Lunar Rover for Extreme Terrain Navigation

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ABSTRACT

Team NOVA participated in NASA's Lunabotics 2025 Challenge by designing and building a compact rover for lunar berm construction. The rover employs a lightweight 3-D printed Poly-Carbonate frame, a bulldozer-style blade for regolith collection, and independently powered DC motors driving caterpillar tracks for navigation. Engineered to withstand harsh lunar conditions, the rover demonstrates effective regolith handling, robust mobility, and efficient energy use.

PROJECT BACKGROUND

Figure 1: BP-1 Simulant

Figure 2: 2024 Winner

NASA's Lunabotics 2025 Challenge invited student teams to create lunar rovers capable of constructing protective berms from lunar regolith simulant. Team NOVA enhanced a commercial tank platform with a custom aluminum blade and protective enclosures, producing a compact, dust-resistant rover designed for reliable lunar terrain navigation.

OBJECTIVES

- Design and build a lunar rover capable of constructing berms using BP-1 regolith simulant.
- Ensure the rover operates safely, efficiently, and within the size and mass constraints set by the Lunabotics 2025 Challenge.
- Integrate a tracked mobility system and bulldozer-style blade for effective regolith handling.
- Protect mechanical and electrical components from dust using custom enclosures.
- Validate the rover's performance through analysis, prototyping, and testing.

DESIGN – ANALYSIS - MANUFACTURING

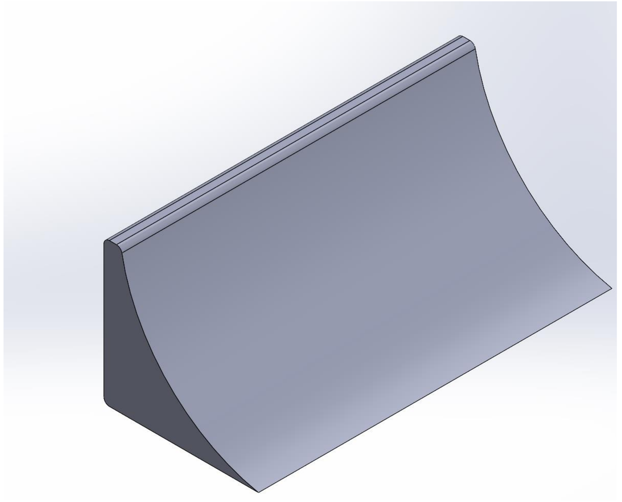


Figure 3: Dozer Blade CAD

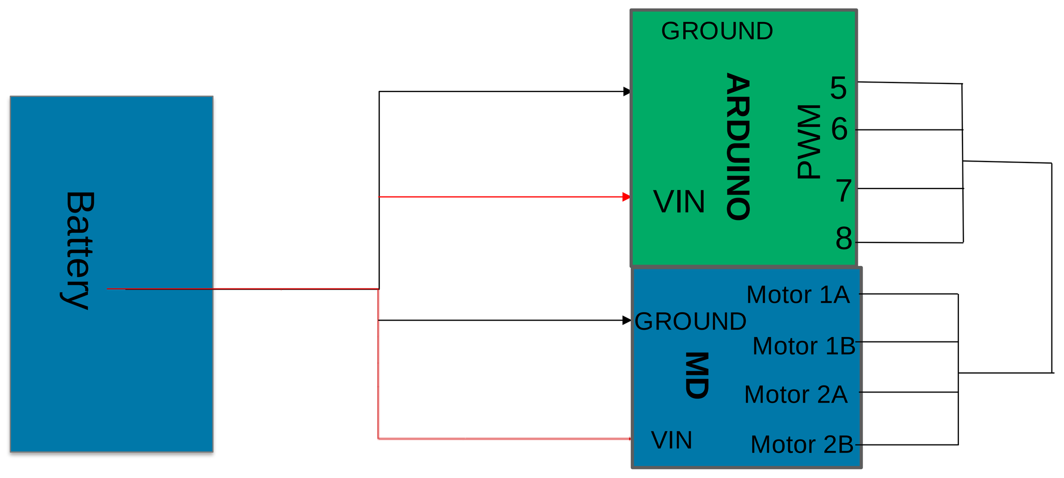


Figure 3: Schematic of Wiring

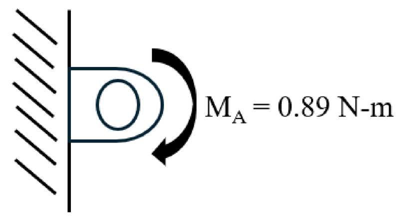
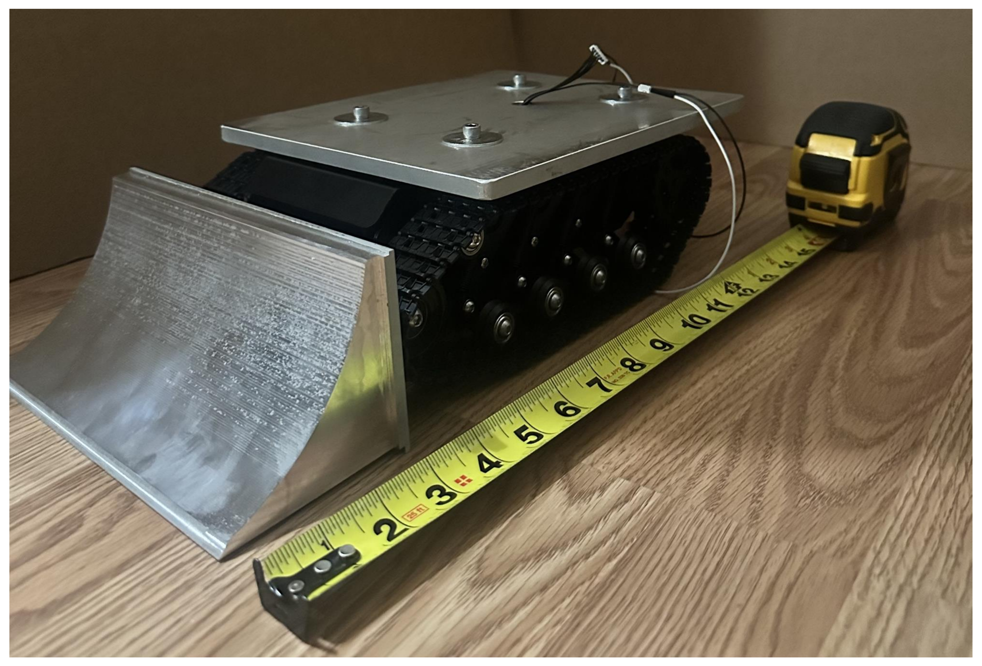


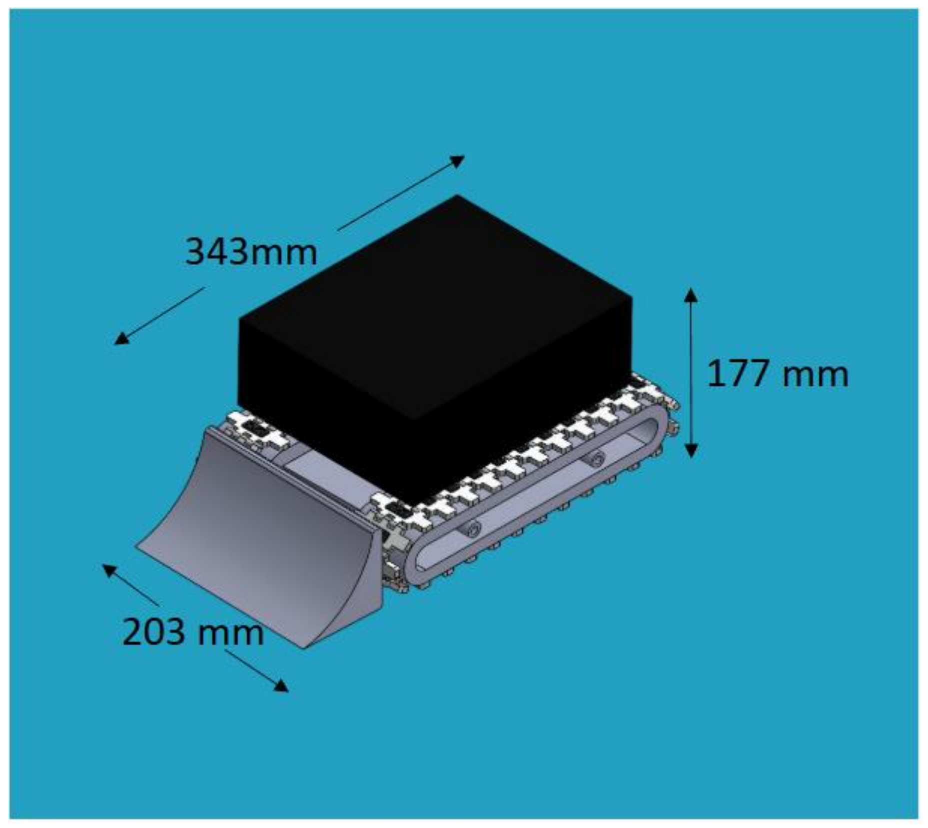
Figure 4: Loading at Dozer Blade Connection

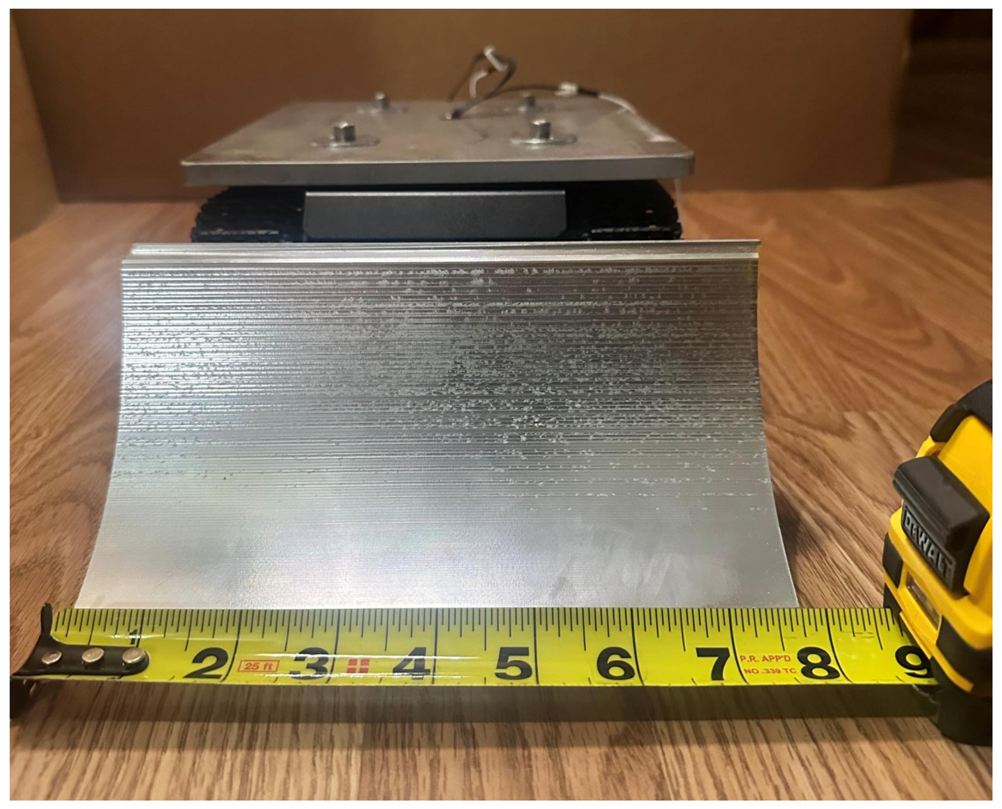
- Adhering to NASA-STD-5001, a safety factor of 3.4 was achieved at critical locations.
- 3D printed parts to cover electronics and tracks.
- Fixed Bulldozer Blade is used for bulldoze operation of lunar regolith simulant replacement (sand).
- The Lunabot operates semi-autonomously via an R3 Arduino Microcontroller using DC Motors that are powered by a motor driver and a 11.1-V battery to drive the tracks.

RESULT AND DISCUSSION

- The Lunar Rover successfully met the overall dimension and weight criteria provided by the NASA 2025 Lunabotics Challenge.
- The bulldozer blade was successfully manufactured, enabling the Lunar Rover to be capable of constructing berms.
- Programming of the Lunar Rover took place, deeming the overall project successful since the Rover was able to maneuver.
- 3D Printing of the Robot Shell will enable the protection of electrical comoponents of the Lunar Rover.







CONCLUSION

The initial prototype meets key design specifications and is ready for upcoming testing and refinement. Current progress establishes a strong foundation for future validation of mobility, structural integrity, and system functionality. Planned improvements include remote operation and enhanced terrain interaction.

FUTURE WORK

- **Mobility and Terrain Navigation Test:** Simulate lunar-like terrain (sand, gravel, slopes) to verify traction, maneuverability, and blade performance under load.
- **Structural Integrity Test:** Apply static and dynamic loads to critical joints and chassis to ensure the rover withstands operational stresses without deformation or failure.
- **Payload Capacity Test:** Load blade or cargo compartments with maximum expected mass to validate handling and structural resilience.
- **Battery Endurance Test:** Run systems under expected load to determine how long the battery lasts and ensure it meets mission duration needs.
- **Integrate Remote Controlled Operations:** Develop and implement wireless remote-control capabilities to enable real-time maneuvering and blade actuation for field testing and competition use.

ACKNOWLEDGEMENTS

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REFERENCES

NASA. (n.d.). About Lunabotics. NASA. https://www.nasa.gov/learning-resources/lunabotics-challenge/about-lunabotics/#:~:text=Lunabotics%20is%20a%20systems%20engineering,(4)%20Presentation%20and%20Demonstration (Accessed April 11, 2025).