LUNA_COMP2: NASA Robotic Mining Competition
Senior Design II – Spring 2021
Dr. Aidan Browne & Dr. Michael Smith (Faculty Mentors)

Joseph Satterwhite (PL), Ryan Barbour, Jacob Daniel, Chaitanya Gokule, Jacob Herbert, Armel Luabeya Tshitala, Peter Mancini, Sydney McCain, Ricardo Martinez, Holden Stanley
jsatter9@uncc.edu, rbarbou6@uncc.edu, jdanie42@uncc.edu, cgokule@uncc.edu, jherber9@uncc.edu, aluabeya@uncc.edu, pmancini@uncc.edu, smccain2@uncc.edu, rmarti89@uncc.edu, hstanle4@uncc.edu

NASA Robotic Mining Competition (RMC): Lunabotics 2021
As a part of NASA’s Artemis Student Challenge, the NASA RMC is meant to stimulate creative ideas towards NASA’s goal of exploring the Moon’s Lunar surface by 2024. Project objective is to use system engineering approach:

- **Design**: Provide a completed CAD model and calculations of the rover
- **Development**: Manufacture an autonomous rover prototype capable of mining, collecting, and depositing lunar regolith
- **Delivery**: Compete in and win the RMC with the most efficient lunar rover prototype

**Project Specifications**

<table>
<thead>
<tr>
<th>Maximum NASA Rover specifications:</th>
<th>Current Rover specifications:</th>
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</thead>
<tbody>
<tr>
<td>1. Payload position: 1m x 0.5m x 0.5m</td>
<td>1. Payload position: 0.993m x 0.492m x 0.477m</td>
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<tr>
<td>2. Operation Position: 1m x 0.5m x 1.5m</td>
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<tr>
<td>3. Deposition Position: 1m x 0.5m x 2.5m</td>
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<tr>
<td>4. Weight: 60kg</td>
<td>4. Weight: 51.2kg</td>
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</tbody>
</table>

**Concept of Operation:**
- Rover begins traversing simulant lunar terrain
- Geolocalization system confirms rover is at mining zone
- Rover begins to mine and collect regolith/gravel until certain weight is met
- With full mining drum, rover begins to move toward deposition bin
- During deposition, rover extends support arms to deposit regolith/gravel
- After depositing all minerals, rover will repeat this process up to 15 minutes

**Design Philosophy and Approach**

Use of systems engineering approach to identify requirements and risks, re-engineer subsystems, and validate performance.

**Five Stages of Systems Engineering:**

- **Conceptualization:**
  - Identify need and goals
  - Split into three sub-systems
    - Mining, Chassis, and Navigation & Control
  - Identify risks
  - Identify design alternatives
  - Create project management plan

- **Design:**
  - CAD models
  - Analysis and calculation

- **Development:**
  - Order parts
  - Fabricate rover

- **Testing:**
  - Code implementation
  - Testing and data gathering
  - Rover troubleshooting

- **Delivery:**
  - Virtual presentation to NASA judges

**Project Implementations**

- **Manufacturing Processes:**
  - Machining
  - Water-jetting
  - Welding and Bending
  - 3D Printing

- **Assembly Process:**
  1. Manufacturing
  2. Assemble Chassis
  3. Assemble Mining
  4. Wire Navigation & Control
  5. Implement Navigation & Control software

**Wireless Localization**
- Localization system consists of two Pozyx tags mounted on deposition bin and three Pozyx anchors mounted on rover
- Each anchor emits ultra-wide band radio waves until tag is detected, with radius of emission being distance to tag
- The point at which all three radii intersect is the location of the tag
- Once each tag is located, the position of the bin relative to rover is known
- To the computer, it appears the bin is moving as the rover moves
- Movement will be translated to instructions for the rover

**2021 Lunar Prototype**

- **Rover Orientations**
  - **Mining Orientation**
  - **Deposition Orientation**

**Performance Goals Accomplished**
- Completed a full mining run in approximately 20 minutes
- Collected 68.51 grams of icy regolith simulant during a full run
- Can operate for at least 15 minutes, continuously
- Can deposit mined material without tipping
- Can operate with minimal dust emissions
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Development
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Delivery
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V System Engineering Approach
Design Implementation

Manufacturing Processes

Machining  Water-jetting  Welding & Bending  3D Printing

Assembly Process

2. Assemble Chassis  5. Implement Navigation & Control software
3. Assemble Mining
2021 Lunar Rover Prototype

- Scoops (4x)
- Electrical Box (5x)
- Inner and Outer Drum
- Rover Frame
- Wheels (6x)
- Conveyor Belt Assembly
- Stabilizer Arms
- Winch Rod
- Rocker-Bogie Suspension
- Pozyx Tag
Rover Orientations

Mining Orientation

Deposition Orientation
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