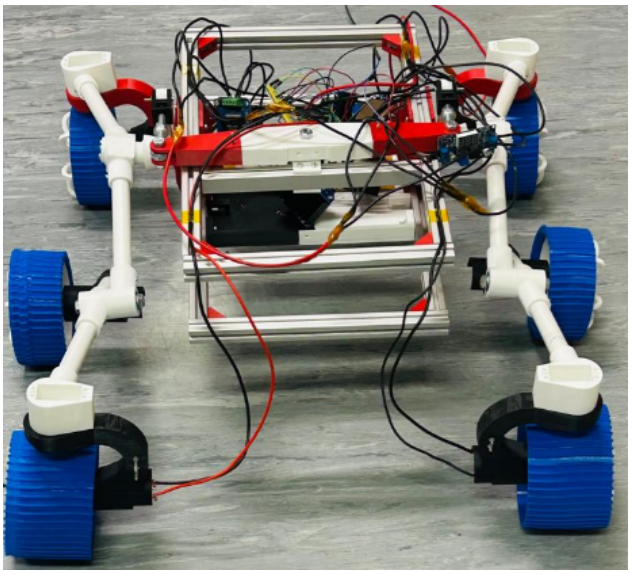
Locked In Aliens

Report on Leadership in the Electrical Department – Cars4Mars Competition



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Introduction

As the leader of the **Electrical Department** for the *Locked In Aliens* team in the Cars4Mars African Rover Challenge 2025, I coordinated a diverse group of students to design, integrate, and implement the rover's electronic systems. The challenge required building a Mars rover prototype capable of wireless operation, vision-based object detection, autonomous navigation, and robust environmental adaptability.

Our department was responsible for ensuring the rover's **communications, control, power, and sensor subsystems** operated reliably and seamlessly with the mechanical chassis and the machine learning (vision) system.

Departmental Structure and Coordination

The Electrical Department was divided into four critical subsystems:

1. **Communications** – Responsible for wireless connectivity and live video streaming from the rover to the command station.
2. **Control** – Handled remote driving operations, skid-steering implementation, and assisted in partial automation for obstacle navigation.
3. **Power** – Designed and integrated the battery system, ensured safe power distribution, and managed charging protocols.
4. **Sensors** – Implemented cameras, detection modules, and feedback sensors for real-time environment awareness and object classification.

As the **coordinator**, I worked closely with subsystem leads to:

- Allocate responsibilities and monitor progress.
- Facilitate communication with the **Mechanical Department**, who designed and assembled the rover's rocker-bogie chassis, and the **Machine Learning Department**, who developed the object detection pipeline (hammer, tennis ball, cones, balloons) with >90% accuracy.
- Resolve inter-team integration issues, particularly where hardware/software boundaries overlapped (e.g., ensuring camera data aligned with ML classification models).

Key Achievements

Under my leadership, the electrical systems achieved several milestones:

- **Wireless Operations**: Established stable wireless communication with a control range of ∼50 m and video streaming up to ∼60 m.

- **Power System**: Integrated a rechargeable battery capable of sustaining operations for over an hour, with safe regulation and distribution.
- **Sensing and Perception**: Enabled vision-based detection and classification of mission-critical objects (hammer, tennis ball, traffic cone, balloons) with testing accuracy between 91–96%.
- **System Integration**: Ensured compatibility between electrical and mechanical systems (power draw, wiring harnesses, weight management) and synchronized operations with the vision and control algorithms.

These developments contributed directly to our team's **qualification for the Mars Stage**, placing us among the **top 10 teams invited to Johannesburg** to demonstrate our rover in real-world conditions.

Challenges and Lessons Learned

Several difficulties arose that tested my leadership and technical skills:

- **Component Delays** – We faced late deliveries of critical parts, teaching us to diversify suppliers and order long-lead items early.
- **Subsystem Overlaps** – Early role confusion caused bottlenecks, which I resolved by introducing clearer documentation and weekly coordination meetings.
- **Cross-Department Integration** – Communication gaps between software (ML team) and hardware (Electrical/Mechanical) initially caused misalignments. Regular joint reviews were introduced to streamline integration.

These challenges emphasized the importance of **proactive project management**, **interdisciplinary collaboration**, and **time-buffering for testing and debugging**.

Outcome and Forward Vision

Our rover successfully passed all Launch Stage requirements and demonstrated robust capabilities in driving, wireless control, live video streaming, and object detection. Although autonomous navigation between balloons was still under development, the solid foundation we built positioned the team strongly for Mars Stage trials.

Looking ahead, the Electrical Department is focusing on:

- Optimizing power systems for longer endurance.
- Enhancing communication stability over larger ranges.
- Supporting the integration of advanced AI-driven autonomy for future rover missions.

Conclusion

Serving as the **Electrical Department Leader** for *Locked In Aliens* in the Cars4Mars Challenge has been a defining experience in both leadership and engineering. It required balancing **technical expertise**, **team coordination**, and **cross-disciplinary integration**. Beyond advancing my own technical skills, I contributed to building a platform of collaboration and innovation that reflects the spirit of student-driven space robotics in Africa.