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SG Fellowship FY25 WNCC Soler (001479)  
NASA GRANT PROJECT CHARTER  
8/28/2024

Mars Rover Reconnaissance:

Environmental Sensing, Laser Communication, and Terrain Mapping via Raspberry Pi GoPiGo Robotics

PROJECT BRIEF

Project Sponsor: Nebraska NASA Space Grant  
Project Location: Western Nebraska Community College, Scottsbluff, NE  
Project Manager: Jessica Soler  
Faculty Advisor: Bill Loring  
Project Scope: August 2024 – April 2025

The Mars Rover Reconnaissance Project aims to develop and deploy a pair of Raspberry Pi GoPiGo robots equipped with environmental sensors, laser communication systems, and LiDAR-based terrain mapping technologies. These autonomous robots will simulate aspects of a Mars rover mission, focusing on the deployment of technology for data collection, communication, and terrain mapping.

The Mars Rover Reconnaissance Project ties into the following NASA Mission Directorates:

**Explorations Systems Development**

This project aligns with NASA’s Exploration Systems Development Mission Directorate by focusing on robotic systems development. The robots will simulate Mars rover missions, emphasizing reliable communication, terrain mapping, and data collection.

**Mission Support**

The project supports the Mission Support Directorate by

The robots will collect and analyze environmental data using ThingSpace, which can predict environmental trends for safer and more efficient exploratory missions.

**Space Operations**

The ability to remotely control the robots aligns with the Space Operations Mission Directorate’s goal of maintaining continuous human presence in space, providing valuable insights into remote operational control in space-like conditions.

FIX: They will be autonomous

**Space Technology**

The project contributes to NASA’s Space Technology Mission Directorate by demonstrating and transferring new space technologies, such as laser communication and LiDAR-based mapping, to enhance future missions.

RESOURCES

**Hardware:**

* Rover Unit: GoPiGo Robot Kit
* Base Unit: Raspberry Pi Case
* 2x Raspberry Pi 3 units
* SD Cards
* Wi-Fi Extenders
* Batteries
* LiDAR Sensors
* Laser Communication Modules
* Environmental Sensor (Grove BME680 sensor is a 4-in-1 environmental sensor with strong sensing capability for Temperature, Humidity, Pressure, and Gas)

**Software:**

* Custom programs for:
* Navigation
* Sensor data processing
* Laser-based communication
* Terrain Mapping
* Tools for Data Handling:
* Data extraction and organization tools
* Web interface or program for data analysis

KEY DELIVERABLES AND OBJECTIVES

1. Development
   1. Design and Assembly
      1. Hardware Configuration: Assemble the GoPiGo robots with Raspberry Pi 3 units and integrate necessary components such as sensors, LiDAR, and laser communications systems.
   2. Programming
      1. Develop Custom Software
         1. Navigation and Control
            1. Program the robots to be navigated through their environment.

Remote Control

Autonomous

* + - 1. Data Collection
         1. Implement software routines for collecting and processing environmental data from the sensors.
      2. Communication:
         1. Develop software for laser-based communication between the robots to enable data exchange and coordinated actions.

1. Deployment
   1. Field Testing
      1. Deploy the robots in a simulated environment to test their functionality
         1. Navigation accuracy
         2. Data collection efficiency
         3. Communication reliability
   2. Evaluation and Iteration
      1. Evaluate performance, identify issues, and iterate on the design and programming to improve robot capabilities and reliability.
2. Expected Outcome
   1. Functional Robots
      1. Two GoPiGo robots that are fully assembled, programmed, and capable of performing their designated tasks in the simulated environment.
   2. Successful Deployment
      1. The robots will be successfully deployed and operational in a controlled setting, demonstrating their ability to map and navigate terrain, collect data, and communicate effectively.

TIME COMMITMENT

**Weekly Hours:** 5 hours

* Wednesdays: 11:00 AM – 2:00 PM (3 hours)
* Friday/Saturday Evenings: 8:00 PM – 10:00 PM (2 hours)
* Additional research as needed.

WORK BREAKDOWN STRUCTURE

**Phase 1: Getting Started, Hardware Assembly**

* **Week of August 19th, 2024:**
  + **Objective:** Initial project setup, gather research materials, and familiarize yourself with project requirements.
* **Week of August 26th, 2024:**
  + **Objective:** Accept grant, create NASA Gateway account, create ORCiD account, accept GoPiGo kit, explore resources on, clone repository.
* **Week of September 2nd, 2024:**
  + **Objective:** Assemble GoPiGo robot with Raspberry Pi 3 unit and install OS, create project workplan and timeline, upload to GitHub. **OTHER?????**
* **Week of September 9th, 2024:**
  + **Objective:** Learn how to program Raspberry Pi, including basic operations, Python programming, and hardware interfacing.
* **Week of September 16th, 2024:**
  + **Objective:** Learn how to program Raspberry Pi, including basic operations, Python programming, and hardware interfacing.

**Phase 2: Navigation**

* **Week of September 23rd, 2024:**
  + **Objective:** Assemble GoPiGo robots with necessary components. SENSORS FOR NAVIGATION?
* **Week of September 30th, 2024:**
  + **Objective:** Integrate basic navigation controls into the robots.
* **Week of October 7th, 2024:**
  + **Objective:** Implement remote-control functionality.
* **Week of October 14th, 2024:**
  + **Objective:** Develop autonomous navigation algorithms.
* **Week of October 21st, 2024:**
  + **Objective:** Troubleshooting

**Phase 3: Sensor Integration and Data Streaming**

* **Week of October 28th, 2024:**
  + **Objective:** Integrate environmental sensor (Grove BME680 sensor is a 4-in-1 environmental sensor with strong sensing capability for Temperature, Humidity, Pressure, and Gas)
* **October 31st, 2024:**
  + **Objective:** Submit Progress Report #1.
* **Week of November 4th, 2024:**
  + **Objective:** Test and calibrate sensors for accurate data collection.
* **Week of November 11th, 2024:**
  + **Objective:** Begin developing software for sensor data processing.
* **Week of November 18th, 2024:**
  + **Objective:** Work on streaming sensor data to the base unit.
* **Week of November 25th, 2024:**
  + **Objective:** Integrate into website for data analytics.

**Phase 4: Communication and Mapping**

* **Week of December 2nd, 2024:**
  + **Objective:** Develop and test laser communication systems between robots.
* **Week of December 9th, 2024:**
  + **Objective:** Integrate communication software into the robots.
* **Week of December 16th, 2024:**
  + **Objective:** Begin work on terrain mapping software.
* **Week of December 23rd, 2024:**
  + **Objective:** Test terrain mapping functionality in a controlled environment.
* **Week of December 30th, 2024:**
  + **Objective:** Finish work on terrain mapping software
* **December 31st, 2024:**
  + **Objective:** Submit Progress Report #2.

**Phase 5: Final Testing and Debugging**

* **Week of January 6th, 2024:**
  + **Objective:** Test video streaming and photography capabilities.
* **Week of January 13th, 2024:**
  + **Objective:** Conduct final debugging and troubleshoot any remaining issues.
* **Week of January 20th, 2024:**
  + **Objective:** Perform a full system test to ensure all components work together.
* **Week of January 27th, 2024:**
  + **Objective:**
* **Week of February 3rd, 2024:**
  + **Objective:**
* **Week of February 10th, 2024:**
  + **Objective:**
* **Week of February 17th, 2024:**
  + **Objective:**
* **Week of February 24th, 2024:**
  + **Objective:**
* **February 28th, 2025:**
  + **Objective:** Submit Progress Report #3.
* **Week of March 3rd, 2024:**
  + **Objective:**
* **Week of March 10th, 2024:**
  + **Objective:**
* **Week of March 17th, 2024:**
  + **Objective:**
* **Week of March 24th, 2024:**
  + **Objective:**
* **Week of March 31st, 2024:**
  + **Objective:**

**Phase 6: Project Completion and Reporting**

* **Week of April 7th, 2024:**
  + **Objective:** Project Completion Date. Finalize the project report and presentation materials.
* **Week of April 14th, 2024:**
  + **Objective:** Prepare for the final project presentation.
* **Week of April 21st, 2024:**
  + **Objective:** Prepare for the final project presentation.
* **April 25th, 2025:**
  + **Objective:** Presentation Date.
* **April 30th, 2025:**
  + **Objective:** Submit Progress Report #4.
* **Summer/Early Fall 2025:**
  + **Objective:** Final Report submission.

\*\*\*\*\*\*\* **ABSTRACT DUE BEFORE PRESENTATION-- WHEN???**