# Autonomous Electronic Airplane Tug (Software)

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## Abstract / Introduction

In airports around the world, aircraft must taxi between runways, gates, and hangars—consuming significant amounts of jet fuel. This emits harmful pollutants in the process, which is a growing concern in Utah[1]. An autonomous aircraft tug offers a promising solution for reducing emissions, lowering fuel consumption, minimizing noise, and improving ground crew safety. This capstone project demonstrates a comprehensive approach to software and hardware integration in robotics, highlighting both the solutions in building a reliable autonomous aircraft tug for real-world applications.

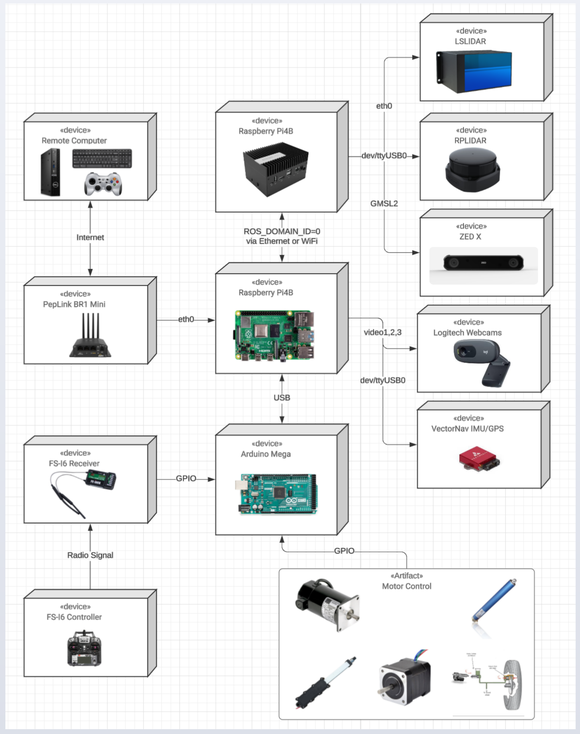
## Objectives

The objectives of the tug are as defined as:

- Navigation and Localization
- Obstacle Detection and Avoidance
- Path Planning and Path Reversal
- Remote Teleoperations
- Safety Protocols
- Simulation Testing
- Reliable and Scalable Software Libraries

## Architecture

The following is a simplified diagram of our software architecture for the robotic tug:



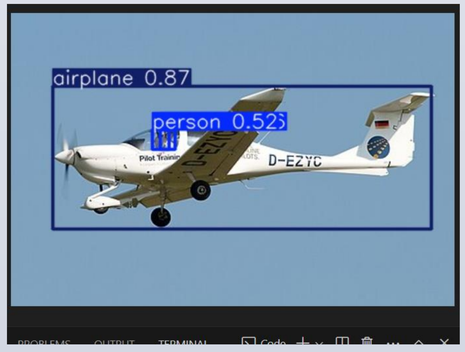




Image Recognition Via ZEDX Camera

## Testing

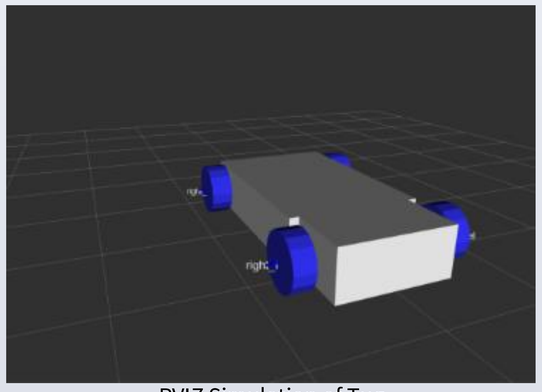
We've categorized our testing methods with the two following types of tests:

Functional Testing

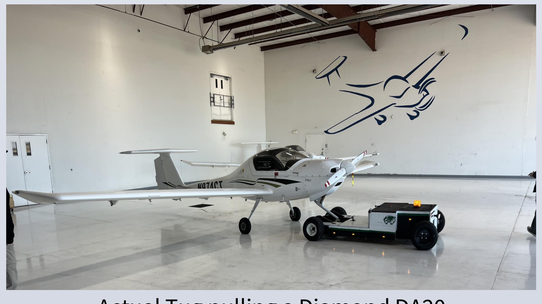
- Unit testing equipment with gtest.
- Bug Reports

Software Testing

- Integrated, simulated testing with Gazebo Harmonic and RVIZ



RVIZ Simulation of Tug



Actual Tug pulling a Diamond DA20

## Conclusions

This year's efforts for the software team have laid a strong foundation for future software-rich features. This would include but is not limited to expanding autonomous navigation via NAV2, further Gazebo simulation improvements, and refined motor control for the operator.

We would like to thank the following individuals that helped us out throughout the school year:

- Our Software Engineer II and III professors Cody Anderson and Dr. Jingpeng (JP) Tang.
- Dr. George Rudolph for guiding this software team throughout the school year.
- Chan Song: Software Engineering II Team Member
- Max Ostler: Sophomore student that worked on ZEDX camera and the image recognition library.
- Jacob Moore and Gabe Snow: BYU students with ROS2 experience.

## References

[1]: https://www.mdpi.com/2073-4433/11/11/1238

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