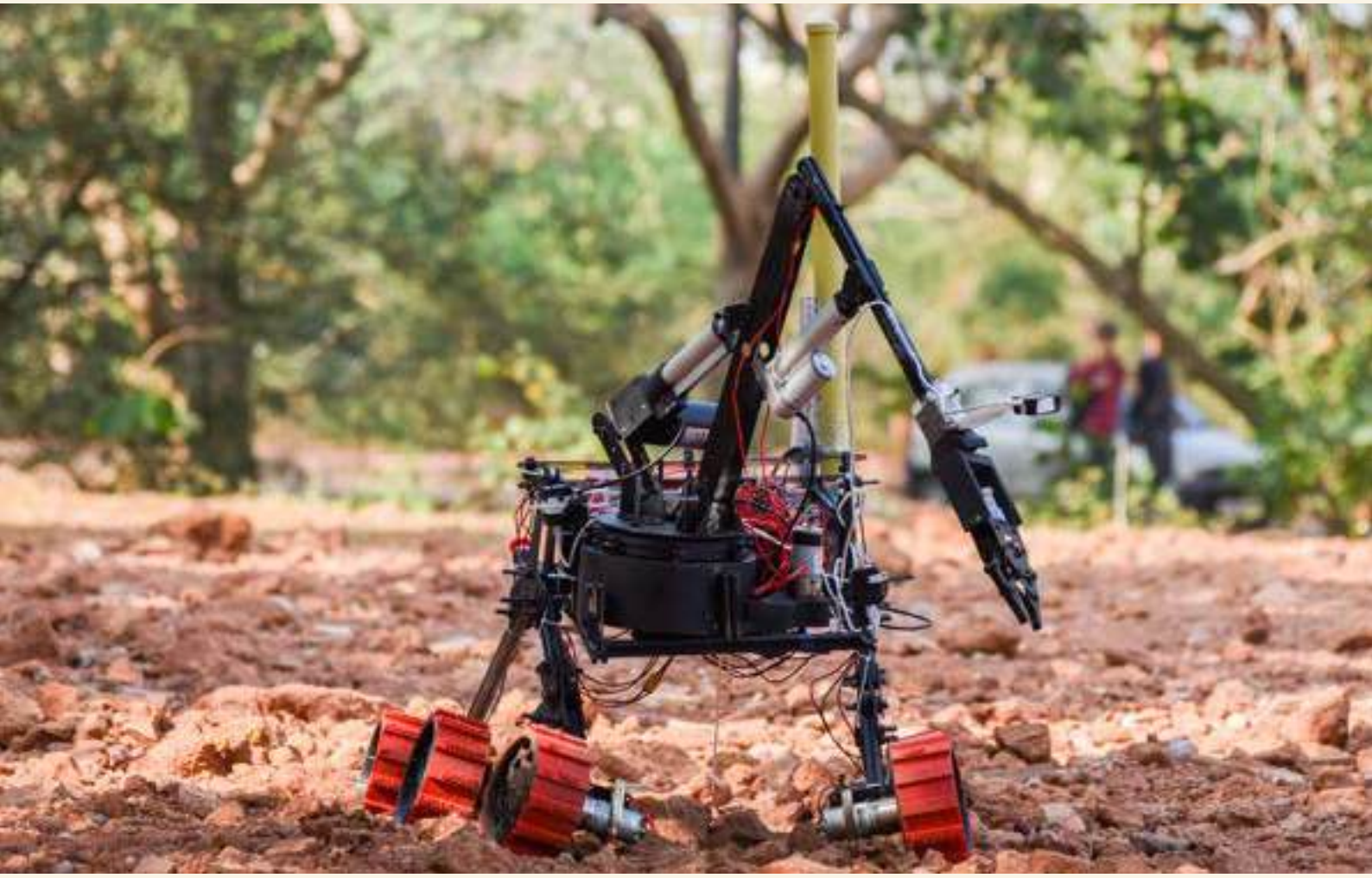
PROJECT MAKARDHWAJ

By Team Trixanth | 2024-25



DAYANANDA SAGAR UNIVERSITY

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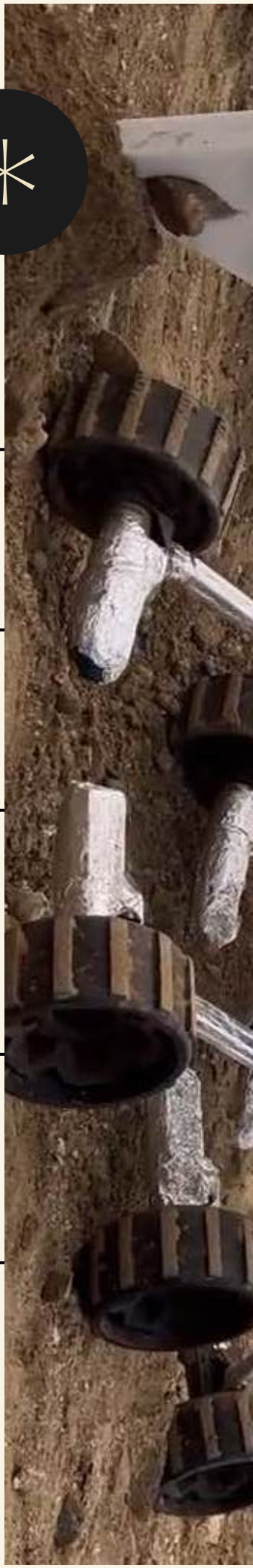

HEARTFELT APPRECIATION

Every contribution shapes the journey to success.

On behalf of our entire team, we express our deepest gratitude for the opportunity to work on Project Makardhwaj. This project has been an incredible journey of learning, innovation, and collaboration, made possible by the unwavering support we have received. Your contributions—whether through funding, resources, or guidance—have been instrumental in driving this initiative forward.

We extend our heartfelt appreciation to the **Center for Space Science and Technology** (CSST) for providing a strong foundation to bring our ideas to life. The infrastructure, mentorship, and opportunities offered by CSST have played a crucial role in shaping our progress and enabling innovation.

A special note of gratitude to our mentor, Prof. Pradeep Kumar K, for his invaluable guidance and insights. We also sincerely thank our guides, Dr. Gopalshrama R Joshi and Dr. Jayavrinda Vrindavanam V, for their expertise and continuous encouragement, which have been instrumental in refining our approach.

We are also grateful to the Department of Mechanical Engineering for providing access to machine labs, the Department of CSE (AI & ML) for high-performance computing resources, and the Department of ECE for essential technical assistance. Their support has been crucial to the project's success.

Our heartfelt thanks extend to our well-wishers—Dr. V. K. Hariharan, Dr. Bahubali Shiragapur, Dr. Naveen Babu, Dr. Joshuva Arockia Dhanraj, and Dr.

Kamalbabu P—for their encouragement and belief in our work. Their motivation has been a driving force behind our efforts.

Additionally, we acknowledge the IT team and facilities team at DSU for their continuous support, ensuring a seamless workflow throughout the project.

Lastly, we thank everyone who contributed in any capacity. Your dedication and teamwork have helped bring this vision to life, and we look forward to future collaborations and successes together.

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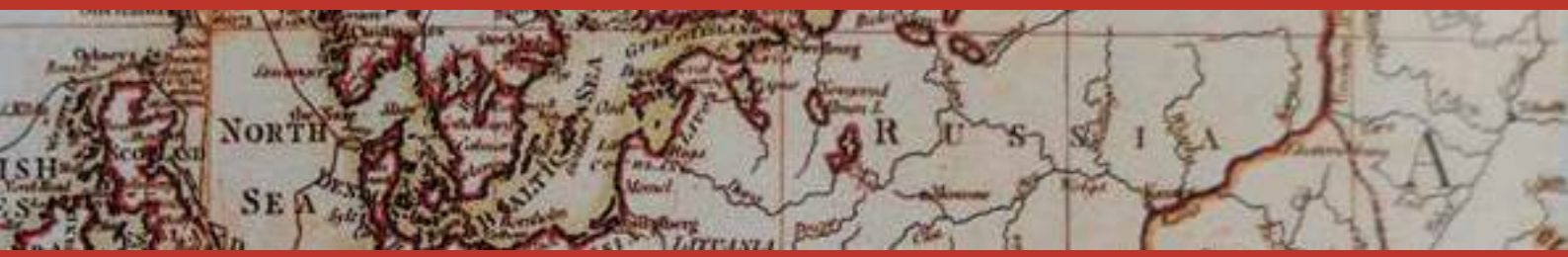
Professor Dept. of CSE (AI & ML)



BACKGROUND & OBJECTIVES

Team Trixanth built Project Makardhwaj, earning global recognition.

Team Trixanth was formed when a group of passionate students came together to take on the challenge of IRoC-U 2024, a prestigious competition organized by ISRO. The objective of the competition was to design and build an autonomous rover capable of executing a sample collection and return mission. Driven by innovation and a shared vision, the team was eager to put their skills to the test.

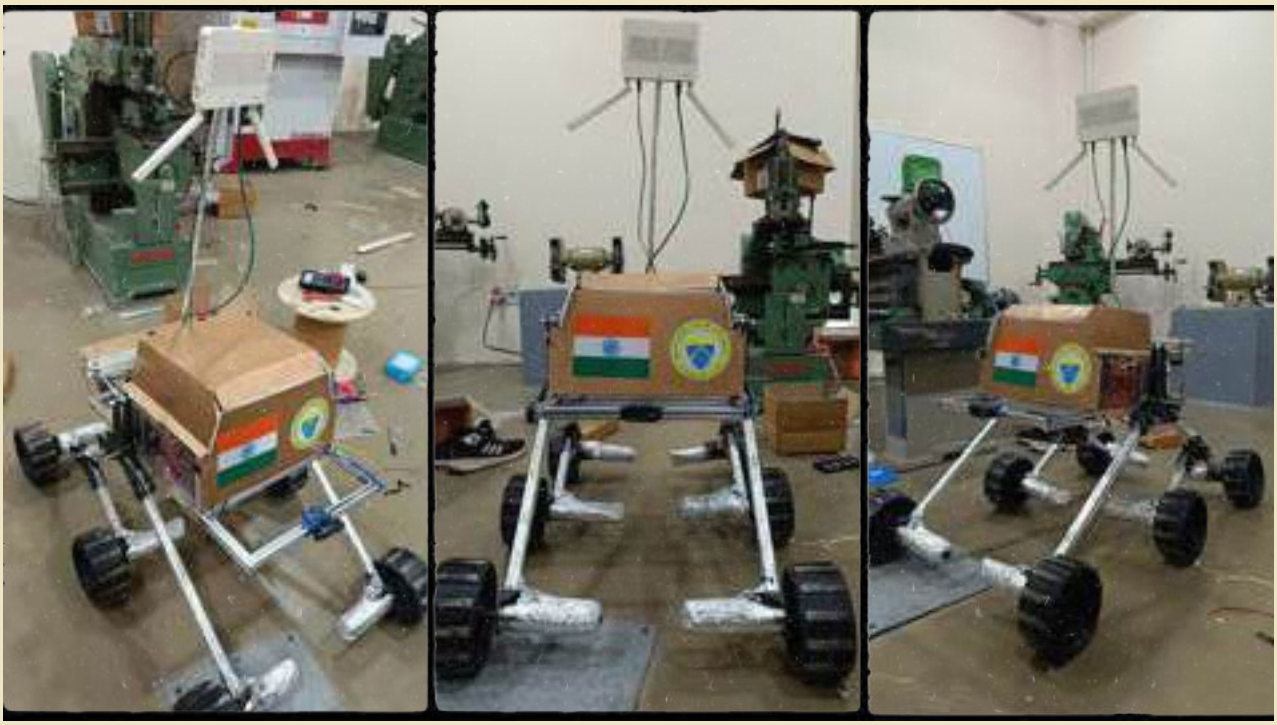
However, despite their dedication, the team was not selected for the competition by the university. Rather than giving up, they refused to let this setback define them. Instead, they chose to continue their journey, working tirelessly to bring their ideas to life. This determination led to the birth of Project Makardhwaj—an ambitious initiative to develop a cost-effective, transposable, and extensible rover design.

Undeterred by the challenges ahead, the team committed themselves to rigorous research, development, and testing. They worked day and night, pushing their limits to ensure that the rover met the highest standards of efficiency and innovation. Their efforts paid off as they successfully completed the project in a remarkably short timeframe, demonstrating exceptional teamwork and technical expertise.

With Project Makardhwaj ready, Team Trixanth sought an opportunity to showcase their hard work on a global stage. They set their sights on the International Rover Challenge 2025, a highly competitive event featuring 110 teams from around the world. Against tough competition, they secured an impressive 21st position and earned recognition as one of the best emerging teams of the year.

The journey of Team Trixanth stands as a testament to perseverance, passion, and resilience. From overcoming setbacks to achieving international recognition, they continue to inspire others to pursue innovation and excellence in space technology.

Technical Discription



Project Makardhwaj is an advanced, in-house-developed rover by Team Trixanth at Dayananda Sagar University, designed for planetary exploration and astrobiological research. The rover is built to be modular, cost-effective, and highly adaptable, making it a versatile platform for space exploration missions. Its design ensures ease of deployment, efficient mobility, and minimal modifications for future upgrades. The rover features partially autonomous navigation, allowing it to follow directional markers and adapt to different terrain conditions, reducing human intervention during operations.

A major objective of Makardhwaj is to analyze soil samples in extraterrestrial environments, contributing to astrobiological studies. By conducting detailed scientific investigations, the rover aids in understanding planetary conditions and assessing the potential for past or present life. The modular architecture enables seamless upgrades, making it suitable for multiple mission profiles. Key features include a rocker-bogie suspension system, a robotic arm for manipulation, and an intelligent navigation system that assists in efficient mapping and monitoring of planetary surfaces.

The mechanical structure of the rover is built with a lightweight yet robust aluminum chassis, optimized for stability. The 40 × 38 cm frame, modeled in Fusion 360 and SolidWorks, includes mounting points for sensors and robotic arms, ensuring structural integrity. The rocker-bogie suspension system enhances terrain adaptability, while 3D-

printed wheels provide maximum traction. Fabrication techniques such as laser cutting and additive manufacturing minimize production costs while maintaining precision.

Makardhwaj's autonomous capabilities are powered by Robot Operating System 2 (ROS 2), which enables real-time environmental mapping, obstacle detection, and path planning. The depth camera captures environmental data, generating a 3D terrain map to analyze navigability.

Using OpenCV and image-processing algorithms, the rover recognizes directional markers and autonomously follows them, adjusting its route dynamically. This system ensures efficient, semi-autonomous traversal across challenging landscapes.

The electronics system is designed for power efficiency and modularity. The 12V primary power rail supplies energy to all components, while DC-DC converters step down voltage to 5V for sensors and control boards. The wiring system is color-coded and labeled, ensuring easy maintenance and troubleshooting. To improve reliability, the team plans to transition from wired connections to custom PCBs, reducing clutter and enhancing signal integrity.

Makardhwaj's 6-DOF robotic manipulator is engineered for instrument handling and sample collection. The arm, made from lightweight yet strong materials, can lift payloads of up to 5 kg. Equipped with high-torque motors and a cycloidal gearbox, the arm performs precise operations required for planetary research. The science module, constructed from 3D-printed components, allows soil sample collection, storage, and analysis using chemical reagents and motor-driven mixing mechanisms.

The rover's communication system employs a dual-band transmission setup, ensuring reliable long-range connectivity. A high power transceiver, combined with an omni-directional antenna on the rover and a directional antenna at the base station, facilitates stable data exchange. The system transmits real-time camera feeds, sensor data, and operational commands, ensuring seamless control and monitoring. Testing of Makardhwaj follows a three-stage validation process: soft testing, hard testing, and integration testing. Soft testing ensures that sensors, actuators, and electronics function correctly under simulated conditions. Hard testing exposes the rover to vibrations, temperature variations, and terrain challenges, validating its durability. Integration testing ensures seamless coordination between all subsystems, allowing the rover to perform autonomous navigation, terrain mapping, and object manipulation efficiently.

In conclusion, Project Makardhwaj is a significant step in modular and affordable space robotics. Its autonomous navigation, scientific research capabilities, and robust communication system make it a promising platform for planetary exploration. The rover's modular structure ensures easy adaptation to various missions, extending its lifespan and versatility. By emphasizing cost-effectiveness and advanced functionality, Team Trixanth aims to contribute to the future of space exploration and robotic technology.

CONCLUSION

As we conclude this edition, we reflect on the incredible journey of Team Trixanth and Project Makardhwaj—a testament to perseverance, innovation, and teamwork. What started as a challenge evolved into a groundbreaking project, showcasing the team's ability to overcome obstacles and push the boundaries of space exploration technology.

Project Makardhwaj stands as a symbol of ingenuity, integrating modularity, cost-effectiveness, and adaptability to create a rover that can contribute to planetary research. With its autonomous navigation, scientific research capabilities, and robust communication system, the project exemplifies the potential of in-house-developed space robotics. The team's dedication and vision have earned them international recognition, proving that with passion and determination, no challenge is insurmountable. As Team Trixanth looks toward the future, their commitment to continuous improvement and exploration remains unwavering.

This magazine serves as a celebration of their achievements and a source of inspiration for future innovators. With every challenge overcome and milestone reached, the journey of discovery continues. The future of space robotics is bright, and Team Trixanth is ready to be a part of it.

Innovation thrives where passion meets perseverance and teamwork.

GALLERY


GPS Map Camera
Ramanagara, Karnataka, India
Nh 948, Karnataka 562112, India
Lat 12.662545° Long 77.451664°


Ramanagara, Karnataka, India
Nh 948, Karnataka 562112, India
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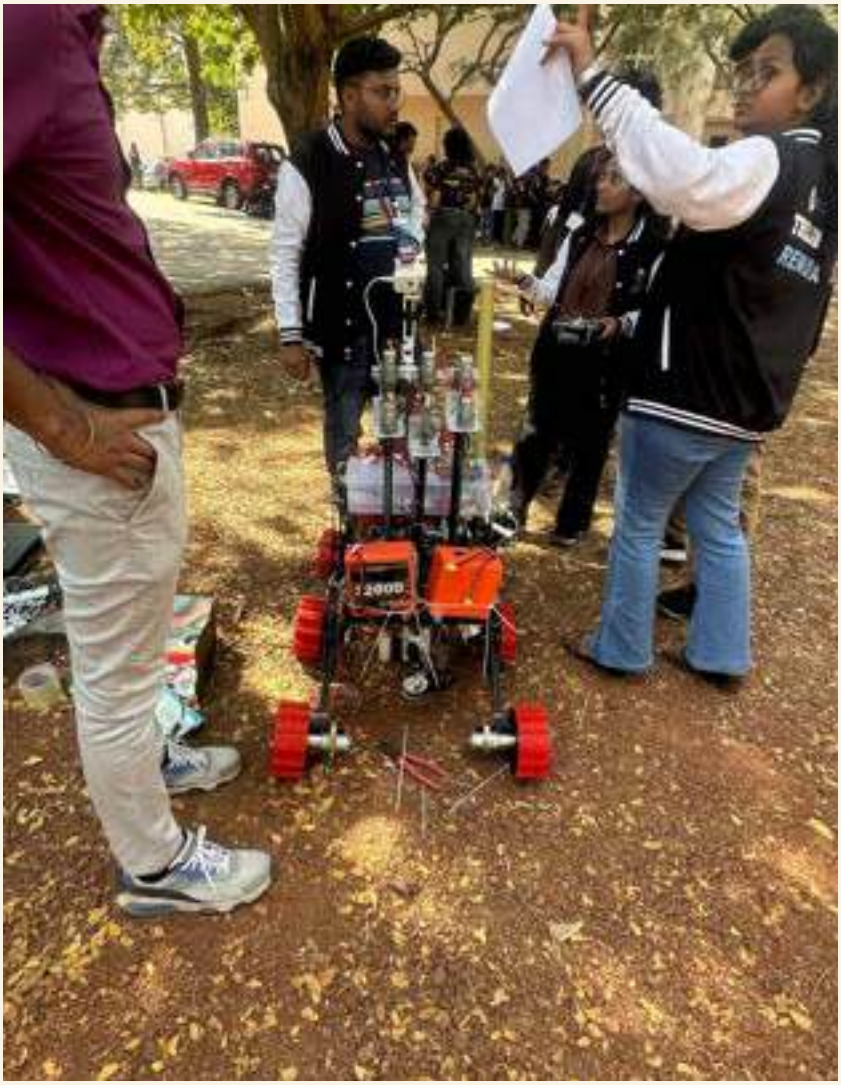

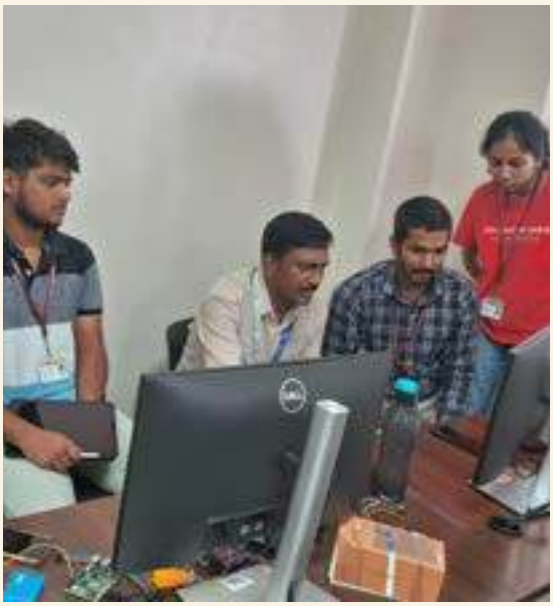

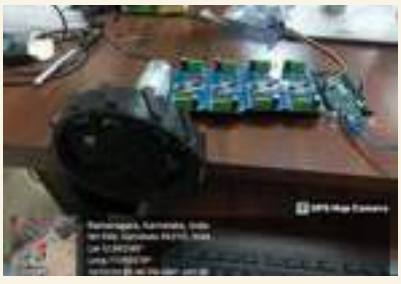

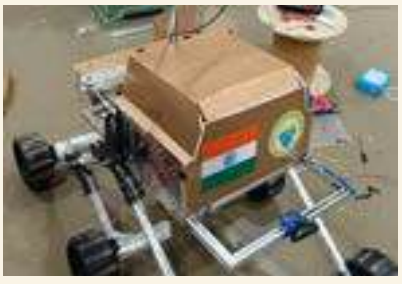

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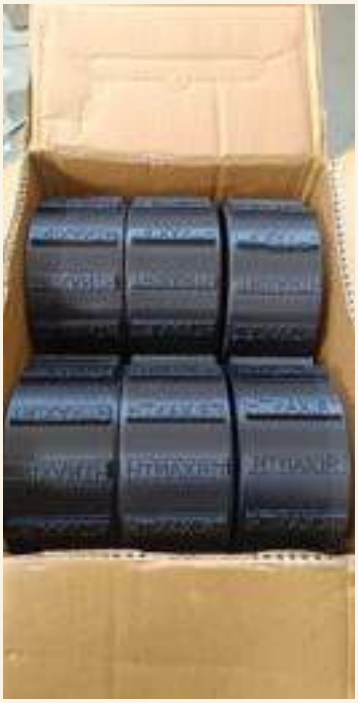

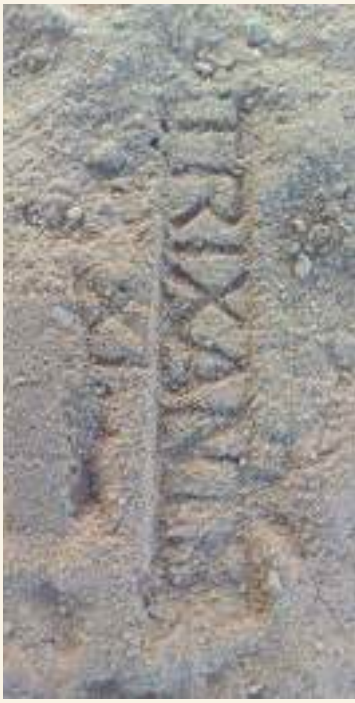

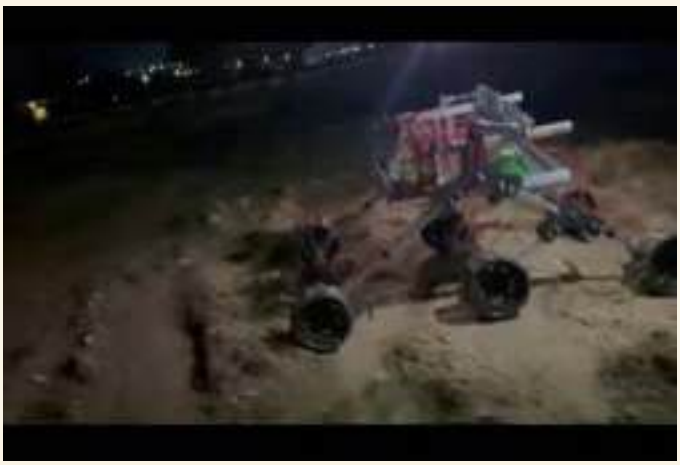

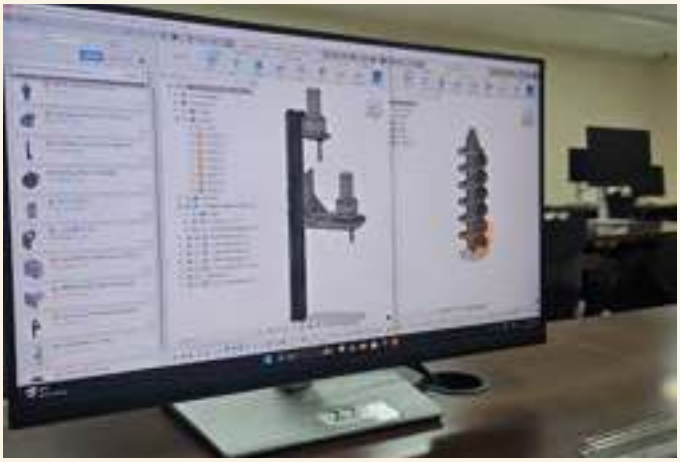

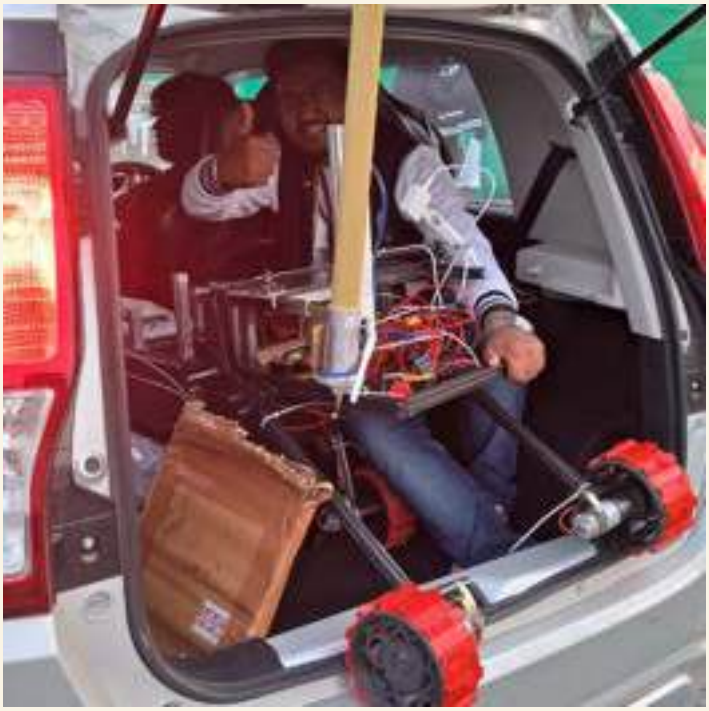

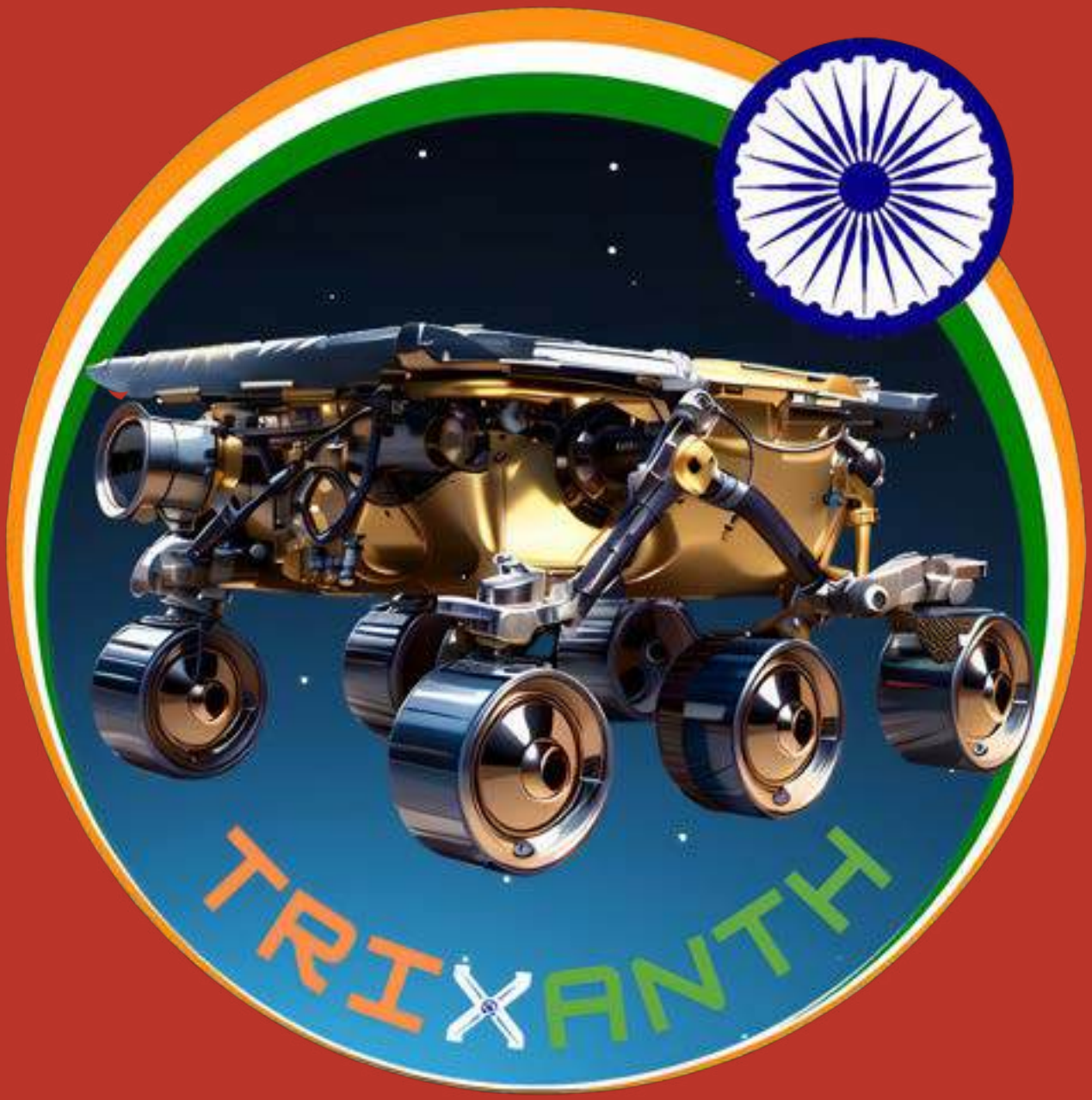

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