CAR-SNOW CLEARING DRONE

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ABSTRACT

Manually removing snow from car windshields exposes people to frostbite and can be especially challenging for those with physical disabilities. This Major Qualifying Project (MQP) aims to make improvements to a drone designed one year prior to solve such problems. Unfortunately, COVID regulations restricted our access to campus resources and team collaboration. Despite these hurdles, this iteration generated a MATLAB simulation of the drone, improved the reliability of the spray bar, and began implementing a Real-Time Kinematics (RTK) system for precise navigation.

OBJECTIVES

In improving the drone, our team had four main objectives:

1. Fly in mild weather conditions while carrying a liquid payload.
2. Remove thin layers of snow from both windshields using an accurate spraying mechanism.
3. Minimize chance of damaging the surroundings, specifically the car, its windshields, or any passersby.
4. Make informed recommendations to future iterations of the MQP.

ASSEMBLY

FEATURES + IMPROVEMENTS

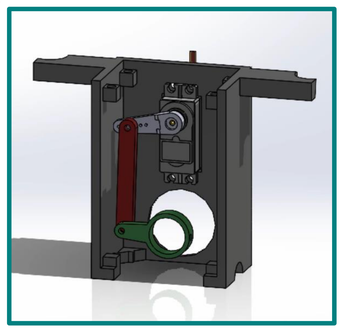
-1200 mm diagonal	28-inch propellers	190 kV brushless motors
Pixhawk 4 flight controller	Two-DOF spray bar	Three 110-015VP Nozzles
5-liter solution tank	IR camera	RTK system
	20-inch radius propeller guards	

DESIGN

MECHANICAL IMPROVEMENTS

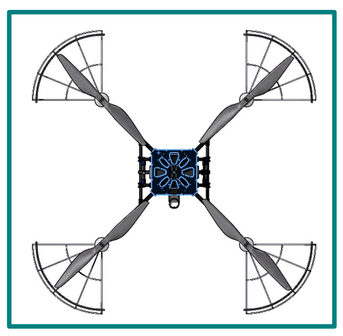
Spray Bar Actuation

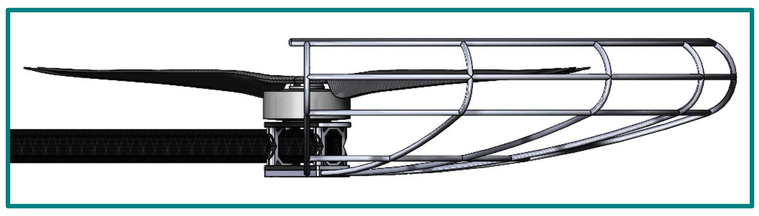
- JX Servo-driven linkage turns sprayer.
- Assembly is 3D-printed from ABS plastic for rapid iteration.



Propeller Guard Development

- Wire-bent cages encase the propellers.
- Attached to the same base structure as the blades.

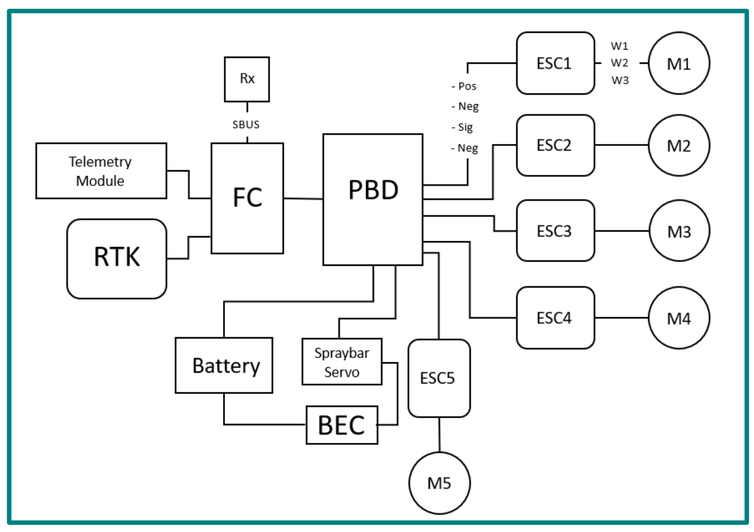




ELECTRICAL IMPROVEMENTS

RTK-Pixhawk Integration

- Real-Time Kinematic (RTK) system interfaces with Flight Controller (FC).
- Configured using u-blox software.



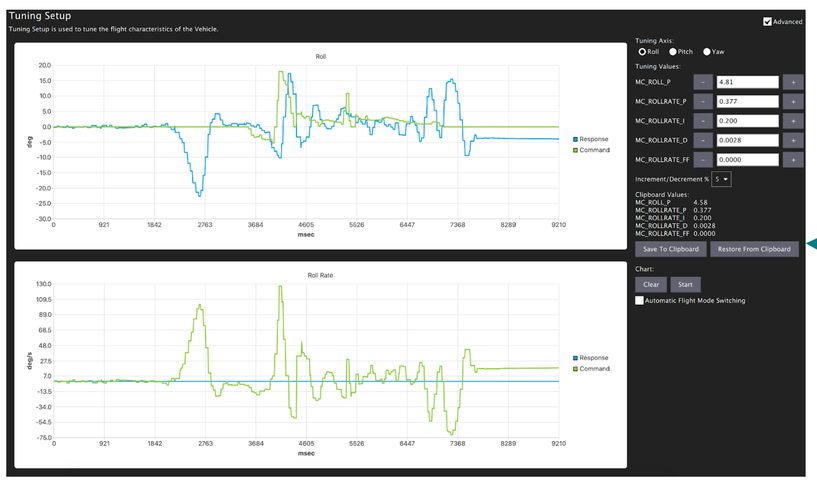
Battery Eliminator Circuit

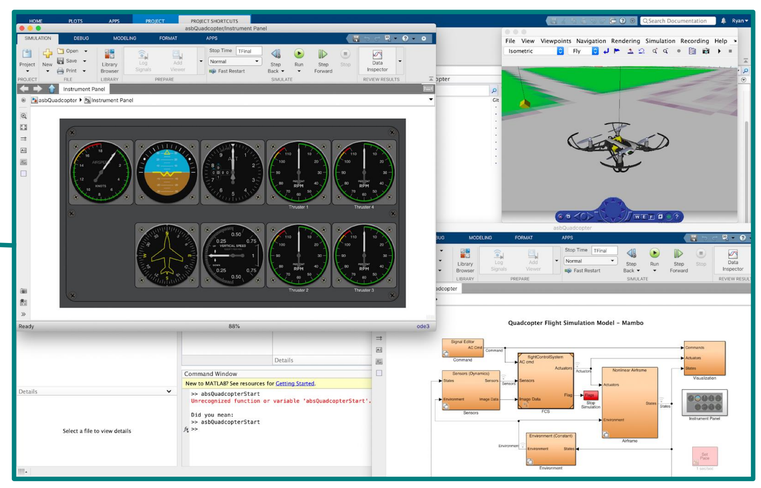
- Powered spray bar servo, eliminating need for second 5V power supply.

SOFTWARE IMPROVEMENTS

MATLAB Flight Simulation

- Aerospace Blockset and SolidWorks were used for initialization.
- Linearized control system and used the model to iteratively find optimal gains.





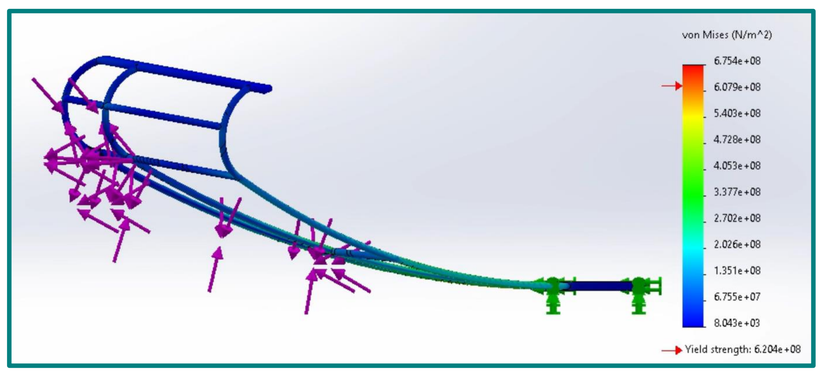
RESULTS

SPRAY BAR EFFICACY

- Servo produces optimal 60° spray bar rotation.
- 3D-printed bearings reduce torque.
- Housing flanges prevent unwanted rotation.

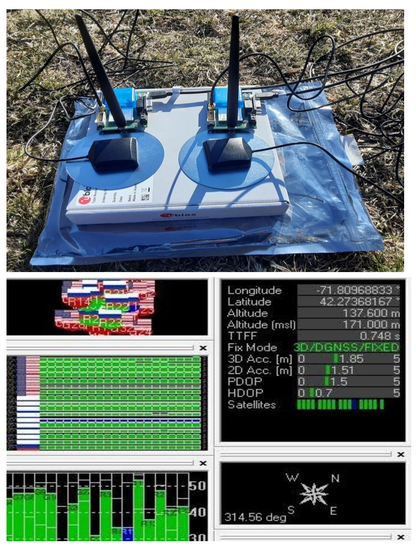
PROPELLER GUARD STATIC ANALYSIS

- FEA analyzed stress and deformation on the propeller guards with a thrust force of 66.25 N.
- Minimal deflection shown on guards.



DRONE LOCALIZATION + SIMULATION ACCURACY

- RTK base station precisely detects changes in rover's longitude, latitude, and altitude. →
- Inaccurate MATLAB simulation was remedied through manual tuning of test flights. ↓



RECOMMENDATIONS + CONCLUSION

- Drone received comprehensive improvements, and individual components were tested in accordance with project goals.
- Future teams should expand on automating snow clearing of a car, attach RTK to drone and connect to its flight controller, build upon safety systems, and find optimal spray nozzles to effectively clear snow.