MAKE TO INNOVATE - PROJECT EXECUTIVE SUMMARY

Mars Analog Vehicle for Robotics Inspection and Construction

Gage Lochner

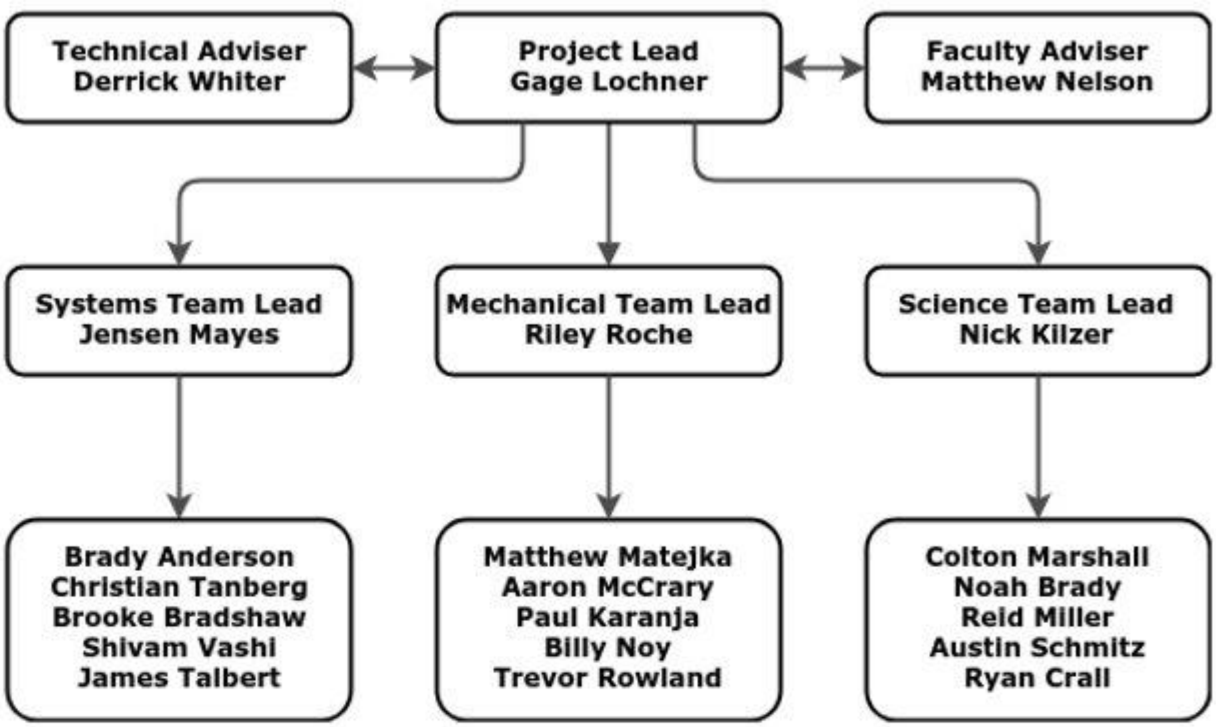
PROJECT INFORMATION

Project Name	MAVRIC	**Semesters in service**	19
Project Classification	Competition team	**Budget Requested**	$8,000.00
Student Leader	Gage Lochner	**Budget Approved**	$6,000
Project Member Size	19	**Budget Spent**	$6,000

The project has 3 teams. The team leaders are Riley Roche, Jensen Mayes, and Nick Kilzer.

The stakeholders for the project are: M2I, ISGC, Danfoss, Quality Manufacturing, Emerson.

ORGANIZATION CHART



PROJECT MISSION STATEMENT

MAVRIC, or the Mars Analog Vehicle for Robotic Inspection and Construction, is a student lead team focused on building the next generation of Mars rovers.

PROJECT GOALS

The primary goal of the project this semester is to finish the rovers' feature set and to polish the operational capabilities and practice operating the rover in a similar fashion as we would see at competition.

PROJECT DELIVERABLES

This project will produce a competition ready rover for URC, or the University Rover Competition, by the end of the spring 2019 semester.

PROJECT SUMMARY

MAVRIC is a student lead engineering group working on Phoenix, our rover entry to the 2019 URC events. Phoenix is the first new rover in 5 years and has been a work in progress since July of 2017.

The primary goal of Phoenix was to create a testbed rover that could be upgraded and evolved over time. This rover would be used to confirm design ideas, manufacturing practices, and allow for newer ideas to be tested with minimal impact to the other systems. Most of the rover was built on campus in the last year. To help accomplish these goals, the rover subsystems were designed to be as modular as possible, and to use common and simple connection points and interfaces.

The rover is designed to accomplish several tasks at competition. The tasks of URC are created with the future operations of rovers on Mars in mind. The primary theme of the competition is to have 4 missions similar to what a rover setting up for a manned Mars mission may require. All missions at competition are completed by teleoperation, without line of sight, and may be up to 1 km away.

During the autonomous mission of the competition, the rover will navigate between gates marked by tennis balls with supplementary GPS coordinates. The rover must decide when it has reached the end of each gate within the mission, and must display this to the base station and on board the rover. Terrain will progressively become more difficult, and the most difficult stages may not have direct line of sight between the start and end points.

For the science mission, the rover must have the ability to detect life onboard the rover. This must be done with no major disturbances to the sample area. Contamination risks and hazardous materials present in the system must be properly accounted for.

The extreme retrieval and delivery mission has the rover traverse difficult terrain while carrying small payloads to GPS coordinates. As the stage progresses, the distance from the base station and difficulty of the terrain will increase.

The final leg is the equipment servicing mission, which requires the rover to perform several dexterous operations on mocked up equipment systems. There is only minimal terrain at this mission. Tasks include operating screwdrivers, keyboard, joysticks, and securing electrical connectors.

PRESENTATION SUMMARY

Systems Team Summary – Jensen

This semester, Systems team has been able to make tremendous progress on the rover and has been able to accomplish a number of large goals. We have added full GPS driving capabilities and can now easily add more functions to the autonomous system due to the transition to a state-machine based approach. We have also completed the addition of feedback to the arm and are now able to control the arm while knowing its position both the camera feeds and potentiometer feedback. In the process of this we went through the development processing of creating a custom hat to gain the needed specifications and are now successfully utilizing a custom ADC hat that meets our required sample rate. Additionally, we have implemented a transition away from a platform based on 4 Raspberry Pi 3 modules to a platform based on a single NVIDIA Jetson TX2 which is able to connect to our existing add-on hats as well as greatly increasing our processing power for implementing computer vision through the existing cameras on the rover. Lastly, we have been developing a more user-friendly GUI that will be useful for both testing and competition by showing a number of important pieces of data along with a visual representation of the arm position and a simple map system for the autonomous mode.

Science Team Summary – Nick

This semester, Science Team focused on prototyping, testing, and manufacturing of the Science Rig. Three different 3D printed mounts and cases were created for the assembly of the laser rotation system, including one to mount the laser rotation to the vertical actuator, one to mount the laser rotation to the forward actuator, and the optical housing. In order to limit the amount of reflection that took place within the optical casing and keep the laser well-aligned, the optical casing was custom-made with black ABS plastic by Danfoss. A Protocase-made container was also custom-designed for vibration dampening the interface between the spectrometer itself and the rover chassis. Aluminum brackets were also made for attaching the rig to the rover chassis.

The optical casing along with the optics, laser, and spectrometer were designed to collect Raman spectra of objects the laser light reflected off of at close range. However, at the moment, Science Team's tests have unveiled the possibility that the ordered notch filter may be faulty. After laser light travels through the optics, the spectrometer still picks up light around 532nm, which is well within the range of light claimed to be blocked by the notch. After performing tests with more precise equipment, the manufacturers will be contacted and this issue will be addressed. After this issue is resolved, the team is confident that the system will be able to collect Raman spectra.

Mechanical Team Summary – Riley

The Mechanical Team spent a large portion of the semester improving Phoenix's robotic arm. String potentiometers at each arm joint can now provide accurate feedback on the position of the arm for fine control. A shoulder upgrade to reduce frictional losses is in the final stages of manufacture and assembly. A new end effector was designed, manufactured, and tested. A power distribution box for the robotic arm was designed and installed to allow for easy wire plugin between tasks. Camera mounts were added to the rover chassis, arm, and mast to provide all-around vision for the rover operators at the base station. An off-rover testing stand and manipulation practice board were created to improve the team's testing capabilities.

The weight of the rover was reduced significantly with various minor modifications. Excess hardware weight was removed, components with excess material were milled and drilled out when possible, and some components were replaced with lighter designs. While the rover is still slightly above the 50 kg mass limit, it is in much better position than it was previously.

In the weeks after spring break, the team began working on designs for the 2020 rover. A 3-bogie suspension style was selected and the team is moving forward with specific component designs. Basic sizing and layout design for both the chassis and the electronics box has also begun. The team is learning from its past successes and failures to design a better rover for the year to come.