Signoff Request - September 16th - Chassis anc

Friday, September 16, 2(9:22 PM

"What it's gonna do"

The tank chassis [1] is responsible for being the main structural frame of the robot. This kit includes the treads that are attached to the chassis, and the motors that will drive them.

" Specs and Constraints'

Size:

The chassis needs to be of an appropriate size in order to accommodate all of the components, b inch maximum height constraint.

Speed:

The motors need to have a torque that it is strong enough to overcome the robot's weight (discussed b an appropriate speed of 0.2 m/s. This speed of a little less than a foot per second was selected by the te time for sensor sampling but also move at a decent pace. Additionally, the robot must be able to move While crawlspaces differ in the makeup and slope of the ground, a maximum scenario is considered in v change in height and length takes place, or, the steepest and most rapid 30 degree slope.

Weight:

The Autonomous Crawl Space Inspection Robot will contain navigational and environmental sensing equ components. It is important to have an accurate measurement of all of the materials' weights so that the around the crawlspace. Below is a table of the components that will be used in the design.

	A	B	C	D	E
1	Subsystem	Component	Count	Weight (g)	Total
2	Navigation	Raspberry Pi	1	46	46
3	Navigation	Voltage Regulator	1	10	10
4	Navigation	Lidar	1	170	170
5	Sensors	Resistance Measure Circuit	1	45	45
6	Sensors	Temperature sensor	1	2.9	2.9
7	Sensors	Humidity Sensor	1	2	2
8	Sensors	Cascading Arm	1	640	640
9	Sensors	Arm Motor	1	44	44
10	Sensors	Linear Actuator	1	74	74
11	Sensors	Probes	1	4.5	4.5
12	Sensors	Bracket	1	5	5
13	Navigation	Ultrasonic Sensors	4	13	52
14	Navigation	Router	1	204	204
15	Power	Batteries	2	454	908
16	Movement	Chassis	1	1000	1000
17	Movement	Motor driver	2	55	110
18	Movement	Motors	2	101	202
19	Movement	Microcontroller	1	5	5
20	Power	Adapters	2	181.4	362.8
21	Power	E Stop Switch	1	26	26
22	Power	Bus Bar	1	306	306
23	Power	Terminal Connectors	2	5	10
24	Power	Blade Fuses	17	18	306
25	Power	Buck Converter	7	15	105
26	Power	E-Fuse	1	20	20
27	Navigation	Antenna	1	41	41
28	Naviagation	HD Camera	1	100	100
29			Total:		4801.2

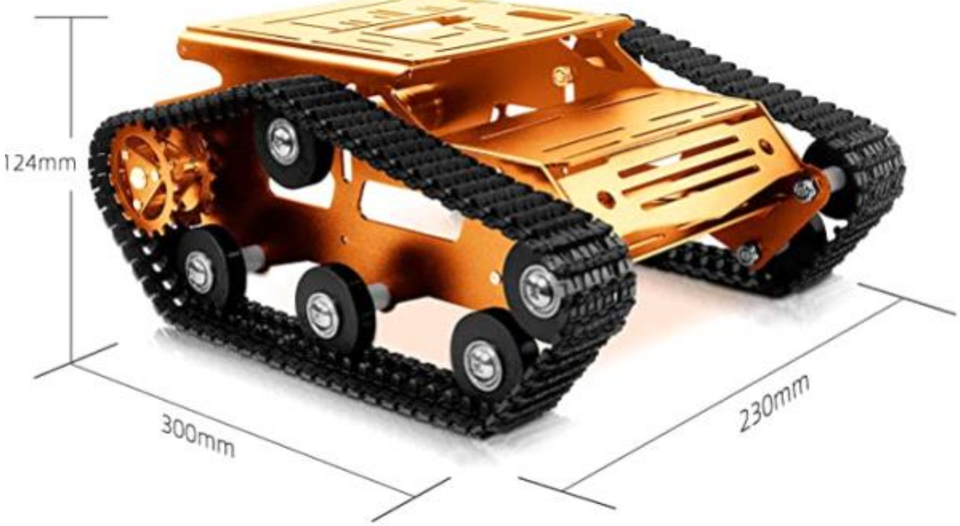
Table 1: Sum of Weights

Some items on the robot are not listed on the table, but are factored into the weights. An example of th temperature sensor. Those 2.9 grams are both the arduino nano and the temperature sensor.

Additionally, this table does not indicate every piece of mass that will be added onto the robot (ex: wire (and any unforeseen circumstances), an additional calculation that assumes the robot weighs 7.2 kg, 50 expects, is made in the analysis section.

"Analysis Compared to Constrain

The Length Width and Height of the chassis kit in mm is 300/230/124. The surface area of the main platf and the height of 124 mm is 4.88 inches, which provides the team with 11 inches worth of height for adc such as the Lidar, Batteries, and cascading arm. More surface area can be added by attaching more platf platform included on the chassis if the need arises. Below *is Figure 1*, which features the original kit whe the amount of holes on the platforms that can be used for adding in more platforms if the need arises as



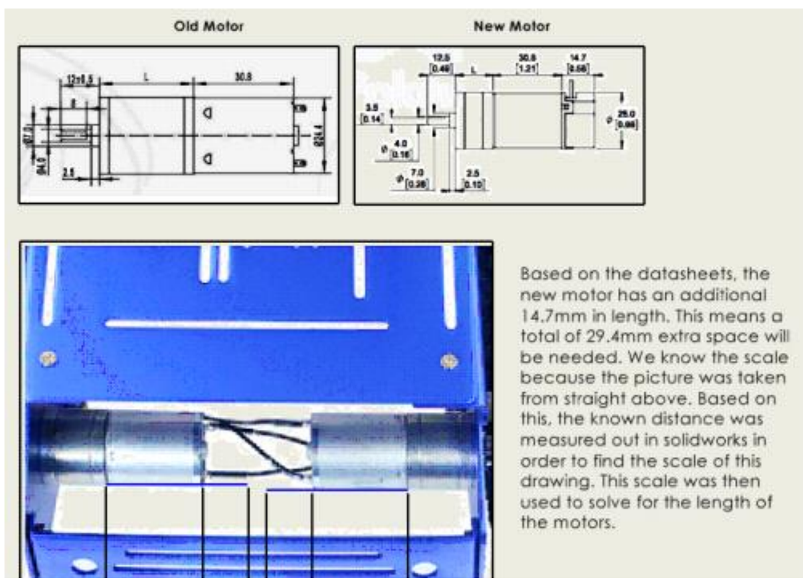
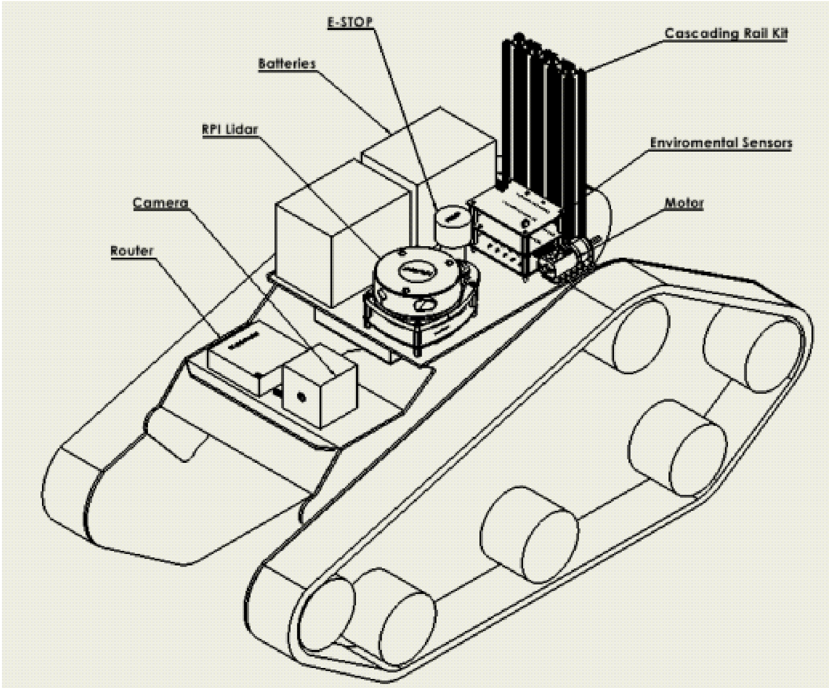


Figure 1: Robot Tank Chassis Kit [1]

Full Model

Figure 2 shows the 3D model with the large components mounted to the chassis. This model was created to parts will fit onto the chosen chassis. Big parts were labeled for clarity. Parts were also called out on the bott gives extra space and provides easier access to the drive motors. This figure shows how the hardware will mo Figure 2 also shows that the height of the robot is 15 inches, which fits into the 16 inch maximum height con



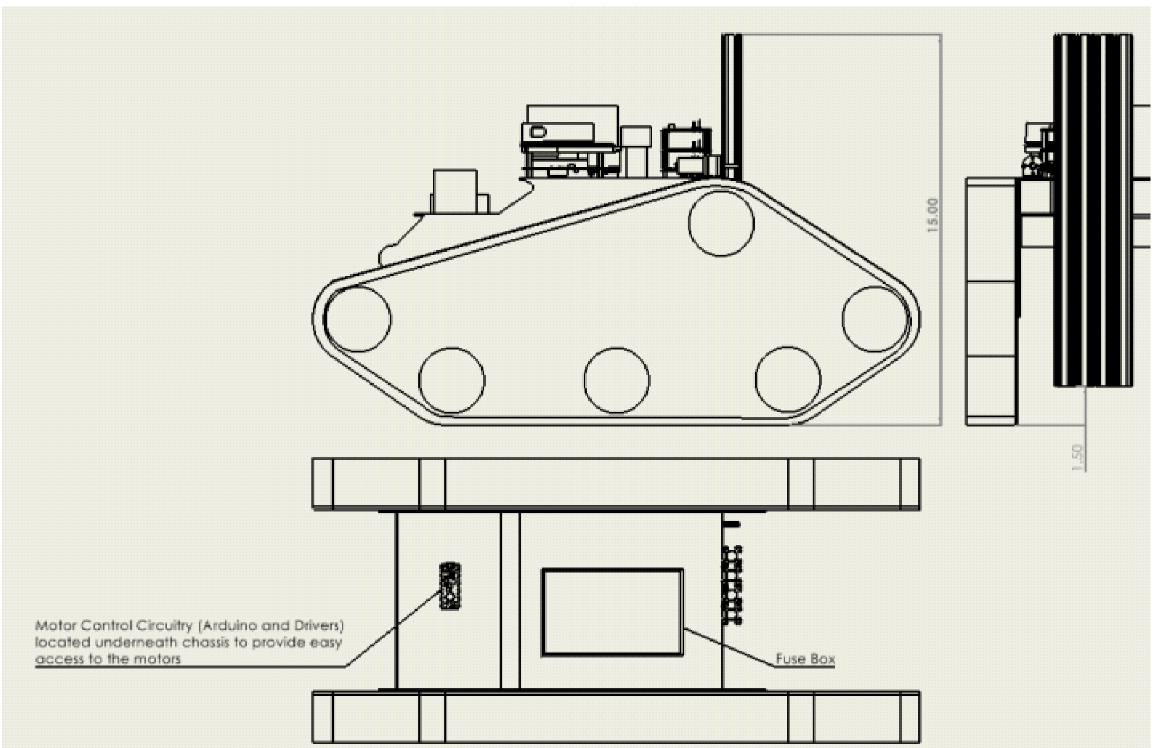


Figure 2: Chassis Model with Hardware

The chassis kit comes with motors. The included motors are described as GM25-370. The following info given on the amazon page for the kit:

Motor parameter:

Type: GM25-370

Output rate: 150 + 10% for RPM

Rated voltage: 12V

Rated current: 2000mA

Locked-rotor current: 4500 mA (Max)

KgNaN locked-rotor torque: 9.5kgNaN

Load speed: 100 + 10%rpm

The load torque: 3000 gNaN

[1]

A quick google of the part number brings up information on it from Pololu. Figure 3a shows the original dimensions. Based on the above information it is best assumed that the included motor has a reductior

After comparing the specs provided in the product description on amazon with the different variations o The specs given on the motors included in the kit are inconsistent and undetailed, so to ensure a buildab new motors that can accommodate the design will be chosen. However, the new motor MUST have simi to the one included in the kit so that the included motors can be easily replaced. The physical size constr follows:

- The motor size must have a shaft diameter of 4mm with length of
- The new motor must be 25 mm in diamet
- The new motor must not exceed a length of 79.7mm in order to fit under t

To identify the strength and speed of the potential motor some calculations need

Inputs:
Wheel Radius: 0.01524 m (measured length of drive wheel in
Weight: 4.8 kg
Forward Velocity: 0.2 m/s
Max Incline: 30 degrees
Acceleration up incline: 0.1 m/s^2

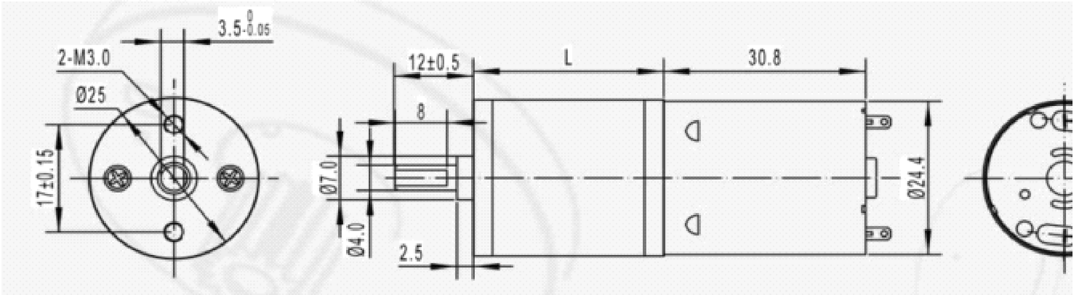
Angular velocity = forward velocity/ radius of wh
=> (0.2m/s) / (0.01524m) = 13.1234 rad
=> (13.1234 rad/sec) * (1 rev/2pi rad) * (60 sec/min) = 125.31

In the following torque equation, we divide by 2 to account for the 2 wh
Also, 125 rpm is about 56% of the max no load 220 rpm. We see from electronics stack exchange that t efficiency all intersect at about 50% [2]. With the 56% of rpms calculated above, we'll assume a 50% eff calculations below. This accounts for some drops in efficiency possibly due to overheating or other stim
Output Torque = (100/efficiency) * (weight * radius of wheel * (accel + g*sin(
= (100/50) * 4.8kg * 0.01524m * (0.1 m/s^2 + 9.81*sin(30)) / 2 = 0.35
Converting: 0.3583391Nm / (9.81m/s^2) * (100cm/m) = 3.7321

3.732192 * 1.5 = 5.598288 (The aforementioned calculation that shows if the robot weighs 50% more then the motors can still handle it)

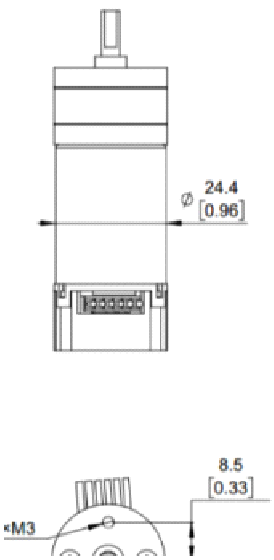
Current = Torque*angular velocity / volta
3.732192 kgcm * 13.123 rad/sec / 12 V = 0.40028 A

Based upon the calculations, a motor from pololu was chosen as the drive motors for the Autonomous (Robot: Pololu item number 4845 [3]. This motor has nearly identical physical dimensions as the one incl with the only difference being the addition of the encoder (dimensions shown in Figure 3b), and its stall load rpm (220rpm), and corresponding range are adequate for the above calculations. A torque curve w seen in Figure 4. The green dot represents the operating point for the robot, and it is well within the tor that even if the robot ends up weighing 50% more than the team expects (7.2 kg) then the motors will s the load. Comparing the motor lengths, diameter, and placement of the mounting holes shows that the

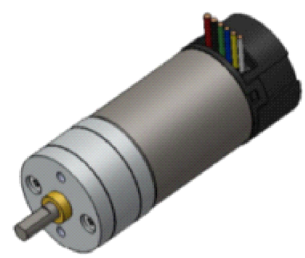


Gearbox with motor	GM25-370CA-15360-XXX									
Reduction ratio	4	10	21	34	47	78	103	130	227	499
Length mm	17	19	19	21	21	23	23	25	25	27
No-load speed rpm	1280	510	245	150	110	68	50	42	24	11
Rated speed rpm	1200	480	230	137	102	62	47	37	21	10
Rated torque kg.cm	0.06	0.15	0.3	0.5	0.7	1.1	1.5	1.7	2.7	5
Max.momentary tolerance torque kg.cm	0.45	1.1	2.3	3.9	5.2	10	10	10	10	10

Figure 3a: Original Motor Dimensions - [4] L=



Gear ratio	L
4.4:1	17 mm [0.68 in]
9.7:1	
20.4:1	19 mm [0.75 in]
34:1	21 mm [0.83 in]
47:1	
75:1	23 mm [0.91 in]
99:1	
172:1	25 mm [0.98 in]
227:1	
378:1	27 mm [1.06 in]
499:1	



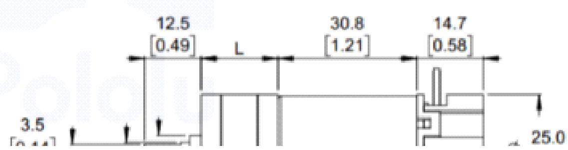


Figure 3b: New Motor Dimensions. L = 2

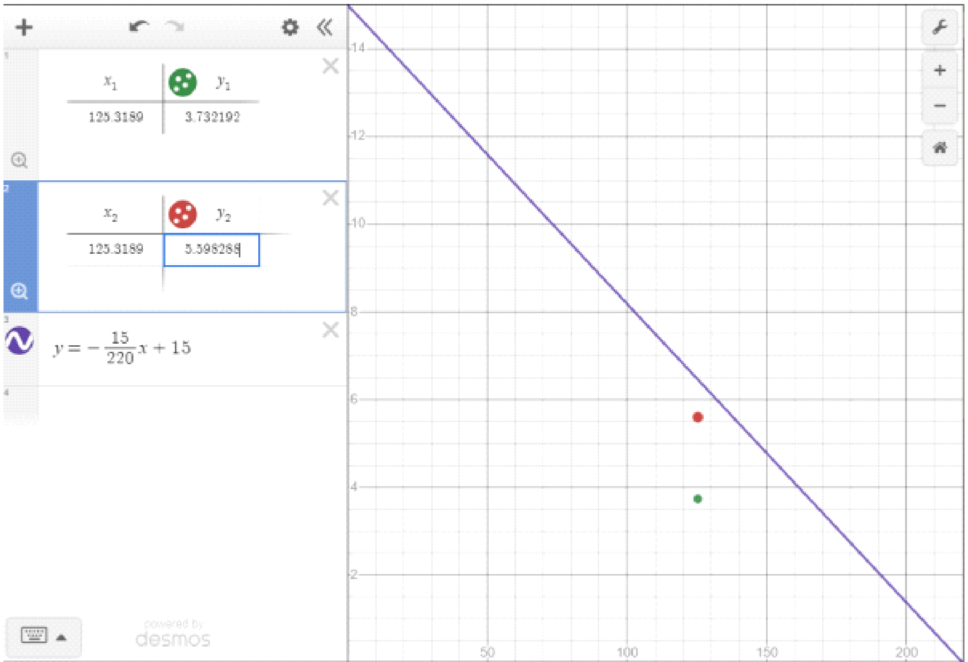


Figure 4: Torque Curve
X Axis: Speed (rpm)
Y Axis: Torque (kgcm)

An additional bonus of the selected motor is that it comes equipped a Hall Effect encoder that ca the speed at which the motor is operating. However, the encoder adds an additional 14.7 mm or motor. Referencing back to figure 1, it can be seen that the 29.4 mm of space necessary for the e Therefore, the new motors will fit into the same space that the old motors used. Figure 5 gives a pictures on how the motor and encoder wires are to be connected.

25D mm metal gearmotor with 48 CPR encoder (with end cap removed).

Color	Function
Red	motor power (connects to one motor terminal)
Black	motor power (connects to the other motor terminal)
Green	encoder GND
Blue	encoder Vcc (3.5 V to 20 V)
Yellow	encoder A output
White	encoder B output

Figure 5: Motor Connections Explanation [.

New Constraint: The 5A stall current of the motors places a constraint on to the motor driver that will b
This information will be considered and analyzed in a future signoff.

Motor Mounting:

These new motors will attach to the chassis in the same way that the original motors would have. Figure
model, and Figure 7 shows how the motors will mount onto the chassis (Figure 7 is NOT a video. It is a p
but the video can be found through source 1). The motors are attached to each side of the chassis by us
The man seen in Figure 7 is installing a motor onto the chassis. Since the originally included motors and
are physically identical, the new ones will mount in the same way.

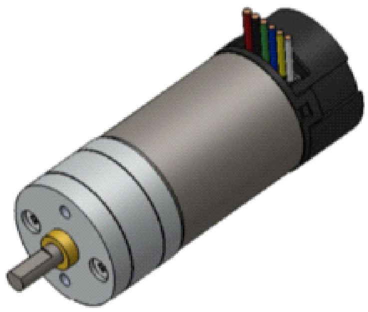


Figure 6: Motor Model - [3]

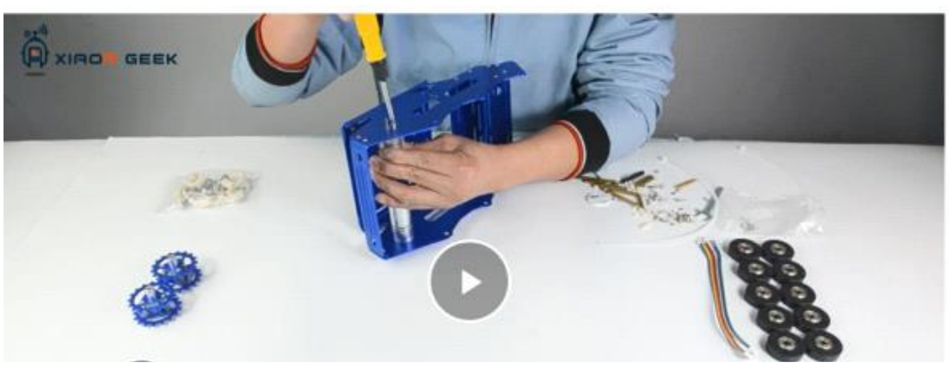


Figure 7: Motor Mounting - [1]

Each Pololu Motor costs $48.95
The Chassis Kit costs $74.99

[1] Chassis Kit
[2] Typical Motor Efficiency
[3] Pololu Motor 4845
[4] Original Motors