2014 NASA/RASC-AL Robo-Ops Competition

Spring Midterm 1 Presentation

Team 11 Members:

Boris Barreto	-	Electrical and Computer Engineering
Jason Brown	-	Mechanical Engineering
Justin Houdeshell	-	Mechanical Engineering
Linus Nandati	-	Electrical Engineering
Tsung Lun Yang	-	Mechanical Engineering

Team 11 Advisors:

Dr. Jonathan Clark – Mechanical Engineering
Dr. Uwe H. Meyer-Baese – Electrical Engineering

Project Scope

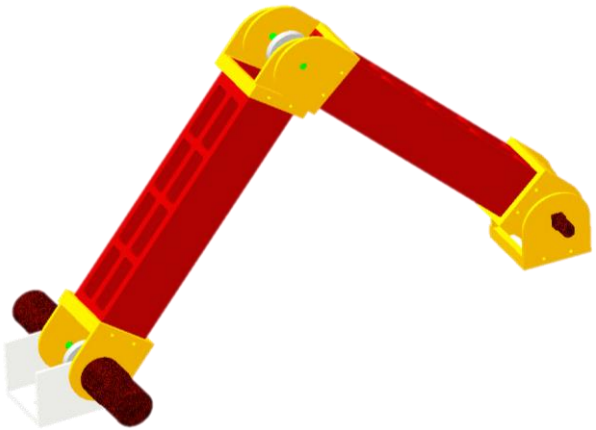
- Fall 2013
  - Build a rover to compete in the 2014 Robo-Ops Competition
  - Areas for development
    - Sample Extraction Module
    - Controls
    - Communications
  - Feed back from NASA about last year's rover system
    - ✓ Locomotion
    - ✗ Extraction module
  - Feed back from NASA about this year's rover system
    - ✗ Locomotion
    - ✓ Extraction module
- Spring 2014
  - Switch to backup plan
    - Build a fully functional, scaled down rover for next year's competition
  - Areas for development
    - Sample Extraction Module
      - Manipulator arm
      - End effector
    - Controls
      - Dynamic control
    - Communications
      - Network
  - Project constraints unchanged

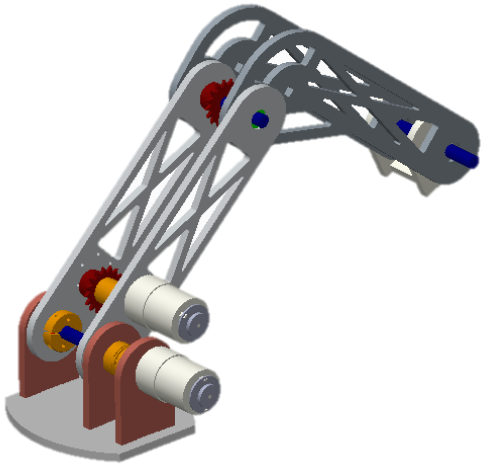
Project Constraints

- Rover Physical Constraints
  - No larger than 1m x 1m x 0.5m
  - Less than or equal to 45kg.
  - Traverse over obstacles up to 10cm in height.
  - Pick up rocks ranging from 2 to 8 cm in diameter and masses ranging from 20 to 150 g.
  - The rover(s) will be controlled remotely based from the home campus of the university

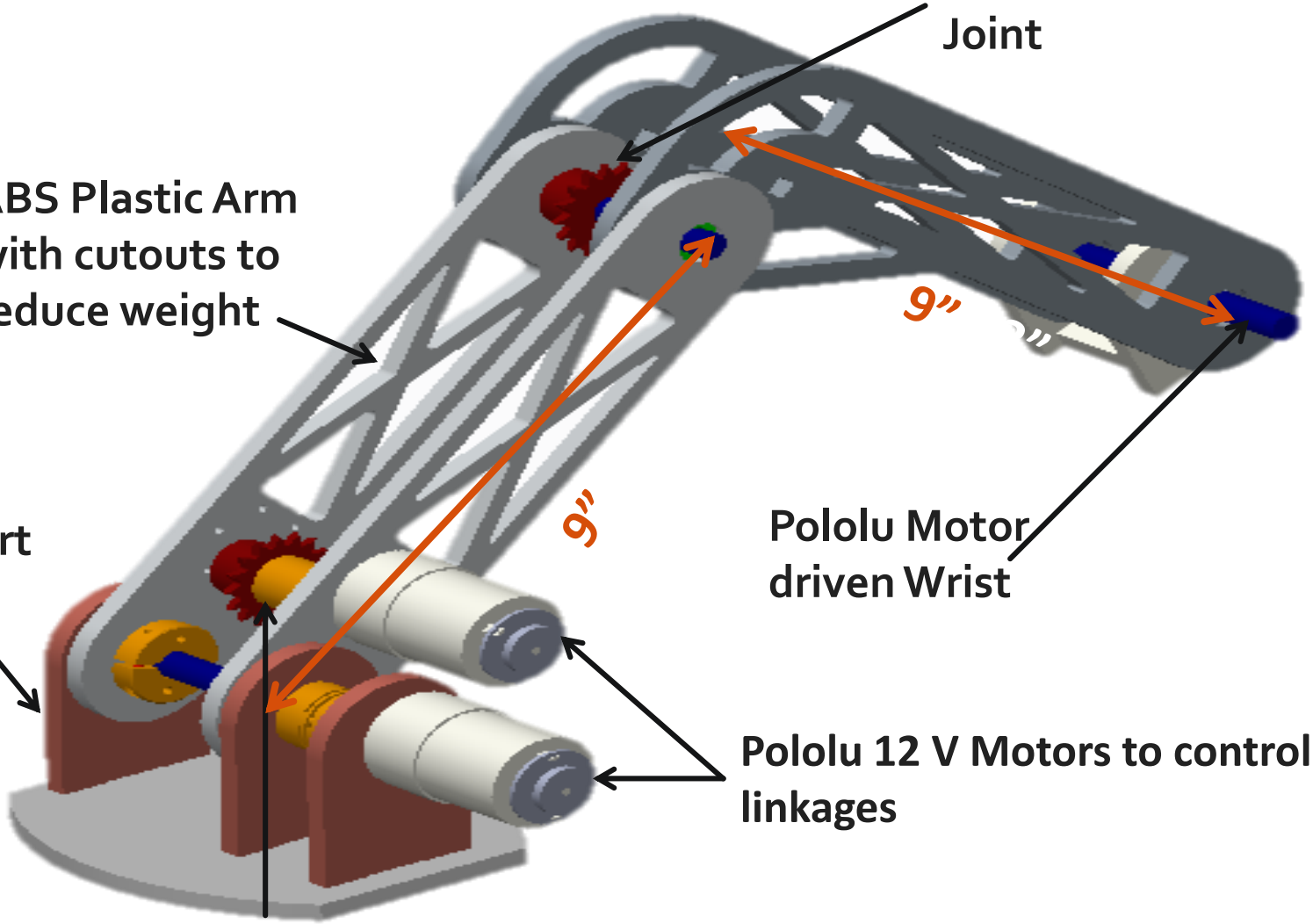
Extraction Arm

	Fall Design	Spring Design
Drive Motors	Maxon Motor with 113:1 Gearbox	Pololu 12V 100:1 DC motors
Wrist Motors	Pololu Micro Metal Gear Motors	Pololu Micro Metal Gear Motors
Link Material	6063 Aluminum	ABS Plastic
Overall Reach	26 inches	18 inches
Estimated Weight	6 kg	4 kg





Extraction Arm



Jason Brown

Extraction Arm

Extraction End Effector

Scooper Design

- Large contact area
- Simple control

Worcester Polytechnic Institute

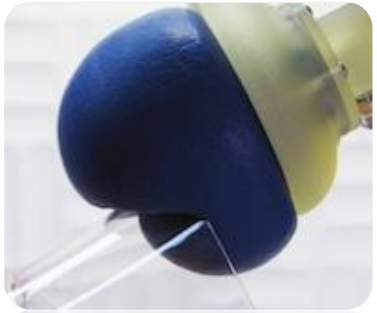
Pincher Design

- Precise
- Orientation sensitive

West Virginia University

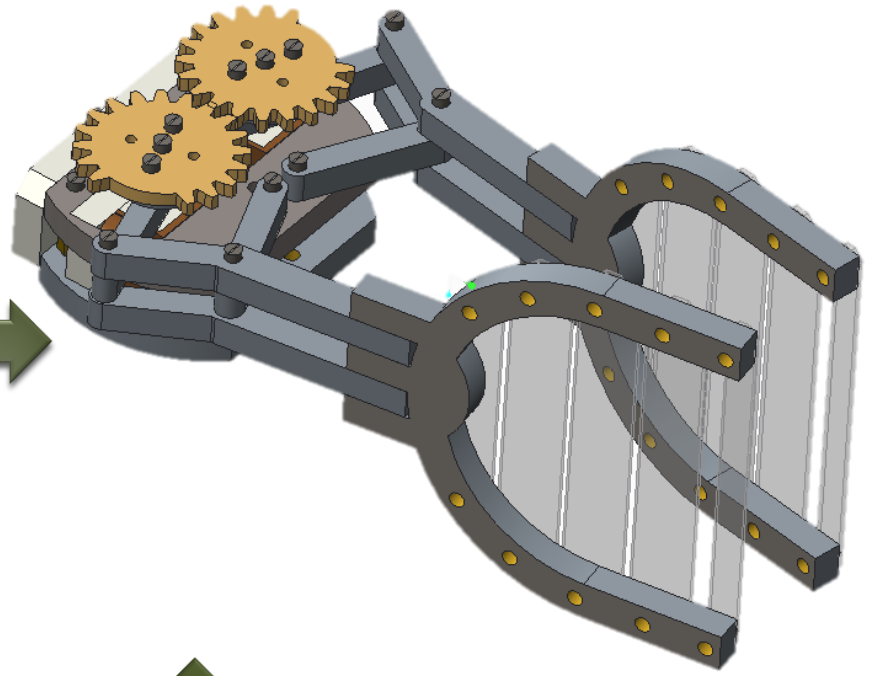
Compliant Design

- Strong shape/orientation tolerance
- High power consumption



University of Chicago

Elastic Pincher Design

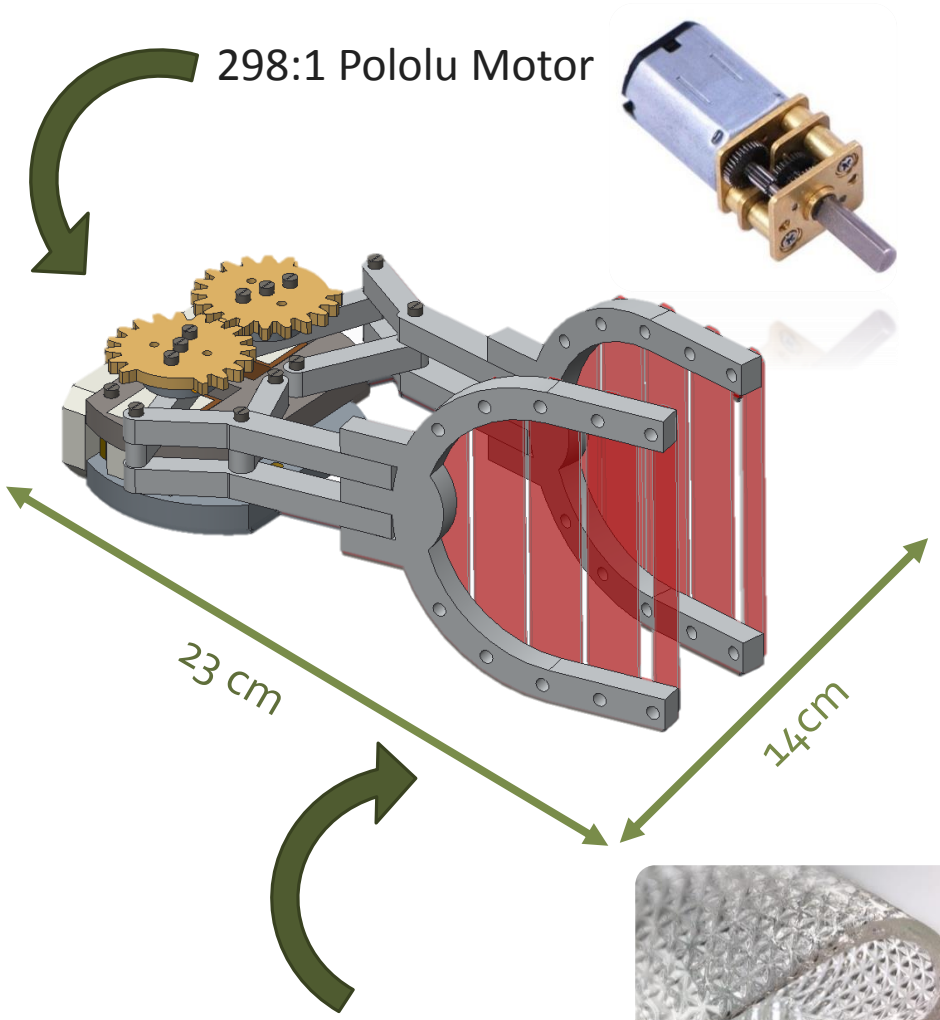


3rd Generation Prototype

Tsung Lun "Chris" Yang

Extraction End Effector

- Elastic Pincher
  - Two pronged pincher design
  - Large contact surface
  - Passive elastic material end effector conforms to sample shape
- Components:
  - 298:1 Pololu Motor
  - Silicon Rubber for Gripper Material
  - ABS Plastic for the Frame



Extraction End Effector Prototype

1st Generation Prototype

- Elastic material viable
- Improve linkage mechanism

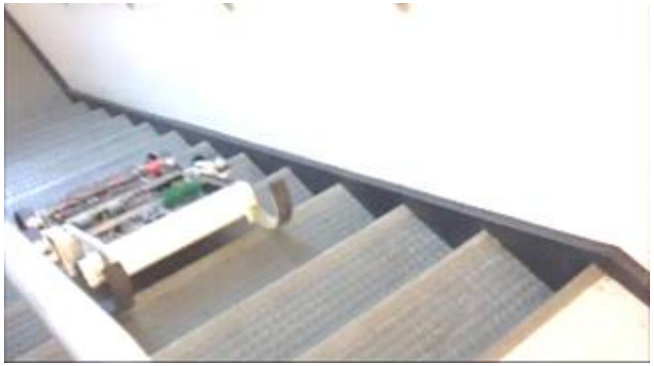
2nd Generation Prototype

- New elastic material: First Aid tape
- Increase elastic surface area

3rd Generation Prototype

- Mars suitable elastic material finalized: Silicone Rubber
  - Temperature range: -120C to 300C

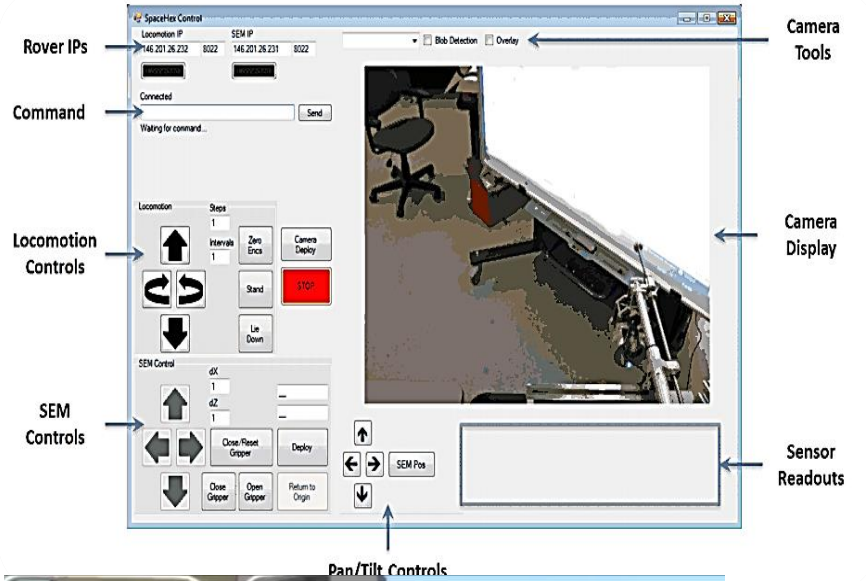
Control Development



Locomotion Types	Status
Buehler Clock Locomotion	Complete
Turn While Walking	Complete
Turn While Climbing	In development
Nudge Function	Not Started
Stair Climbing	Prototype Complete

Advanced Controls

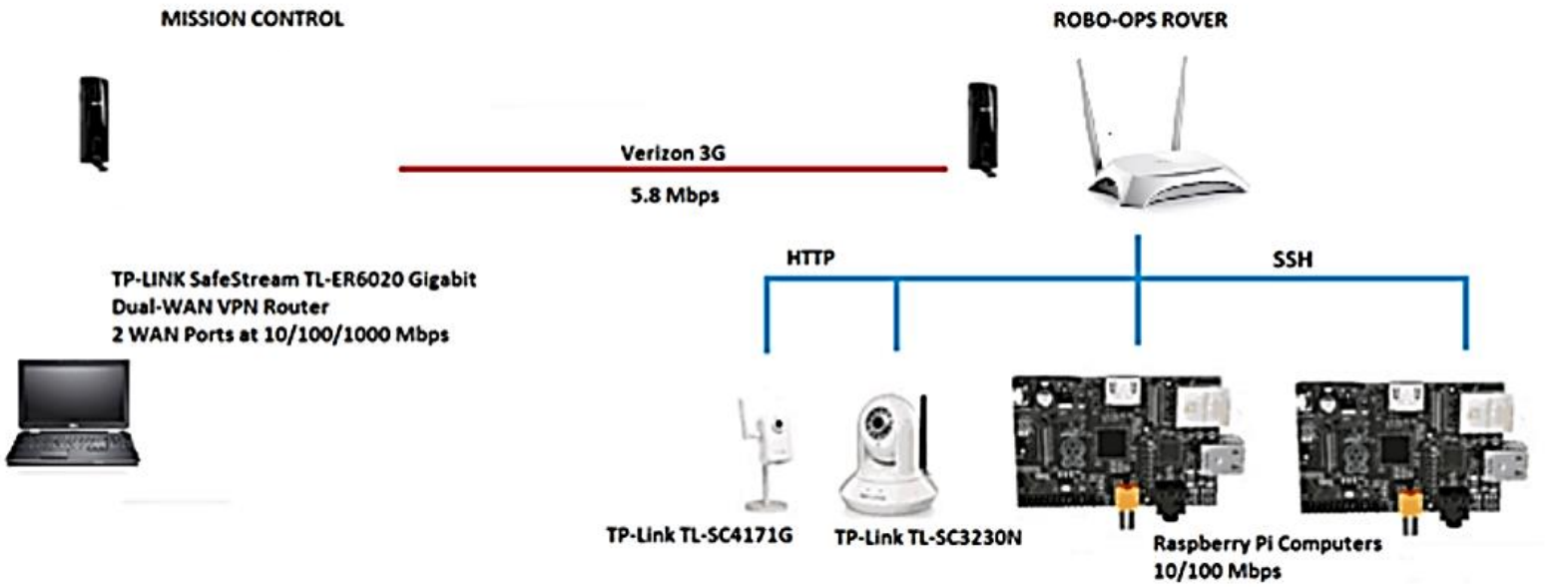
- Operation through Gaming Controller



SDL
Simple Directmedia Layer

Linus Nandati

Existing Design



- Upload speed to WAN from LANs does matter
- Data processed and transferred in WAN different than LAN

Bandwidth Issues

- Typical 480p hour long video is 300 MB
  - Or 2400 Mbits
- 2 Video feeds and controls
- Larger Bandwidth beneficial

Upgrades

1. 3G to 4G

2. Dual Networks
   - Verizon and AT&T

3. Dynamic Switching
   - For redundancy in case of network failure

Project Procurement

	Item	Vendor	Part Number	Cost	Quantity	Total
Arm	Pololu 12V Motors with Encoders	Pololu	397172	$39.95	3	$120
	Encoders	Pololu	110512	$8.95	4	$36
	Pololu 298:1 Micro Metal Gear Motor	Pololu		$16.95	4	$68
	Shafts, Bearings, Chain, Sprocket and Misc. Hardward	Misumi		$270	1	$270
	¼ " ABS Plastic	Interstate Plastics		$15.00	4	$60
TOTAL						$554

PROJECT SUMMARY

Competition Status	Not selected to participate 2014 Robo-Ops competition
	Switch to back up plan
Rover Locomotion	Improved locomotion control (turn while walking/Stair climbing)
	Dynamic control (Xpadder/SDL)
Extraction Module	Lightweight, ABS plastic frame manipulator with 3 DOF
	Elastic pincher proven viable, developing next generation prototype
Communication	Dual 4G network wireless adaptor (AT&T/Verizon)
	Investigate dynamic network switching (WAN)
Future plans	Continue procurement process
	Transition from prototyping to final product

References

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Question/Comment?