Space Out Hackathon

Team Musk’s Children

Challenge Statements

1C. End-Effector
2B. Battery Sizing

End-Effector (1C)

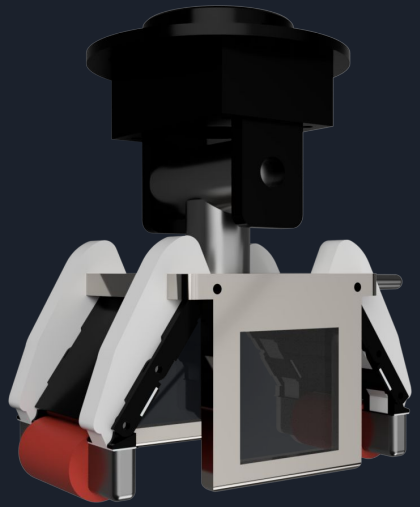
The end-effector is one of the most important components in a rover as it handles moving objects such as rocks to conduct experiments which is usually the main objective of sending a rover to another planet.

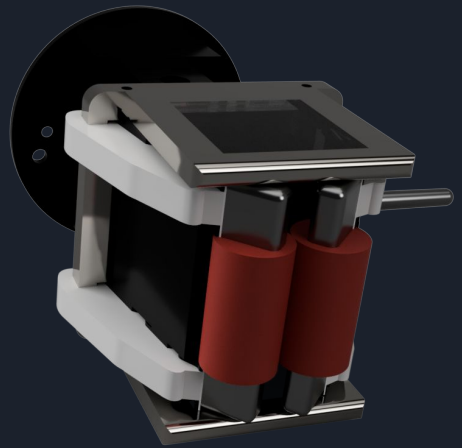
However, most concepts of end-effectors tries to replicate the human hands as it is the easiest thing that we could take inspiration from for the robot to take and move things around.

The human-hand is a source of inspiration, but robots have a harder time in managing the force to handle brittle objects.

Solution

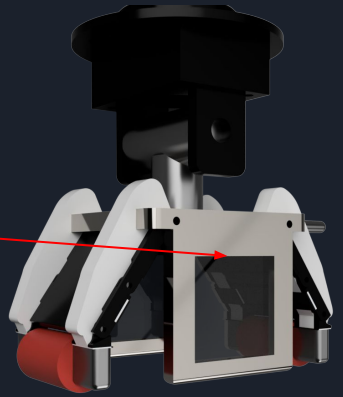
As such, this is the design of the end-effector that we have come up with:

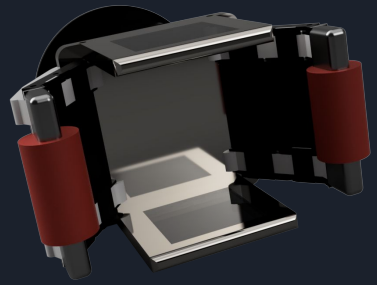




How it Works

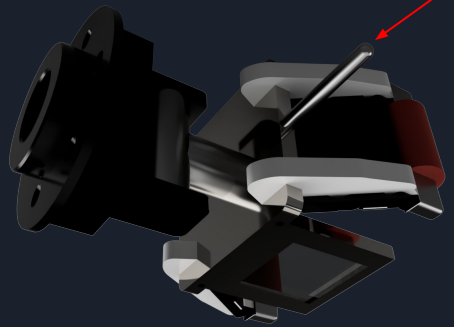
Protective casing for picked-up objects

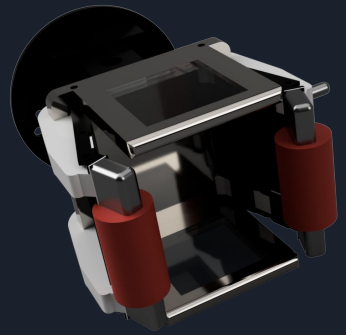




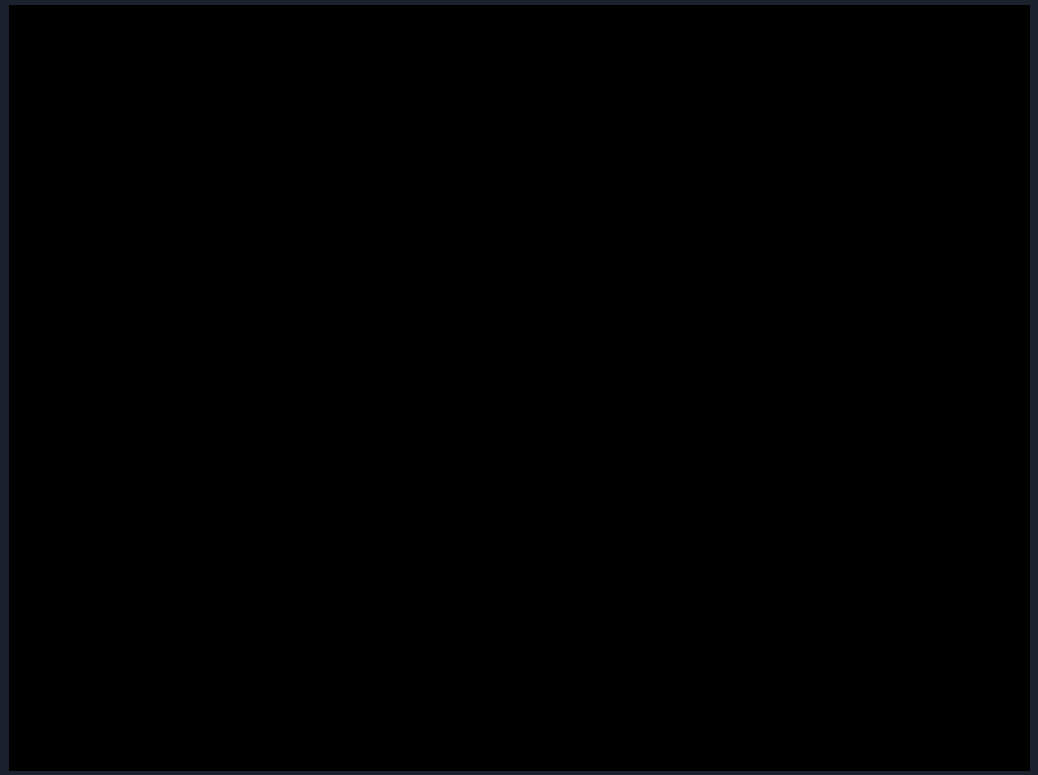
Moving rollers to pick up objects

For typing: fitted with miniature camera module

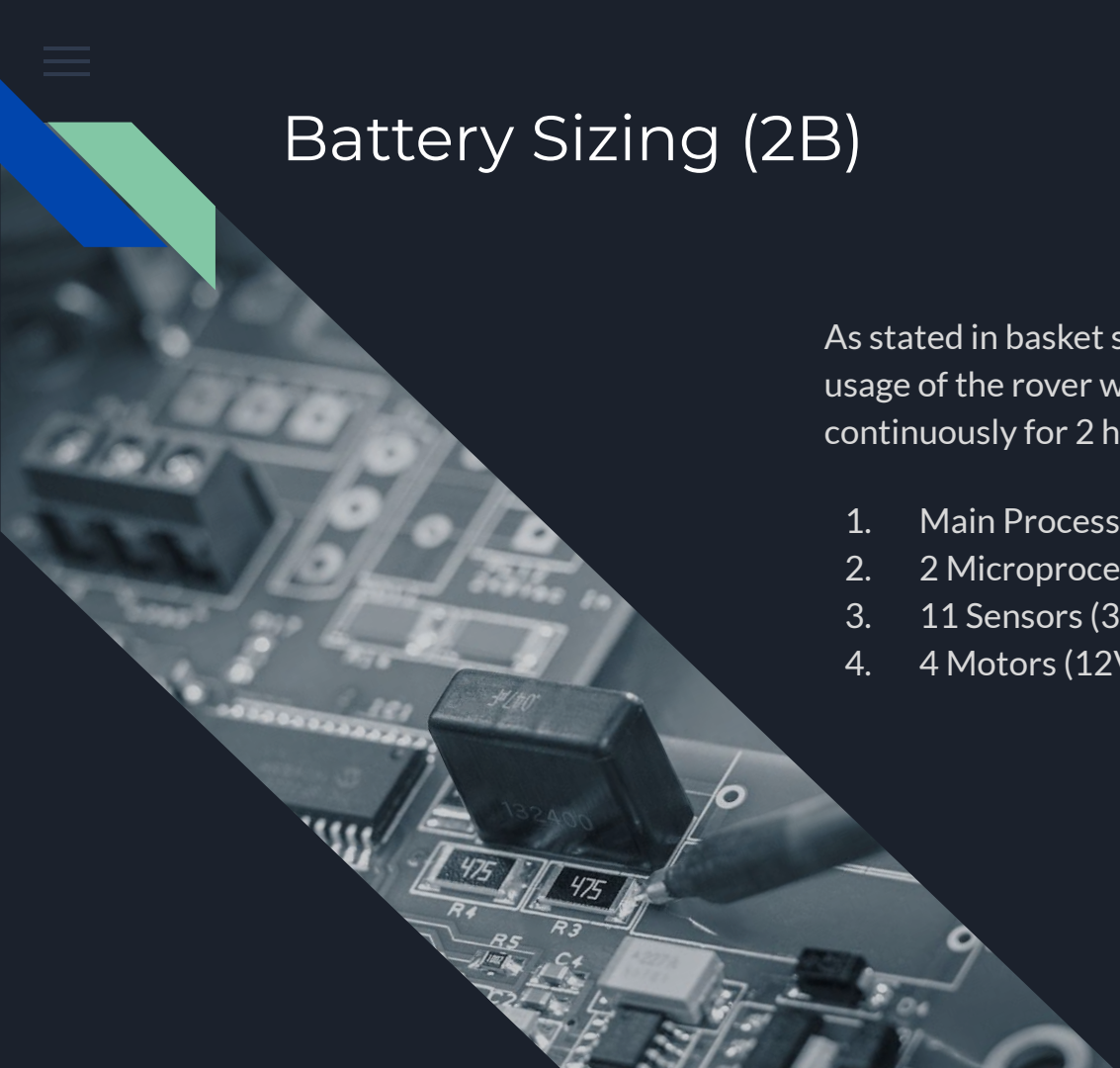




Simulation



Battery Sizing (2B)



As stated in basket statement 2B, these are the power usage of the rover which will be required the rover to run continuously for 2 hours:

1. Main Processor (5V, 4W)
2. 2 Microprocessors (5V, 2W each)
3. 11 Sensors (3.3V, 2.25mW each)
4. 4 Motors (12V, 12W each)

Initial Calculations

	Main Processor	Microprocessor	Sensors	Motors
Voltage (V)	5	5	3.3	12
Power Rating (W)	4	2	0.00225	12
Current (A)	0.8	0.4	0.000682	1
Max Wh	56.02475			
Requirement for 2 hours	112.0495			
Max Current	5.6075			

	Amount
Main	1
Micro	2
Sensors	11
Motors	4

In the initial calculations, all the components of the Rover were assumed to be running at maximum power for 2 hours straight. This gives us that the rover needs a 112 Wh battery to last for 2 hours with a current rating of roughly 6A

Assumptions

01 Main Processor, Microprocessors and Sensors will be running at all times albeit not at maximum power

02 Robot uses its motors for 80% of the duration in the 2 hour course (assuming 50% flat terrain and 50% rugged terrain)

03 The rover uses 75% of the motor’s maximum power to run on flat terrain and max power on rugged terrain

Final Calculations

Realistic Assumptions	Main Processor	Microprocessor	Sensors	Motors (Flat)	Motors (Rugged)
Voltage (V)	5	5	3.3	12	12
Power Rating (W)	2	1	0.00225	8	12
Current (A)	0.4	0.2	0.000682	0.666666667	1
Requirement for 2 hours	88.0495				
Max Current	4.8075				

Using the assumptions made, the rover battery size was able to be downsized to only 88 Wh with a 5A rating. With contingency in mind, a 100Wh battery would be a great fit for the rover.

Examples of Battery

In general, a 100Wh battery should be lighter than a 120Wh battery. However, the examples found show otherwise:

Custom Li-Ion 18650 Battery: 12V 10.05Ah regulated (120Wh 7A rate, NCR18650B)

Your Price: $260.00

In Stock

Product ID # 10856
Part Number: PR-CU-R533

Lead Time: 5 Business Days

Quantity: 1 Buy

Add to a new shopping list

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Important Shipping Regulation	This pack is for testing (prototype) only. It has not been UN38.3 tested yet. Read more...
Battery	• High capacity Li-Ion battery is made of 12 pcs 18650 3.6V 3350mAh cell in 4S3P configuration. • Battery is placed on fiberglass board with heavy duty shrink wrap in special setup
Voltage	Nominal: 10.8V; Charge Cut Off: 12.6V; Discharge Cut Off: 7.5V, 12V (regulator output)
Capacity	10.05 Ah
Protection	• 1x PCB(10A) is installed with the battery pack to protect battery from ○ Overcharging / Over-discharging / Over-drain • 1x 7 Amp polyswitch installed to limit max. discharging current at 7A and to protect wrong polarity • 2x 4A DC to DC regulators
Terminal	• Discharge terminal: 16.0" 18AWG 5.5x2.5mm Male barrel (AD-5525M-10) • Charge Terminal: 6.0" 18AWG 5.5x2.1mm DC Jack/PCB Panel. • Free hanging Fuel Guage with 12" wire.
Charge Current	5A / 0.5C
Max. Discharge Current	**7 Amp** limited by polyswitch
Dimensions (LxWxH)	230mm x 125mm x 23mm (9" x 5" x 0.9")
Weight	1lb13oz (810g)

NiMH Battery Pack: 12V 9Ah (108Wh) for Diving light of Salvo 9Amp (MH-4/3AF4500)

See Reviews

Your Price: From $189.95 to $199.95

Lead Time: 5 Business Day

Product Options

options: Select options

Personalizations

* denotes required field

Please provide Canister's model and model# *

Quantity: 1 Buy

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Battery	NiMH Battery Pack: 12V 9Ah for Diving light build with NiMH China 4/3AF 4500mAh cells.
Voltage	Voltage: 12.0 (working) 14.5 V (peak) 10.0V (min.)
Capacity	9000mAh
Protection	65°C Thermostat & 7.3A Polyswitch
Terminal	10" wire with 18AWG wire without connector
Charging Rate	1.5 A(recommended), 3A max.
Discharging Rate	• 8.4 A@20°C limited by polyswitch ○ **Discharging current will be reduced if the operate temperature increase**
Dimensions	8.0"(202mm)L x 2.2"(56mm) diameter
Weight	2.0 lbs 8 Oz (1.1 kg)

Citations

Battery Examples:

1. https://www.batteryspace.com/custom-li-ion-18650-battery-12v-10-05ah-regulated-120wh-7a-rate-ncr18650b.aspx
2. https://www.batteryspace.com/nimhbatterypack12v84ah100whfordiydivinglightofsalvo9amp.aspx

Research:

1. A. Aichhorn, M. Greenleaf, H. Li and J. Zheng, "A cost effective battery sizing strategy based on a detailed battery lifetime model and an economic energy management strategy," 2012 IEEE Power and Energy Society General Meeting, 2012, pp. 1-8, doi: 10.1109/PESGM.2012.6345103.
2. Akpolat, Alper & Yang, Yongheng & Blaabjerg, F. & Dursun, Erkan & Kuzucuoglu, Ahmet. (2020). Li-ion-based Battery Pack Designing and Sizing for Electric Vehicles under Different Road Conditions. 10.1109/SEST48500.2020.9203196.
3. Dubey, Venketech & Crowder, Richard. (2004). Grasping and Control Issues in Adaptive End Effectors. 2. 10.1115/DETC2004-57126.

Thank you!