries.