Moonshot Mission Control

Executive Summary

Community Partner
Heather Jones
Student Consulting Team
Andrew Wang
Riya Kinny
Dhanya Shah
Fatou Gueye

Background

Moonshot Mission Control is a research lab and command center, located in Carnegie Mellon University's School of Computer Science, with a mission to advance robotics and space exploration. The lab is best known for the 2024 Iris mission, which launched the first American university- and student-built rover into space. Currently, their primary focus is MoonRanger, an autonomous rover mission designed to explore polar ice on the moon. The project brings together expert staff and student contributors to develop integrated hardware and software systems, in close collaboration with key stakeholders including NASA and the Pittsburgh-based aerospace company Astrobotic.

Project Description

Project Opportunity

Our consulting project focused on improving the Mission Control Software (MCS) which is the core software component of MoonRanger. MCS is a web application used to monitor the rover, send commands to it, and display telemetry data. The software faced three key challenges: slow query responses in the database, which caused delays in real-time telemetry data retrieval; the lack of a database management process, which compromised security and reliability; and the absence of timestamps in telemetry messages, making event correlation and data analysis difficult.

Project Vision

Our project vision is to enhance the performance, data management, and usability of the Moonshot Mission Control Software (MCS). By implementing indexing to improve query performance, adding a timestamp feature for better telemetry analysis, and developing a database management system for backup, restoration and deletion, we aim to empower the team with faster data access, accurate time-based analysis, and increased control over database management. These improvements will directly benefit mission-critical decision-making, enhance operational efficiency, and ensure data integrity, supporting the success of the MoonRanger mission.

Project Outcomes

- **Improved Query Performance:** Implemented indexing on key telemetry tables, reducing query latency by 99.9%, going from 40 seconds to just 40 milliseconds on average, and improving real-time data retrieval, benefiting operators and the Science Team with faster data access.
- **Timestamp Integration:** Added a timestamp column to the telemetry database, enabling accurate time-based filtering and analysis of telemetry data. This enhancement supports real-time event analysis for mission-critical decisions.
- **Database Management System:** Developed a backup management system integrated with Google Drive using rclone, with the ability to backup, restore and delete the MCS database. This significantly improves database organization, enables version control, and gives the team greater flexibility and safety in managing test data.

Project Deliverables

Our final project deliverables include a Google Drive repository and three GitHub pull requests. The Drive repository contains all technical documentation, research, implementation details, and project updates, organized into five folders. The three pull requests to the private MCS GitHub repository integrate our key contributions regarding timestamp, indexing, and backup process.

Recommendations

During our work on MCS, we identified two major bottlenecks that should be top priorities. First, the broken CI/CD pipeline, originally part of our project scope but later reassigned to another student, remains unresolved, delaying merges and hindering development speed, code quality, and integration. Second, updating deployment configurations of MCS to better support macOS devices would ease onboarding and reduce setup issues that were a big hurdle for us. In the long term, migrating MCS to the cloud would be valuable to streamline database management, improve reliability, and remove the need for manual infrastructure maintenance.

Student Consulting Team

Andrew Wang served as development lead. He is a third-year student majoring in Information Systems with a minor in AI. He will be interning at Amazon this summer.

Riya Kinny served in quality assurance and as a developer. She helped optimize queries and tested them on the entire database. She is a third-year student studying Information systems and Computer Science. This summer she will be interning at BNY Mellon.

Dhanya Shah served as a developer in the project, taking lead on the backup management solution. He is a third-year student majoring in Information Systems and Computer Science. He plans to work on a startup, he is co-founding, this summer.

Fatou Gueye served as project manager. She is a third-year student majoring in Information Systems with minors in Business Administration and HCI. She will be interning at SENATI this summer in Peru under the TCINGC program.