Autonomous Demining System: Phase V

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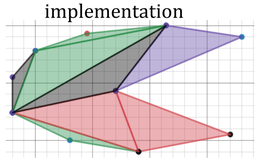
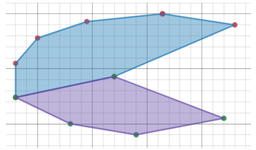
Abstract

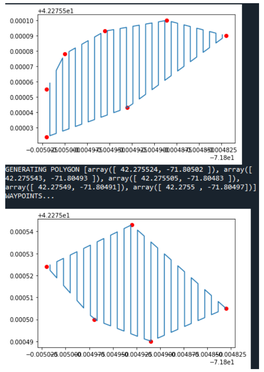
Every year at least 7,000 people around the world die from landmines that are leftover from abandoned, unexploded landmines. Current demining methods are expensive, dangerous, and slow. To combat this issue, our team is continuing the project to create an operational autonomous demining system. The system will consist of three parts: a rover, a drone, and a base station. The rover will be able to search a user defined area for unexploded landmines. When the rover finds a landmine, it will record the location. After the search is complete, the drone will then fly to the locations of the landmines and will drop a small payload onto the mines to detonate them. The base station acts as the communication link between the rover and the drone and provides a user interface for the operator to control the system. The goal of our project is to have a functioning, relatively inexpensive system that can increase the safety and efficiency of global humanitarian demining efforts.

Base Station Communication and Search Algorithm

- **Takes in boundary points and generates waypoints**
- **Convex Implementation:**
  - Finds which lines are upper and lower bounds
  - Generates waypoints in the correct order along those bounds
- **Concave Implementation:**
  - Triangulates the concave shape
  - Finds the most efficient convex partitions of the triangles
  - Passes the convex partitions into the convex implementation

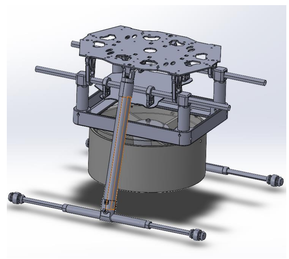






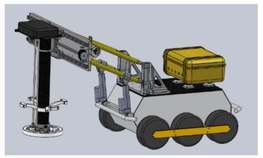
Drone Payload Dropper

The dropping mechanism needed to be attached to the Tarot T-18 drone in a way that allows for quick attachment. The dropper attachment mechanism was also designed to house the onboard computer and a battery for the dropper mechanism.

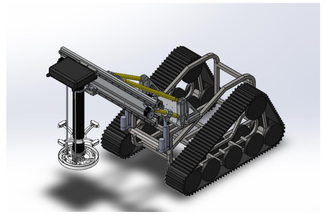


Rover Mechanical Re-Design

- **Previously used a 6-wheeled Husky drivetrain**
  - Weight of the metal detection system in front of the base made it difficult to turn
- **Transitioned to a tread-based drivetrain**

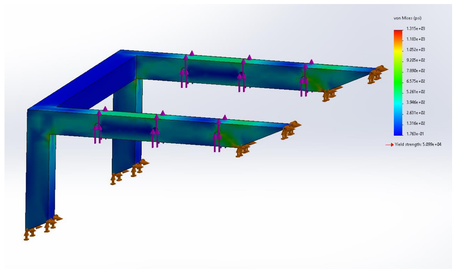


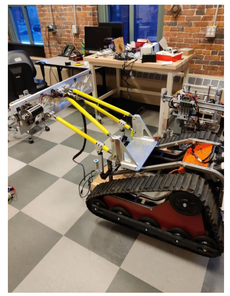
Demining Phase 4 Rover CAD



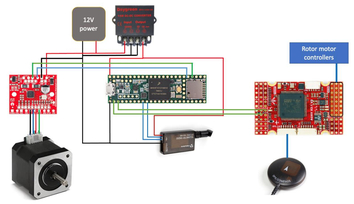
Demining Phase 5 Rover CAD

- **Modifications to the frame were conducted to attach the metal detector and four bar mechanism**
- **Attachment configuration on new base placed the center of mass near the center wheel of the tread**
- **Stress concentration and deflection analyses were conducted on four bar mechanism and attachment components**
  - Ensured the design was capable of withstanding the weight of the metal detector and applied forces during operation



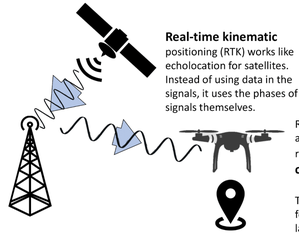


Drone System Design



Tarot T-18 from UAV Systems International

The team updated the systems on the new Tarot T-18 to incorporate an onboard computer, RTK GPS, and finite state machine mission planner.



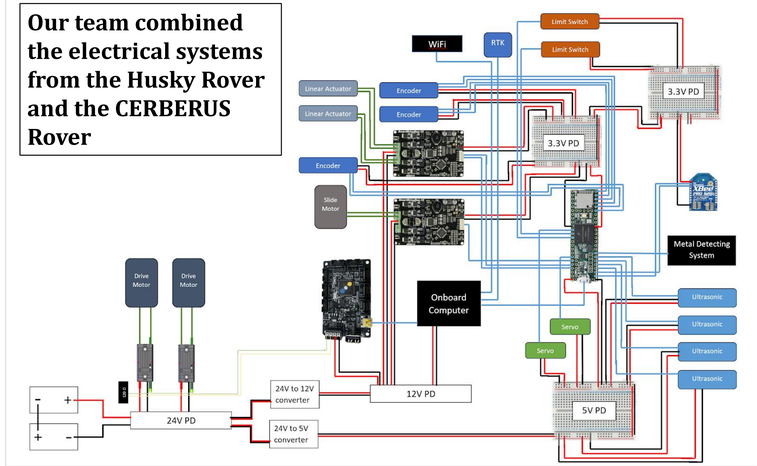
Real-time kinematic positioning (RTK) works like echolocation for satellites. Instead of using data in the signals, it uses the phases of the signals themselves.

Relative positions between a Base Station and a moving receiver unit have **1-2 centimeter precision.**

This precision is imperative for our drone to detonate landmines from a safe distance.

Rover Electrical Schematic

Our team combined the electrical systems from the Husky Rover and the CERBERUS Rover



Results

Rover

- **Modified the new rover for metal detector arm mounting, and conducted stress analysis**
- **Re-designed electrical system to accommodate new rover hardware and XBee for manual control**

Base Station

- **Established Communication between base station and drone**
- **Search Algorithm generates path from user input search area**

Drone

- **Improved dropping mechanism design and mounting to drone**
- **Integrated Teensy and RTK with new drone control system**
- **Flight testing with waypoints from base station and dropping payloads**

Future Work

Future teams will need to implement communication between the base station and the rover, investigate encoder mounting solutions for autonomous rover driving, and test the integrated system performance. Other possible future work includes implementing mine detonation verification and rover obstacle avoidance.