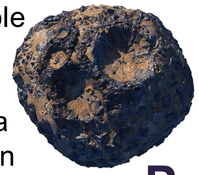
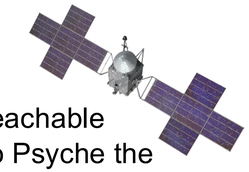
ROBOTIC EXPLORER FOR HYPOTHESIZED SURFACES OF THE ASTEROID PSYCHE

Group 32: Marissa Moretti, Emily Chapman, Kalani Fuellas, Ezekiel Mcneil, Karen Trejo Mentor: Professor Cassie Bowman

Problem Statement: Develop a robotic explorer capable of efficiently traversing Psyche's hypothesized surface, thought to consist of metal (nickel and iron), rocky debris, and steep or uneven terrain. The system must operate in a low gravity, environment with limited traction and no human intervention.





PSYCHE

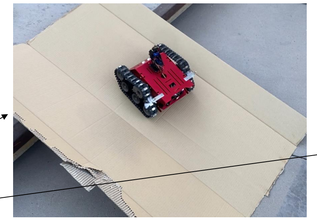
Introduction: Since Earth's core remains unreachable due to extreme heat and depth, scientists look to Psyche the asteroid. It's believed to resemble a planetary core; its metal rich body allows us the unique opportunity to gather insight in how planets are formed like Earth. This project supports far-future exploration of Psyche by creating a rover that's able to navigate its terrain. The final prototype incorporates magnetic traction, onboard sensing, and obstacle navigation to simulate realistic mobility it might encounter.

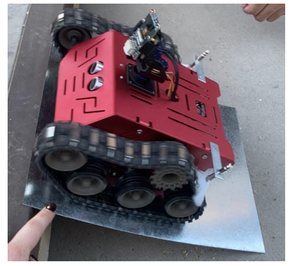
Testing:

Test 1: Determining how well the different modes built into the app work.
- obstacle avoidance
- camera movement

Test 2: Deciding how to attach the magnets

Test 3: Magnets on different hill slopes
- 12° slope without use of the magnets
- 29° slope with the use of the magnets



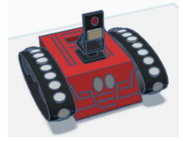


Electromagnet for actual rover

Magnet for prototype

Test 4: Determining how to convert a one electromagnet circuit with a button, to a multiple electromagnet circuit with alternating cycles without needing a button.

Test 5: Different timing for alternating electromagnets.
- 1 second vs 3 seconds vs 5 seconds



Model of rover prototype with electromagnets

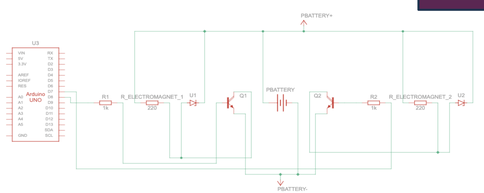
Circuit Schematic Concept:

Our actual model will consist of electromagnets implemented onto its tracks. The schematic shown is an example of how the electromagnets are wired to produce an on/off outcome with nominal voltage.

```
unsigned long T1 = 0, T2 = 0;
uint8_t TimeInterval = 3000; // 3 seconds for alternating

// Define the pins for two electromagnets
#define EM_PIN1 7    // Electromagnet 1
#define EM_PIN2 8    // Electromagnet 2

void setup() {
  pinMode(EM_PIN1, OUTPUT);
  pinMode(EM_PIN2, OUTPUT);
}

void loop() {
  T2 = millis();
  if ((T2 - T1) >= TimeInterval)
  {
    // Alternating the electromagnets
    static bool EMState = false;  // Alternate between the two pins
    if (EMState) {
      digitalWrite(EM_PIN1, HIGH);  // Turn on electromagnet 1
      digitalWrite(EM_PIN2, LOW);   // Turn off electromagnet 2
    } else {
      digitalWrite(EM_PIN1, LOW);   // Turn off electromagnet 1
      digitalWrite(EM_PIN2, HIGH);  // Turn on electromagnet 2
    }
    EMState = !EMState;  // Toggle the state for next time

    T1 = millis();
  }
}
```

Circuit Code Concept:

The code consist of an Arduino based code. The code is based off of two electromagnets with an on and off loop sequence showing that when one is on the other is off.



Results:

- Successful robotic explorer prototype with full movement and ability to avoid obstacles in its path
- Embedded magnets using bus wire, heat shrink tubing, super glue
- Magnets were successful in keeping the rover on a metal surface up to 35°, which shows how the rover will be able to remain and traverse Psyche's hypothesized metal surface with extremely low gravity.
- Brush system added to remove dust & iron particles from the tracked wheels
- Camera used to collect visual data for Psyche's surface

Conclusion

The goal of this project was to build a rover with concepts that would assist in autonomously exploring Psyche. The different tests displayed results that the concepts of the rover would succeed on the asteroid, even with different gravitational factors. Group 32's prototype remained on budget and produced a rover with concepts that would be beneficial to exploring Psyche.

*This work was created in partial fulfillment of **Arizona State University** Capstone Course "**EEE498**". The work is a result of the Psyche Student Collaborations component of NASA's Psyche Mission (https://psyche.asu.edu). "Psyche: A Journey to a Metal World" [Contract number NNM16AA09C] is part of the NASA Discovery Program mission to solar system targets. Trade names and trademarks of ASU and NASA are used in this work for identification only. Their usage does not constitute an official endorsement, either expressed or implied, by Arizona State University or National Aeronautics and Space Administration. The content is solely the responsibility of the authors and does not necessarily represent the official views of ASU or NASA.*