



Mid-Term Progress Report



Lunar Regolith Excavator Student Competition Team 15: Hexcavator

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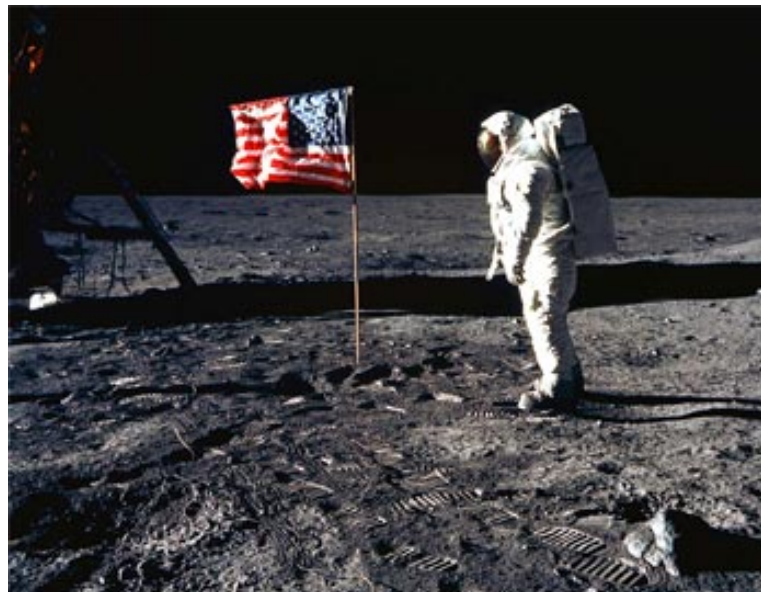
Seth Murphy

Devin Walden



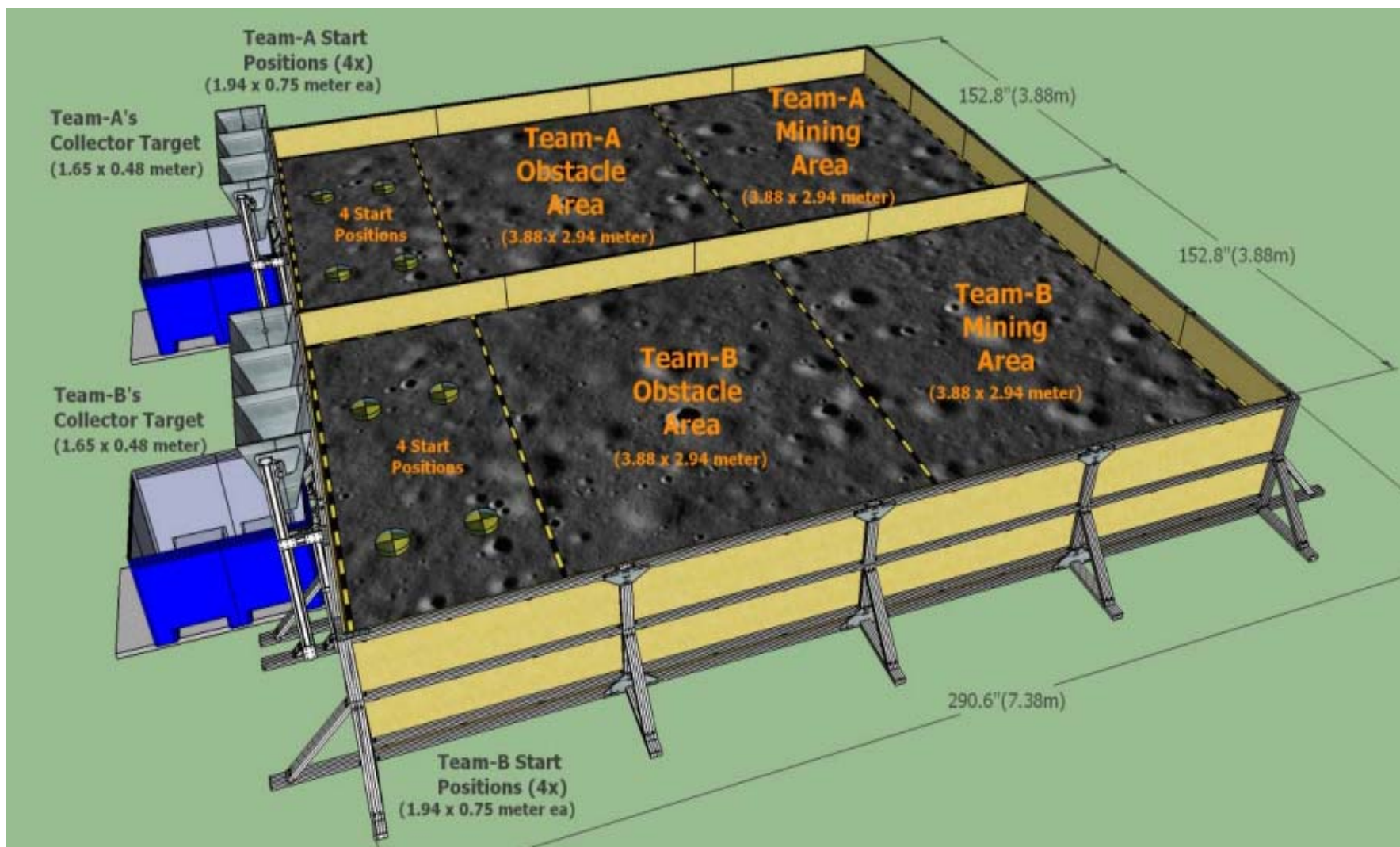
Project Inspiration

- NASA's Third Annual Lunabotics Competition
- Competition Date: May 22, 2012
- Determine feasibility of lunar inhabitation
 - Analyzing lunar soil (regolith)





Competition Area





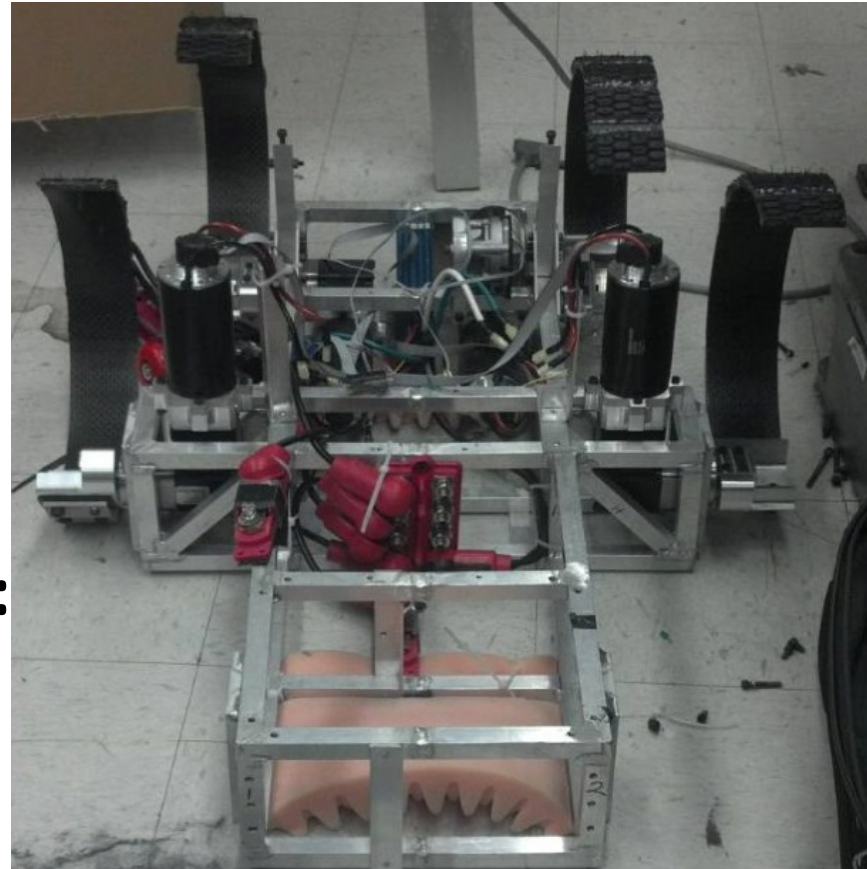
Previous Hexcavator Efforts

Completed as of August 2011:

- Frame
- Legs
- Motors
- Batteries
- Stop Button

Needs as of August 2011:

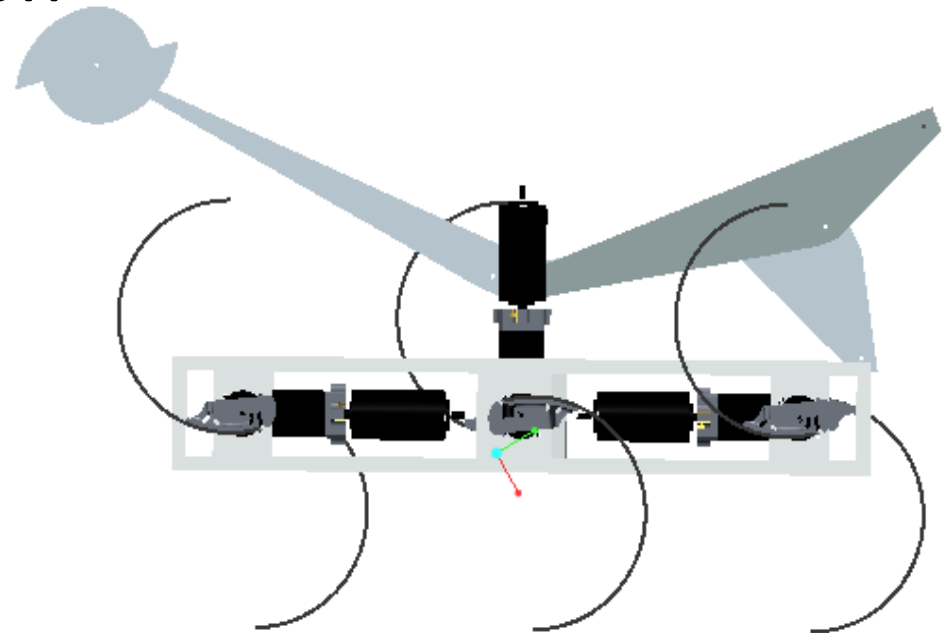
- Excavation
- Controls





Approach

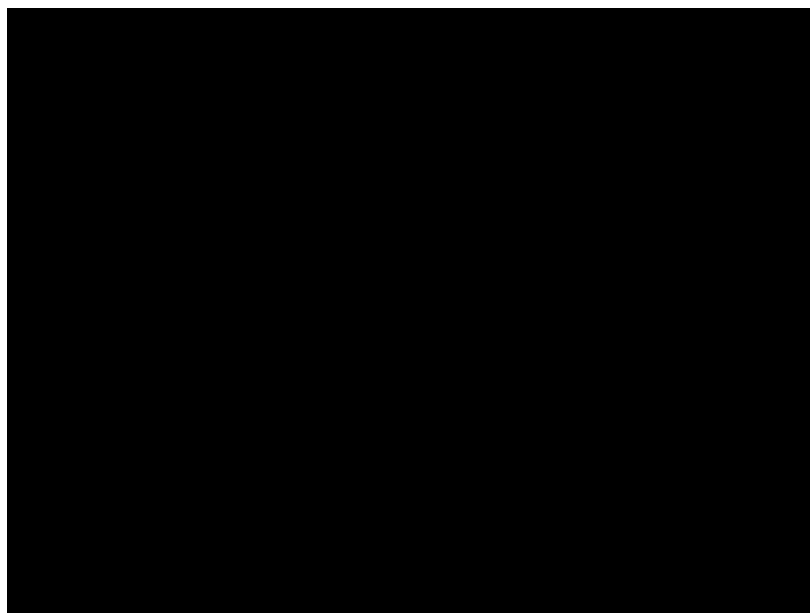
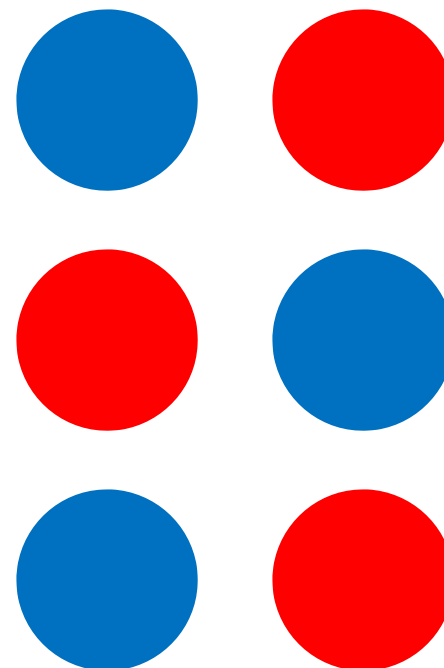
- Locomotion Scheme
- Excavation Design
- Inter-robotic communication
- Wireless Communication
- Cost Analysis
- Time Line





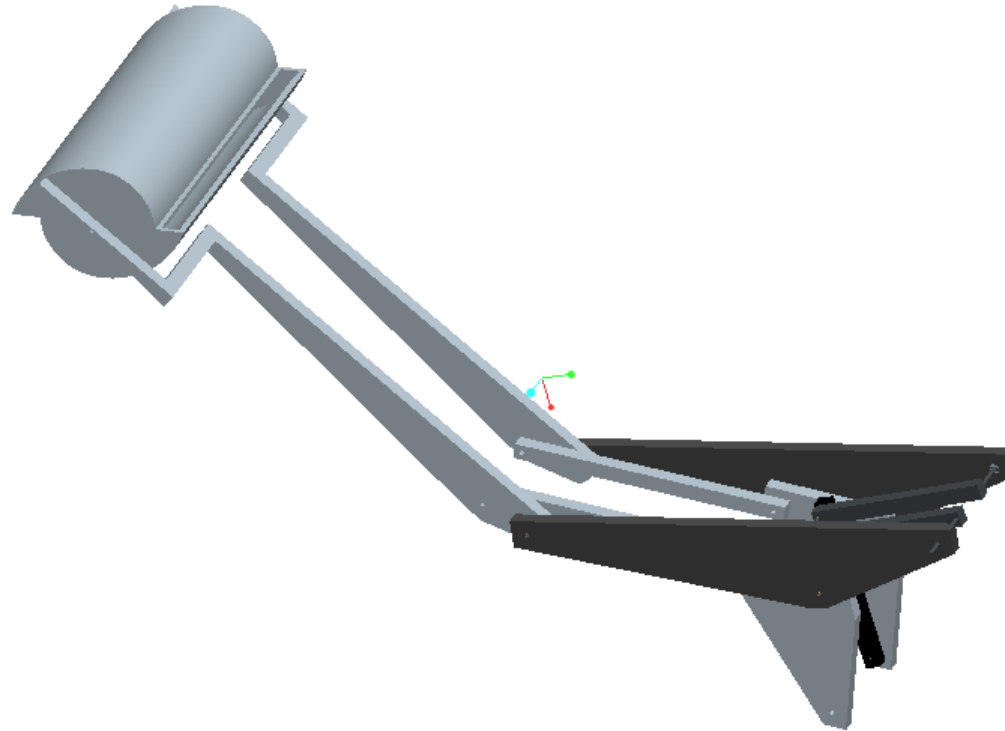
Locomotion

- Hexapedal walker
- Alternating tri-pod gait
- C-Legs
- Uses Bueheler Clock





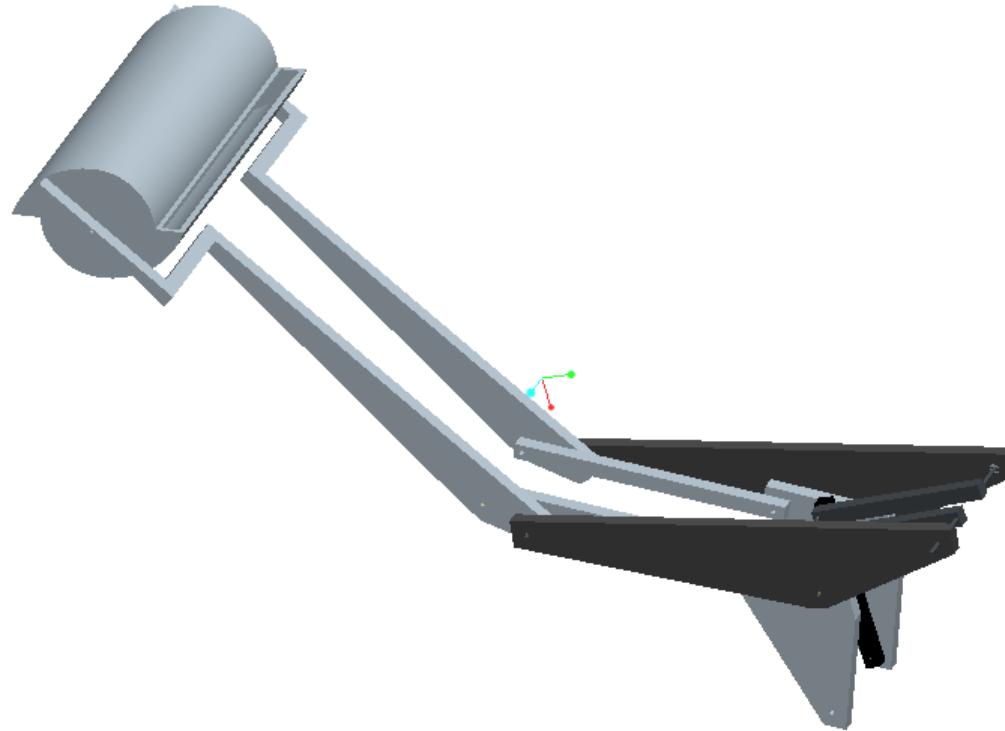
Excavation Design Status



- Linkage moves correctly
- Fixed Length – waiting for new part
- Testing in Sand when new link done



Excavation Design Status

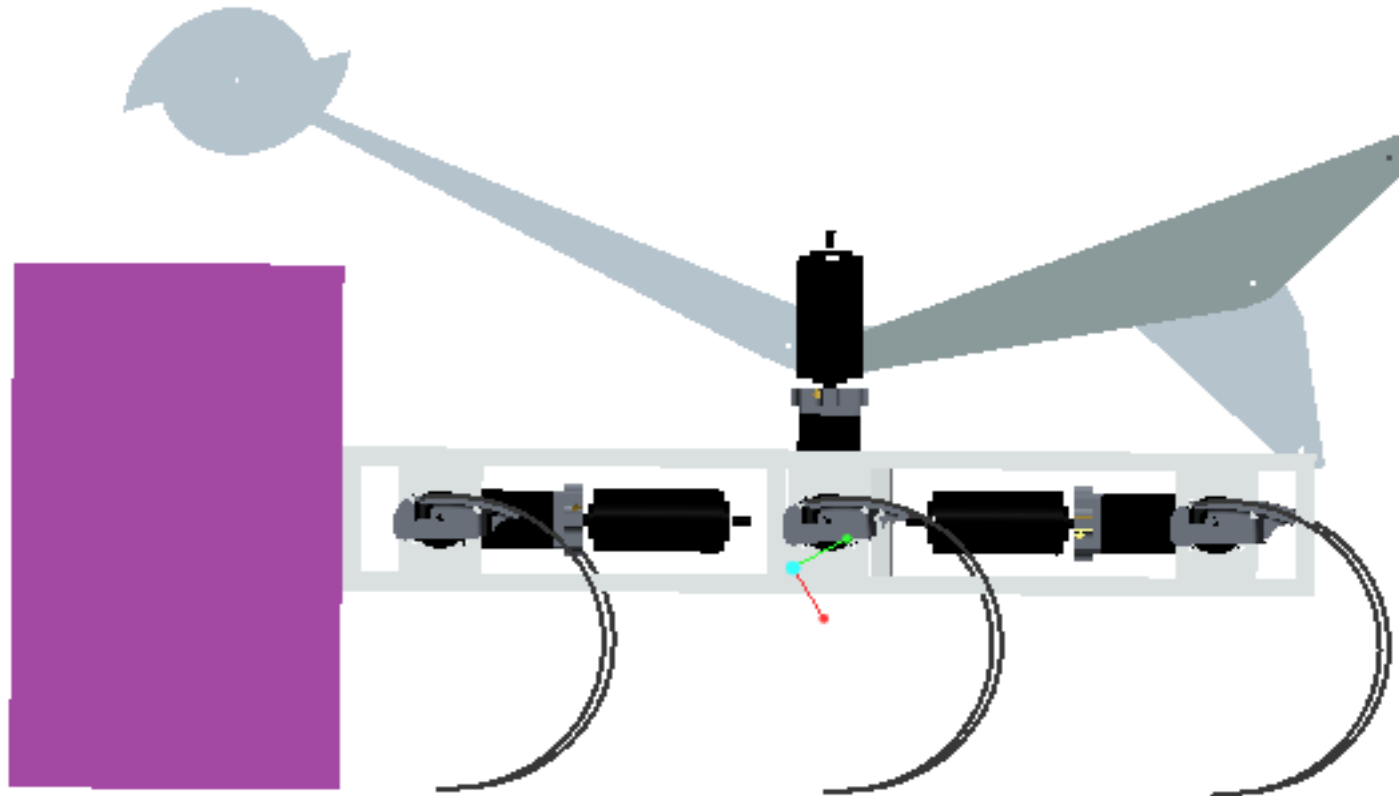


- Forked Arms Status
- Lateral Instability
- Drum Rotation



Excavation Design Future Goals

- Testing lateral instability
- Testing loading and unloading





Intra-Robotic Communication Status

Previously

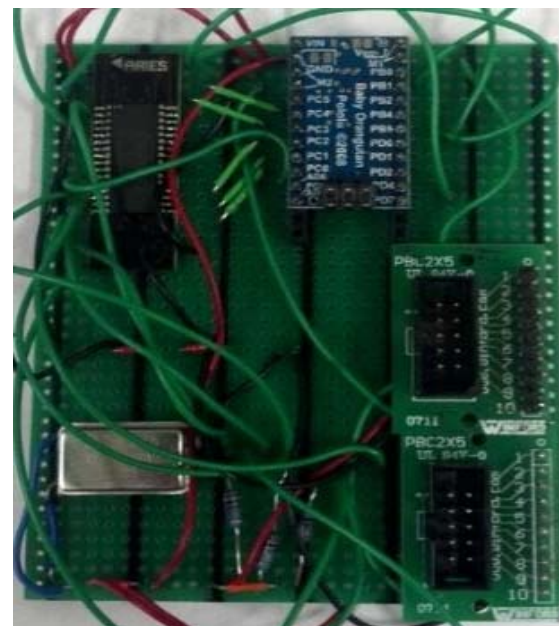
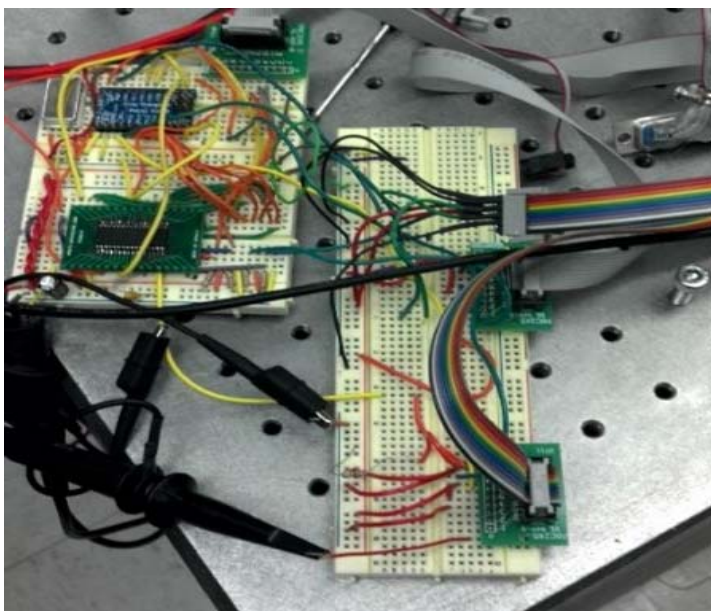
- Two legs moving unsynchronized with a simplistic control law
- Have required disconnect system



Intra-Robotic Communication Status

Current Electronics

- Two legs moving in a synchronized gate
- Have required disconnect system
- Motor Controllers Soldered



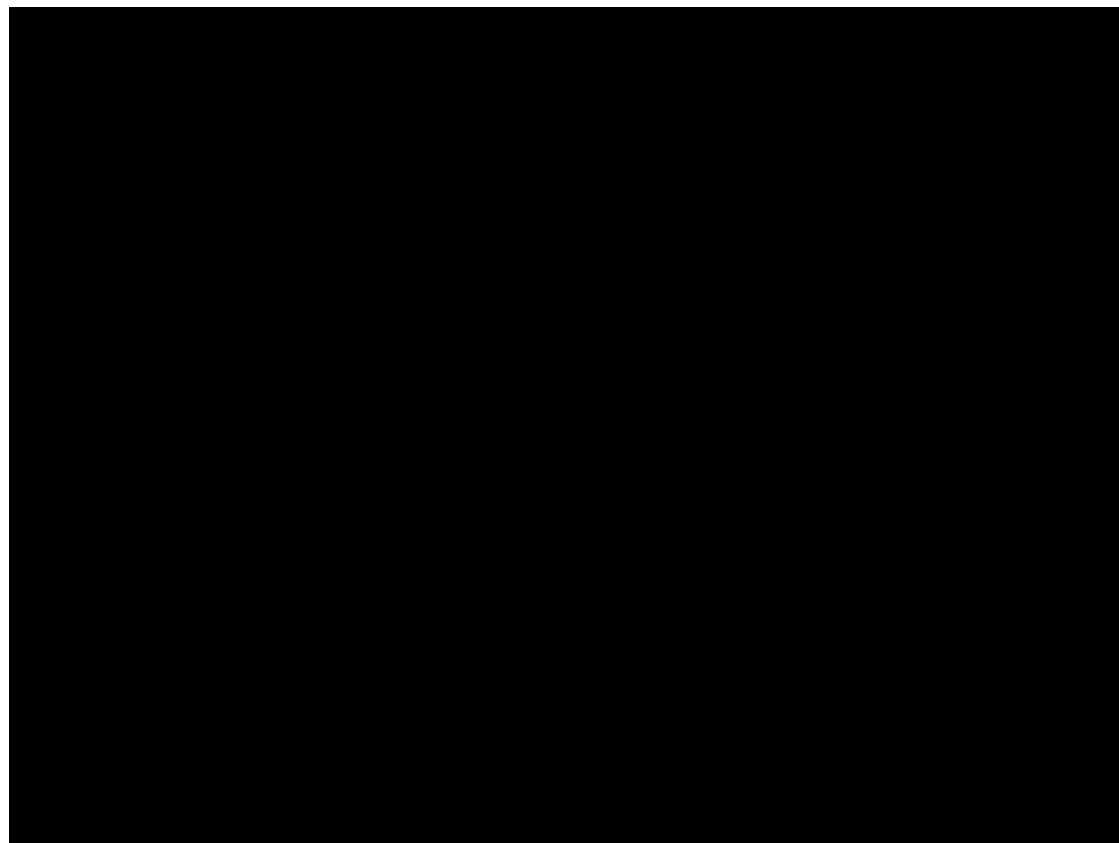


Intra-Robotic Communication Status

- **Current Mechanics**
 - All 6 legs and motors mounted
 - Motor driver mounts fabricated



Two Legged Motion





Future Work

Future Work

- Tune gates for walking
- Integrate with wireless communications
- Add control for excavation

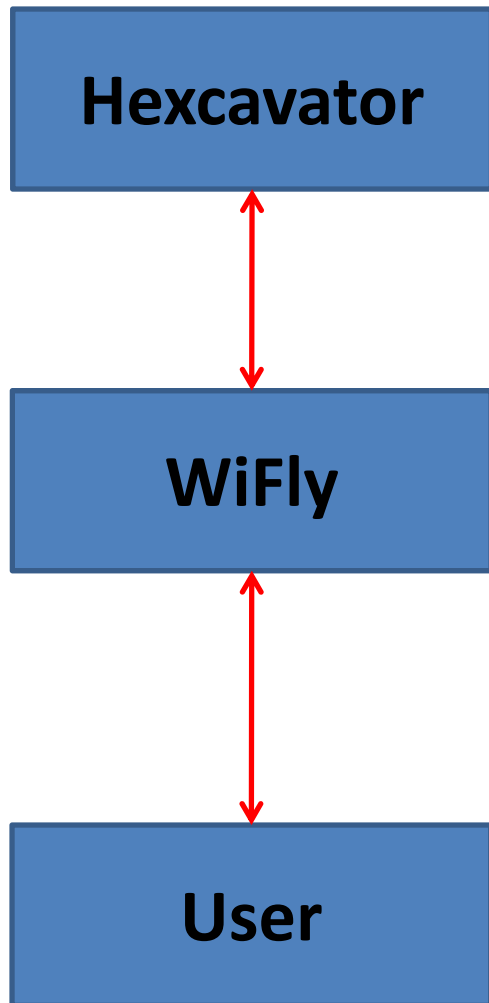


Wireless Communication

- NASA required
- Previously
 - Unable to communicate
 - Coding
- Currently
 - Reverse to Data Mode
 - Use Wifly Tester
 - Unable to communicate to Wifly from PC

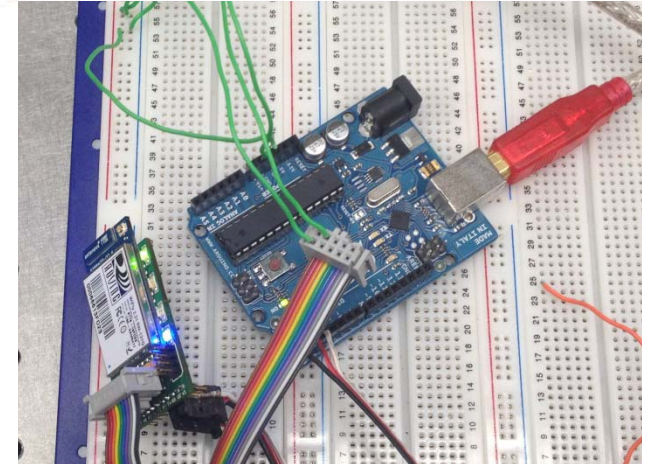


Wireless Communication



Current Status

- Able to communicate from WiFly to Computer



In Progress:

- SPI-UART Bridge Connection
- Passing Serial Data



Cost Analysis

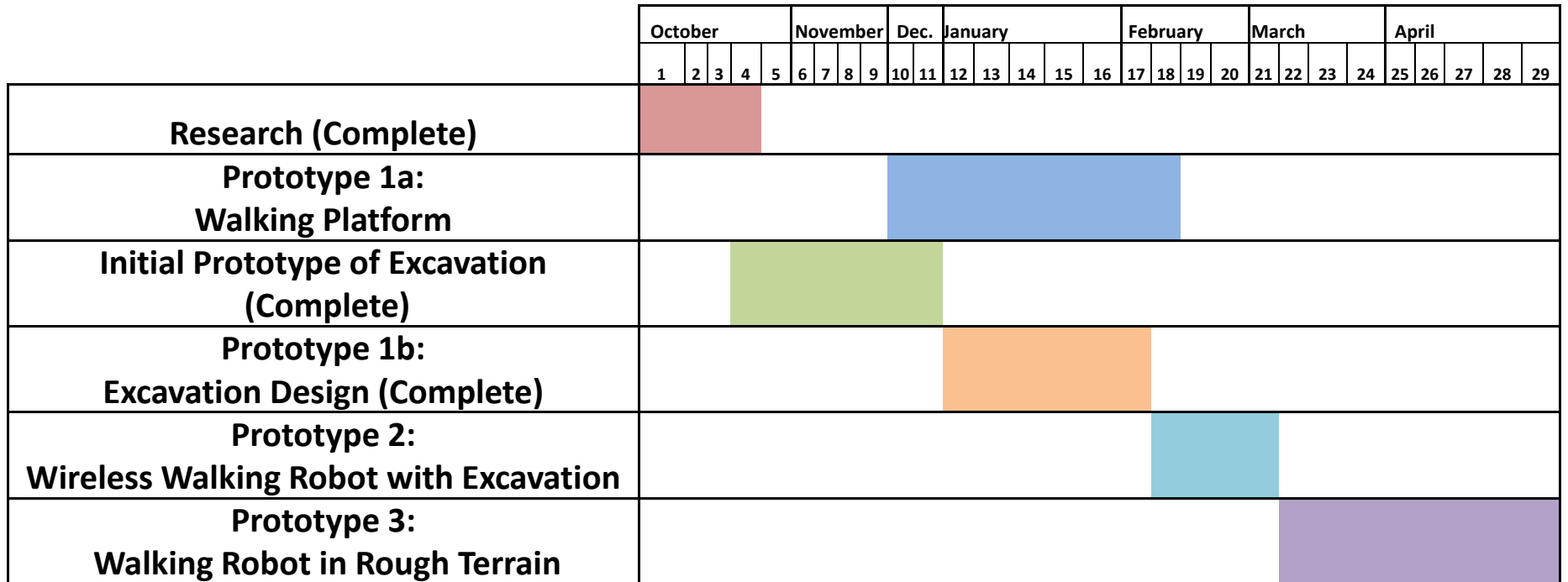
Components	Cost	Quantity	Total Cost
Bushings	\$ 0.72	50	\$ 36.00
PC104	\$ 691.00	1	\$ 691.00
Aluminum (Excavation)	\$1,445.22	1	\$ 842.22
ABS Plastic (Excavation)	\$42.43	1	\$ 42.43
Steel Shafts	\$ 41.60	1	\$ 41.60
CirClips (Pack of 10)	\$ 8.50	5	\$ 42.50
Motor for Excavation	\$ 359.34	2	\$ 718.68
Motor for Drum	\$ 249.99	2	\$ 499.98
WiFly	\$ 84.95	5	\$ 424.75
Baby O	\$ 19.00	5	\$ 95.00
Motor Drivers	\$ 220.00	4	\$ 880.00
Voltage Regulators	\$13.49	5	\$ 67.45
Decoders	\$13.10	5	\$ 65.50
Clocks	\$5.49	7	\$ 38.43
Copper Sheet	\$58.99	1	\$ 58.99
Travel Expenses (Estimated)	\$1,880.85	1	\$ 1,880.85
Total			\$ 6,425.38

Total Budget: \$9000

- FAMU/FSU College of Engineering: \$2000
- National Space Grant: \$ 4000
- Northrop Grumman \$3000



Gantt Chart





Questions?





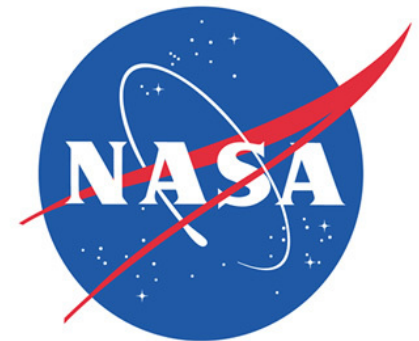
References

- U. Saranli, M. Buehler and D. E. Koditschek, "RHex: A Simple and Highly Mobile Hexapod Robot", *International Journal of Robotics Research*, vol. 20, no. 7, pp. 616-631, 2001
- www.sparkfun.com
- Roboteq. *Hdc2450_datasheet*. 20 July 2010. PDF.
- Maxon Motors. *RE-65-353294_11_EN_084*. May 2011. PDF.
- "Robot Power Products - Open Source Motor Control (OSMC)." *Robot Power*. Web. 04 Dec. 2011.
<http://www.robotpower.com/products/osmc_info.html>.
- Lloyd, Sonny, Matt McFadden, Don Jennings, and Robert L. Doerr. *Osmc_project_documentation_v4_21*. 24 Dec. 2001. PDF.



Customer Requirements

- Initial dimensions: 1.5m x 0.75m x 0.75m
- Maximum weight: 80kg
- WiFi Communication
- Capable of operating in lunar environment
 - Obstacles and craters
- Minimum regolith excavated: 10kg
 - Two, ten minute attempts
- Emergency stop button





PC/104

- CPU Stack
 - Advantech PCM-3355
 - Cost: \$247.00
 - CPU: AMD LX800 500MHz
 - Ports: 2 USB, 2 RS-232,
1 RS-485
 - Operating System: Windows CE 6.0 Pro Embedded





PC/104

- Serial Port Stack
 - Advantech PCM-3644
 - Costs: \$144.00
 - Ports: 8 RS-232





PC/104

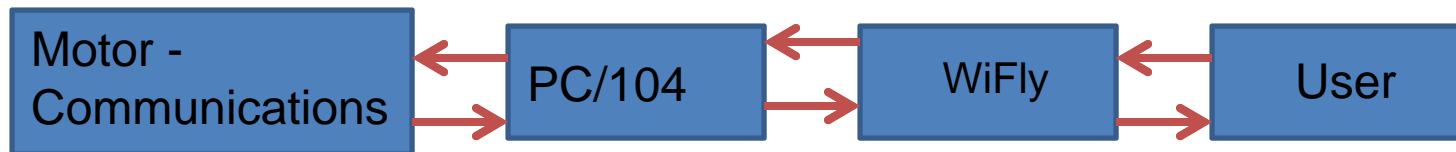
- Digital I/O Stack
 - Advantech PCM-3724
 - Cost: \$79.00
 - Ports 48 I/O ports
 - All configurable
 - Logic: 5V TTL





PC/104

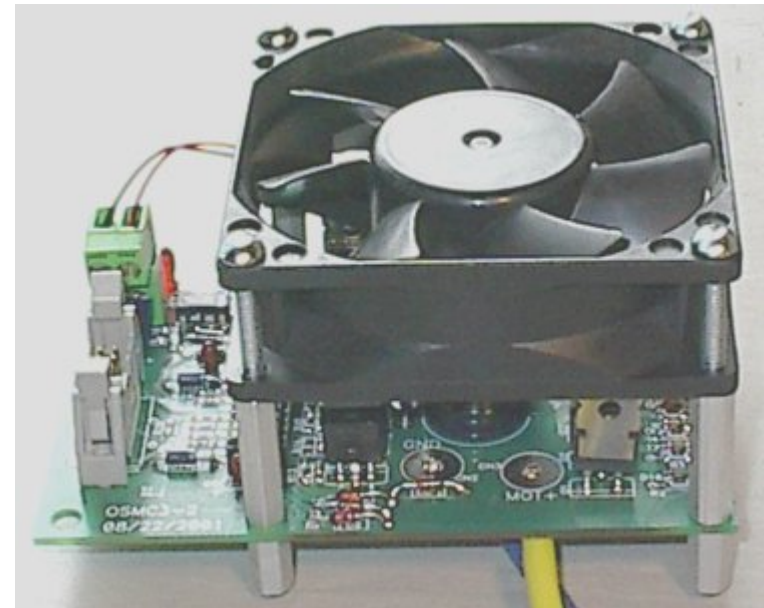
- Testing Procedure
 - Communicate with PC/104 with WiFly
 - Control motor with PC/104
 - Incorporate all three devices
- Motor control mechanism
 - Difficulties due to legged robot





Motor-Driver

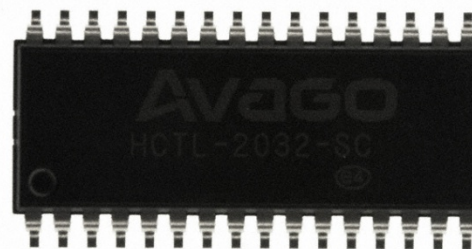
- OSMC Motor-driver
- Intersil HIP4081A
- 160A continuous
- 400A surge
- Voltage control





Decoder Chip

- HCTL2023-SC
- 102,400 counts per revolution
- 32bit
 - Used to track multiple revolutions
- Single Byte Read

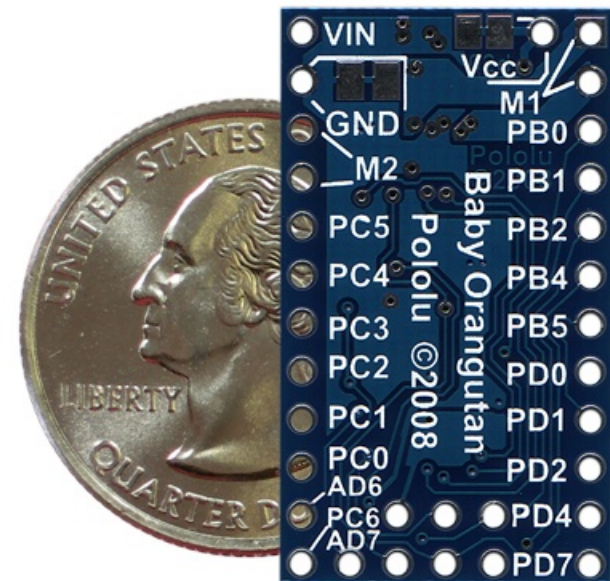


		BYTE SELECTED			
SEL1	SEL2	MSB	2ND	3RD	LSB
0	1	D4			
1	1		D3		
0	0			D2	
1	0				D1



Baby Orangutan

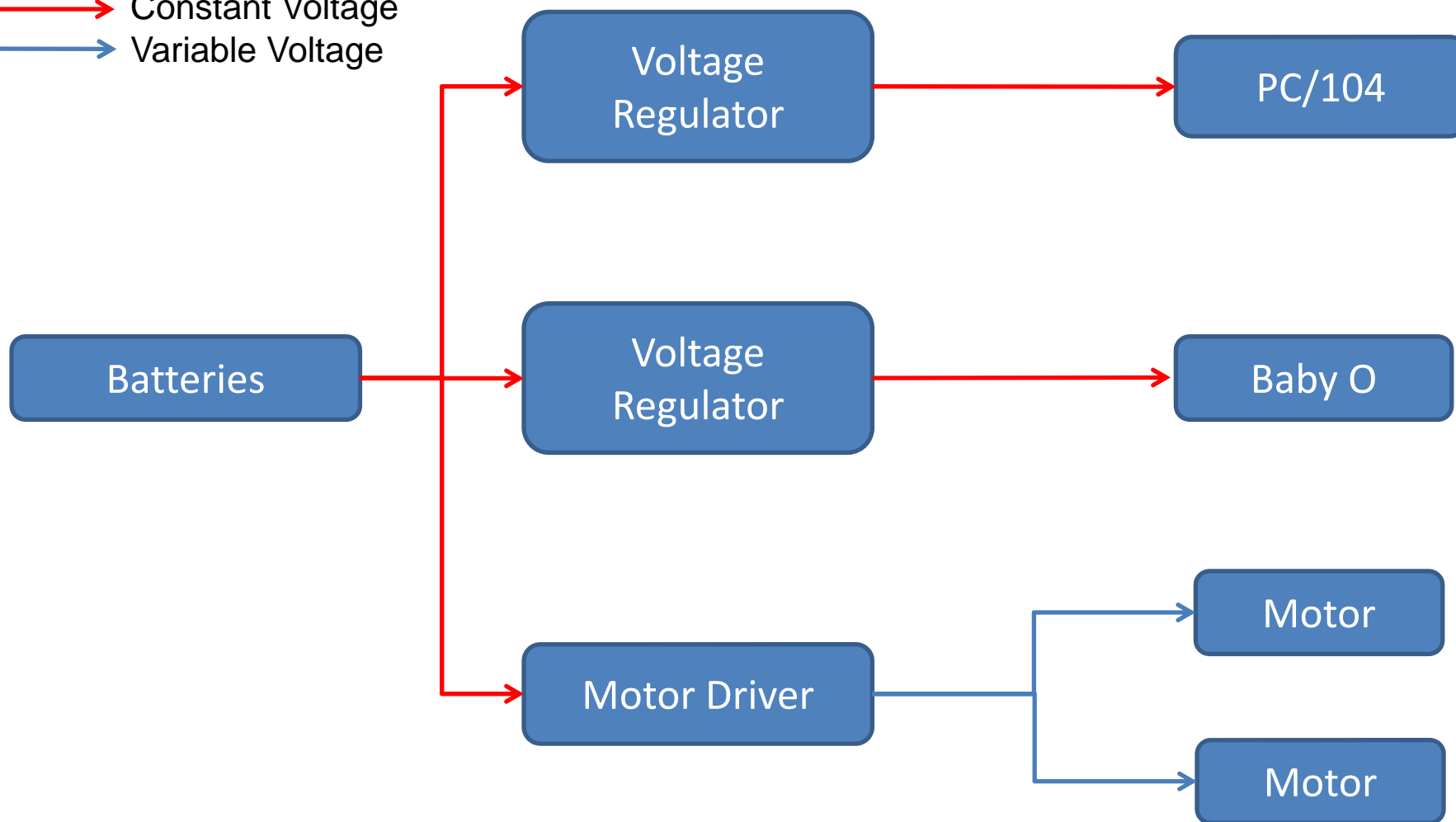
- Atmega 328P
- 20MHz
- 18 I/O lines
- 1.2" x 0.7"
- 1.5g





Power Flow Chart

→ Constant Voltage
→ Variable Voltage





Batteries

- Rated for 37V
- Actual output about 42V
- Run in Parallel for 37V potential and double current





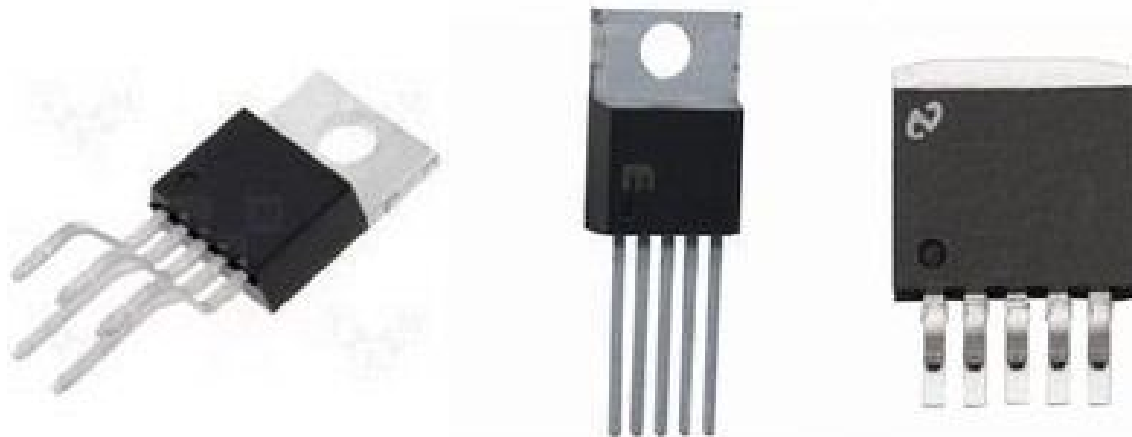
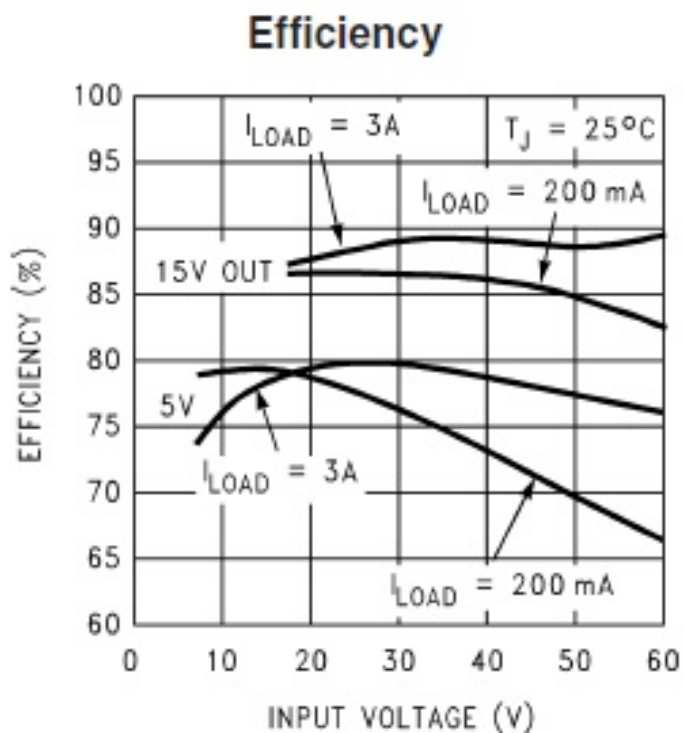
Voltage Regulator

Part No: LM2576HV-5.0

$I_o = 0.5$ to 3.0 A

$V_{in} = 8$ V to 60 V

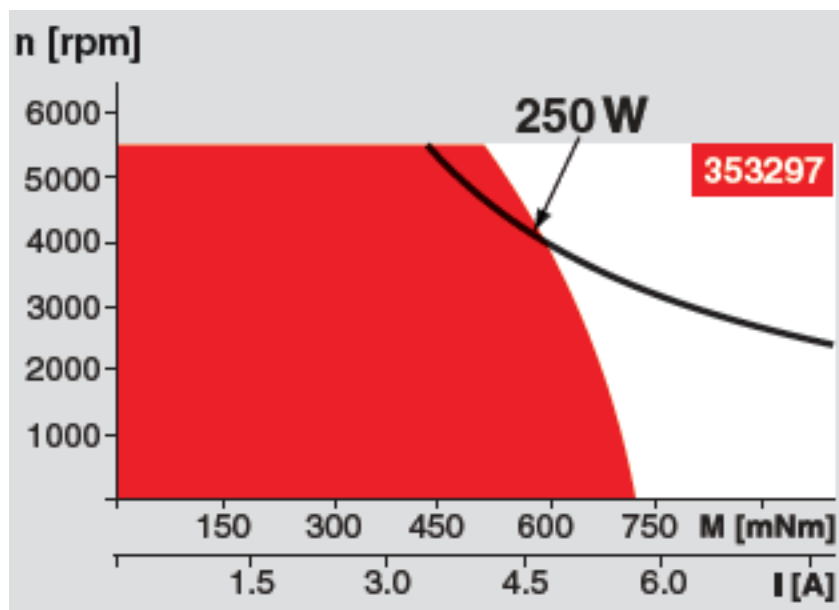
$V_o = 5$ V





Motor

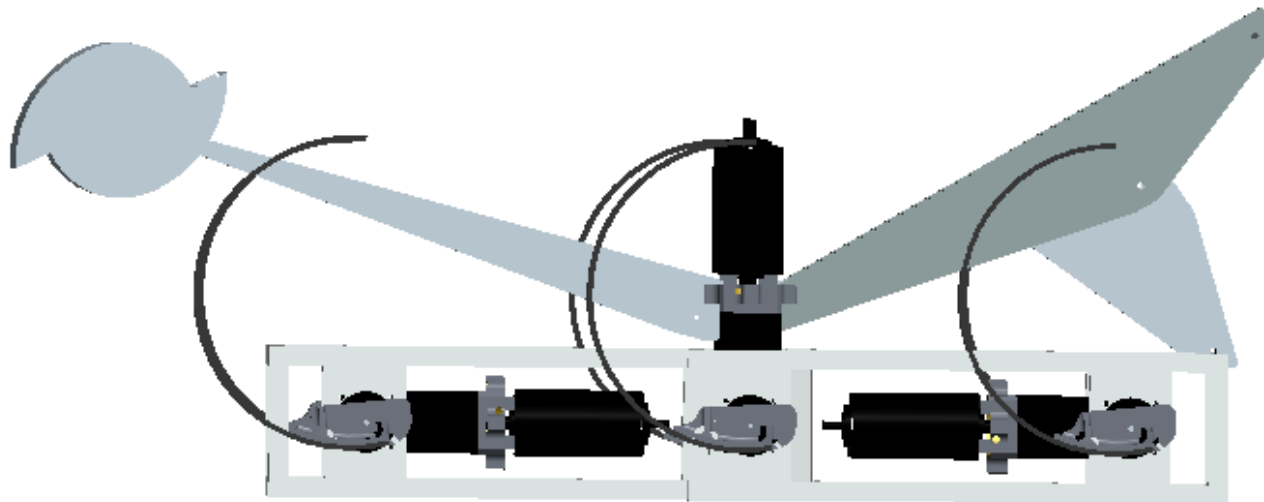
Nominal voltage = 18V
Nominal torque = 442mNm
Nominal current = 10A
Stall torque = 14 Nm
Starting current = 296A
Nominal speed = 3,150rpm





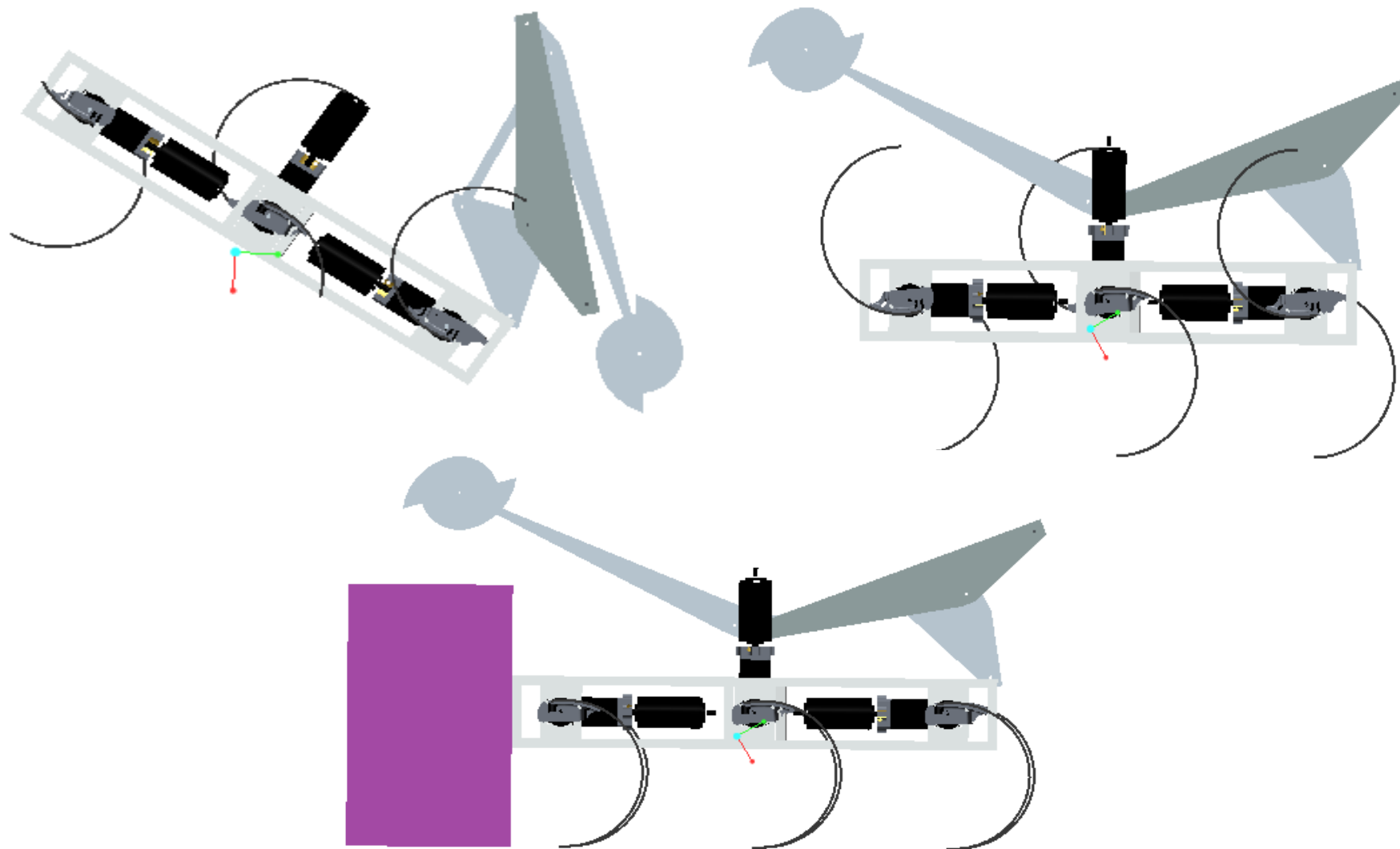
Excavation Conditions

- Hexcavator initial dimensions:
 - 38.97cm x 123.01cm x 75cm
 - Mass: 67kg
- Measured while sitting
- Dimensions of Lunarena:
 - 7.38m x 3.88m x 0.62m





Major Positions



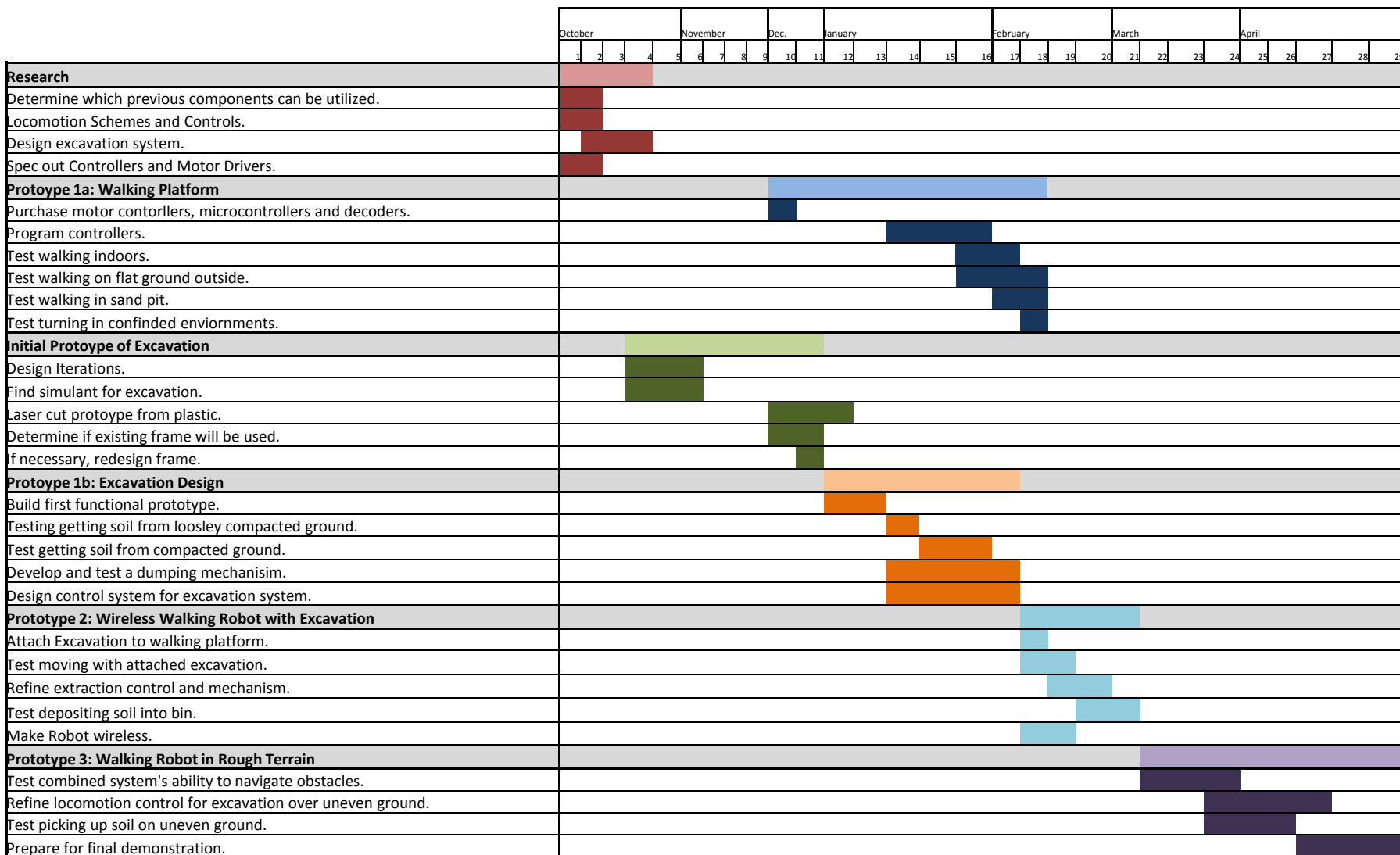


PC/104

- Windows CE 6.0 Pro Embedded
 - Costs: \$18.00
 - Requirements: 1GB on storage
 - Restrictions: 512 MB RAM
 - Restricted by OS
 - Benefits: Advantech Software
 - Not compatible with Linux
 - Costs \$20.00
 - Makes interfacing with stacks easier



Complete Gantt Chart





LunaBin

