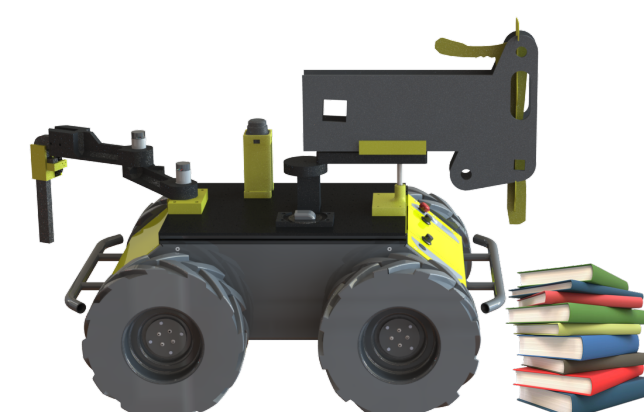


Project Overview

In compliance with Massachusetts law, Eversource technicians must mark any cable on a digsite to an accuracy of plus or minus 18" within 72 hours of a ticket being generated. Currently, they use handheld cable detectors and maps to find and mark these cables.



We developed a robot based on the Clearpath Husky A100 platform capable of finding and marking the required cables accurately. In addition, we performed research on the social implications of using this robot and developed a technical manual for our end users.

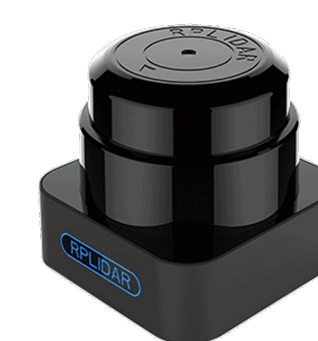


Navigation

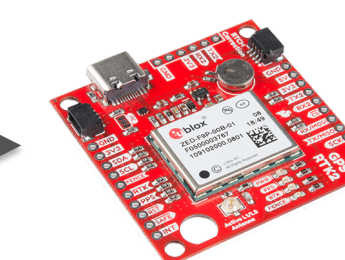
The robot uses an NVIDIA Jetson TX2 as a ROS Master. When moving, the Jetson is running the Clearpath Navigation stack designed for the Husky.



The Jetson communicates directly with an outdoor rated RPLIDAR S1 2D LiDAR system to avoid obstacles in the local environment.

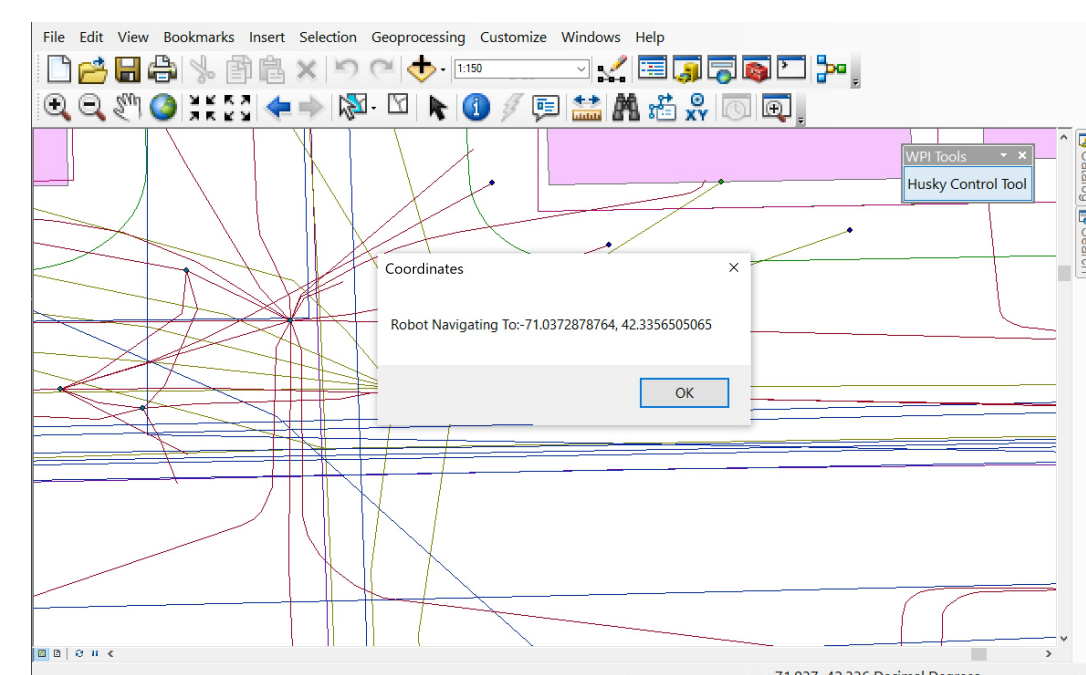


A Raspberry Pi 4 serves as a secondary computer on the ROS network to distribute I/O load. It's responsible for driving a SparkFun zed-f9p GPS.



The zed-f9p is RTK equipped, meaning it can achieve up to 3cm levels of accuracy by triangulating with a known ground station. The Pi enables this accuracy by constantly receiving data from the Massachusetts Department of Transportation over an on-board 4G cellular network. These data are then piped into the GPS using ROS.

User Interface



Eversource technicians use ESRI's ArcMap in the field. A custom ArcMap Add-In allows users to send commands to the robot and monitor its status during jobs.



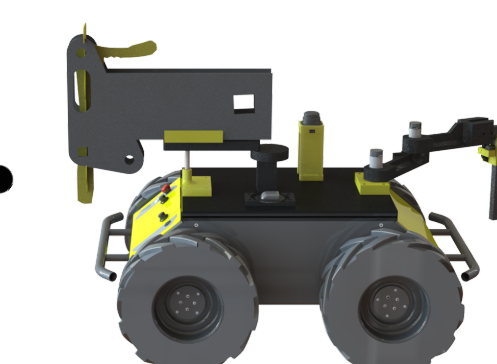
The Add-In offers custom UI elements which can interact with mouse presses and allow the user to



rosbridge



These commands are relayed to ROS using rosbridge. Each interaction creates a service call.



The robot hosts its own local rosbridge server, using an on-board router as the connection point.

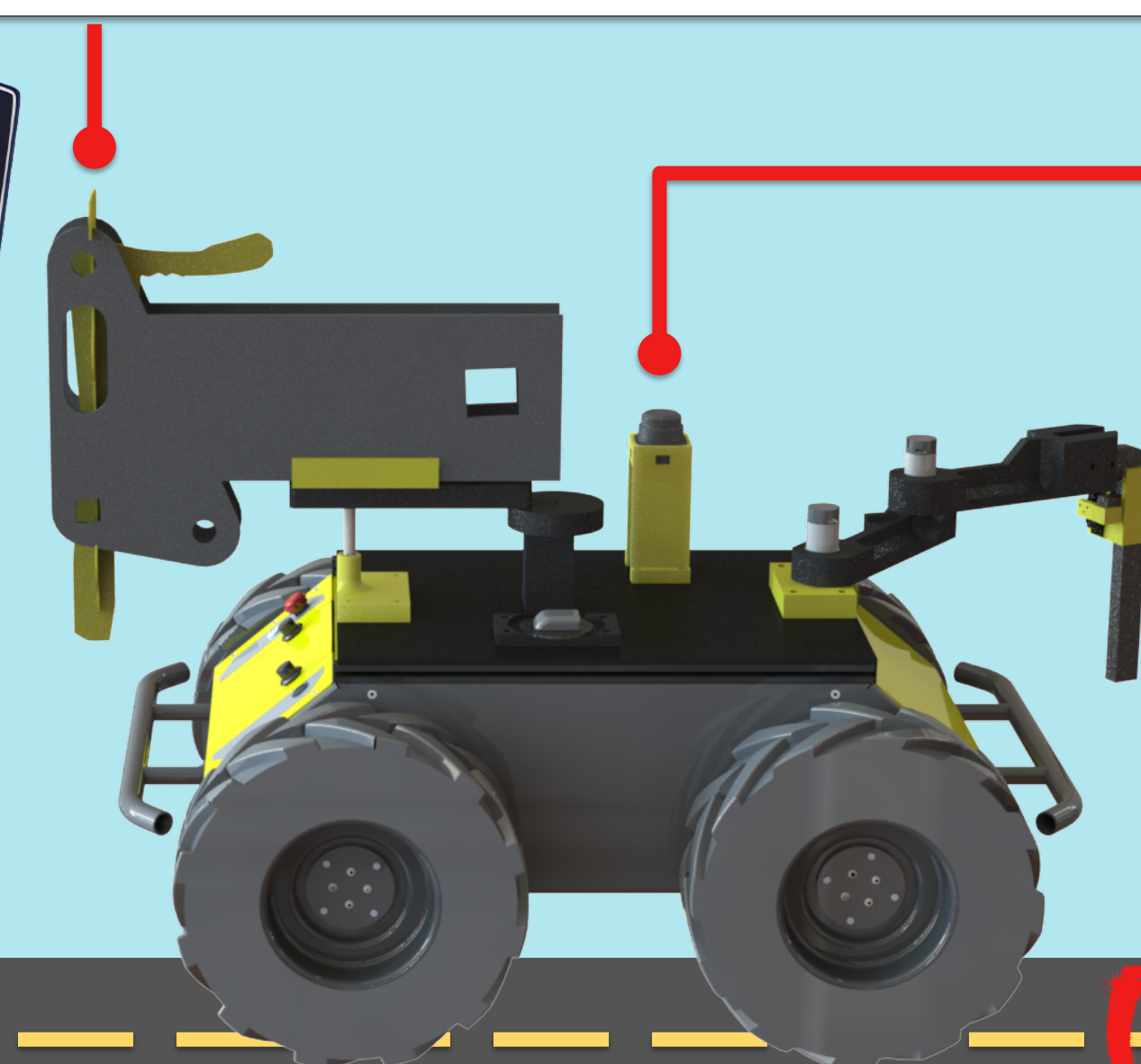
Detection



ROS

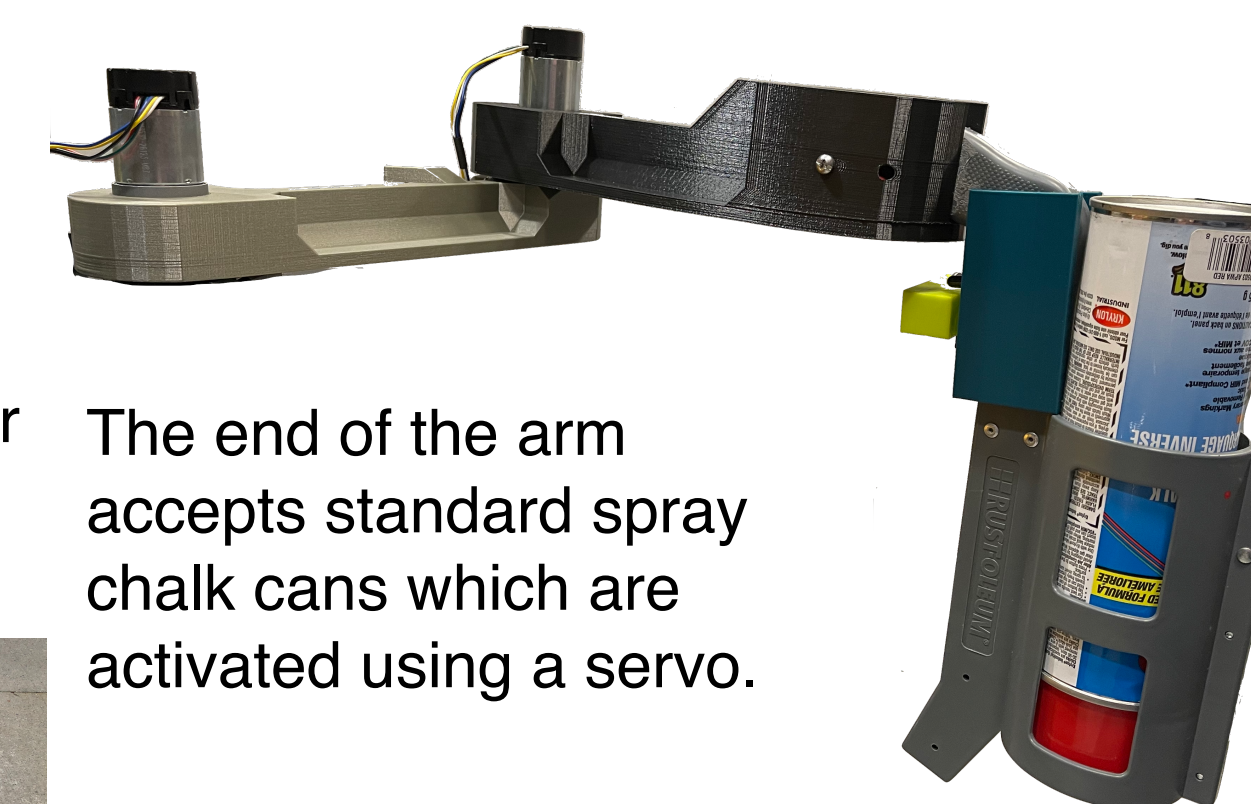
The robot uses a vLoc3 RTK-Pro Utility Locator from Vivax Metrotech to detect electromagnetic fields emitted by underground power cables.

A microphone on the device is used to relay any findings into ROS. This microphone is tied to a custom circuit that isolates the correct frequency.



Marking

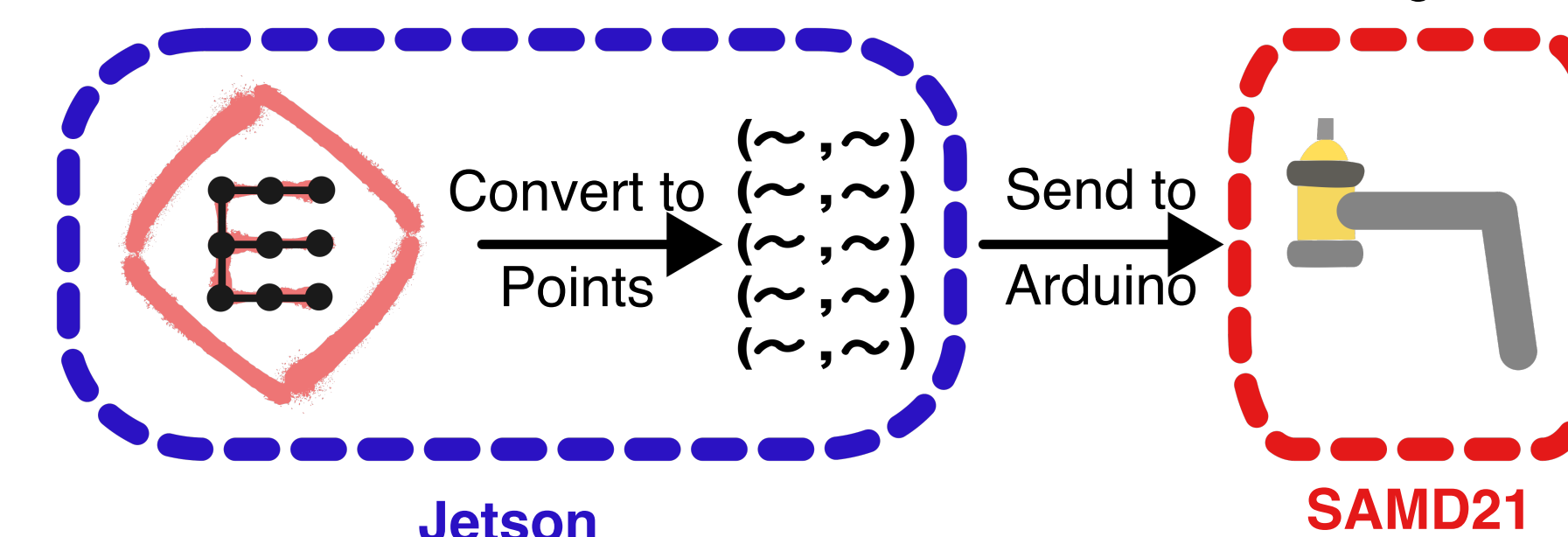
A 2DoF arm is responsible for replicating all the necessary symbols for marking DigSafe worksites.



The end of the arm accepts standard spray chalk cans which are activated using a servo.



The whole marking system is controlled using a SAMD21 microprocessor. The needed symbols are communicated from the Jetson to the SAMD21 using rosserial.



Acknowledgements

Thanks to Eversource for their guidance throughout the project, especially Umair Zia and Mike Sweeney, as well as Michael Berthed at Utilitronics and Kelvin Cherrington at Vivax Metrotech for their help.

Future Work

Testing revealed that the Clearpath Husky A100 is not a suitable platform for the task of finding cables. Thus, next year's MQP team is tasked with the development of a custom replacement chassis.