# UAVs for Space Exploration:

## Recover and Rescue Operations

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Introduction:

As methods of space exploration continue to progress it has become evident that drone exploration is the most efficient way to explore foreign planets. However, what happens when one of these drones becomes no longer operable? A plausible solution would be to send drones out in pairs (one flying and one ground-based). Each robot will have to have advanced programs such as computer vision, the ability to ping one another, and the ability to find and repair each other. This method would allow packages of drones to be sent to planets and upon termination of operation or a loss of signal to find and repair each other, saving exploration missions and extending mission time. This research project aims to create a program that allows a UAV to find it's terminated ground-based counterpart.

Overview:

This project and it's subsequent simulations ran through multiple methods of finding a ground-based rover via a C++ program that searches for the rover using computer vision and then landing to rescue said rover (Fig. 2) with a UAV (Fig. 1). Programs such as these will allow current and future missions to other planets to continue to run even if a rover becomes damaged while conducting research. This program was written using software and libraries that NASA utilizes in the process of programming their rovers for space exploration. Overall, if NASA were to utilize these programs in future space missions, drones could work in pairs to explore planets and answer the questions of what lies beyond.

FIG 1

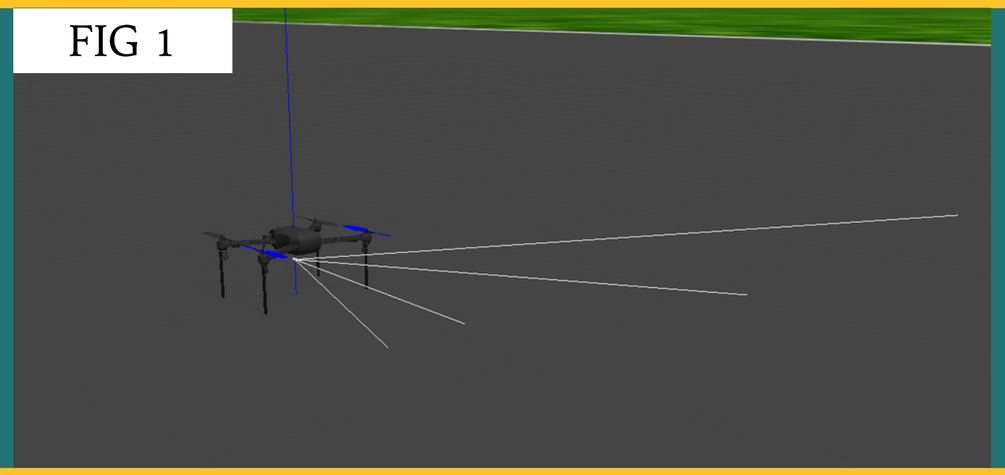
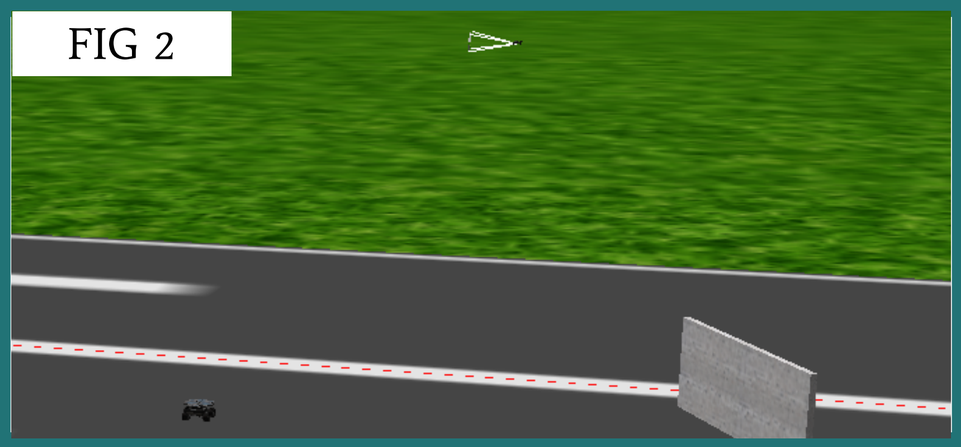


FIG 1: This figure shows the designed UAV (quad-rotor drone) in Gazebo software.

Fig 2.: This figure shows the C++/ROS Program in action, as the UAV locates the afflicted rover (behind cover) and begins descent for rescue mission.

FIG 2



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Method:

These simulations were run via a Virtual Machine on Ubuntu Linux 18.04. The Robot Operating System (*ROS*) software that NASA utilizes was used to program the UAV to carry out commands such as takeoff, search, and locate the ground-based drone. From there, Gazebo was used as a Graphical User Interface (GUI) to visualize the simulations. While Gazebo is launched the first-person and third-person view of the UAV can be used to view the UAV's general location and progress (third-person) and the UAV's computer vision/built-in machine learning software that locates any obstructions, and eventually the drone in distress (first-person).

Conclusion:

This program is the first step of many towards programming drones to carry out space exploration on behalf of the human race. Creating drones that have the ability to repair each other could be very beneficial and cost-saving in future space exploration missions. Programs such as these could be designed for future use in similar fashion for finding injured personnel, resources necessary for population, and potentially life on other planets.

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