

Development of a Outdoor Mobile Manipulation UAV to Remotely Sense and Collect Environmental Data

Kye Morton¹, and Felipe Gonzalez²

¹ Queensland University of Technology, 2 George St; Brisbane, QLD 4000,
kye.morton@hdr.qut.edu.au

² Australian Research Centre for Aerospace Automation, 22 Boronia Rd, Brisbane Airport
QLD 4009, felipe.gonzalez@qut.edu.au

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Abstract:

There is a growing interest to autonomously take gas samples, images, collect or manipulate objects in remote or unknown environments, such as pipes, mountains, gullies, bush-land, or rough terrain. There are several limitations of conventional methods using manned or remotely controlled aircraft. The capability of small Unmanned Aerial Vehicles (UAV) used in parallel with robotic manipulators could overcome some of these limitations [1]. By enabling the autonomous exploration of both naturally hazardous environments, or areas which are biologically, chemically, or radioactively contaminated, it is possible to collect samples and data from such environments without directly exposing personnel to such risks [2,3,4].

This paper discusses the preliminary advancements of an Outdoor Mobile Manipulation Unmanned Aerial Vehicle (MM-UAV). Discussed is the use of a modular framework for such an MM-UAV, as well as the initial attempts at various in-flight manoeuvres for image collection of the inside of a pipe, and retrieval of a known specimen. The MM-UAV was tasked to perform an internal inspection of a drain pipe.

The MM-UAV utilizes a DJI Flame Wheel 550 Airframe with a custom developed robotic manipulator [5]. The platform uses multiple methods for outdoor localization (Inertial, GPS and optical flow) to maintain position while the manipulator is autonomously operated. A camera is positioned on the end effector to collect images of the internals of the drain pipe, with light emitting diodes to provide sufficient lighting. The images are transmitted live to the Ground Control Station (GCS) over a 2.4GHz link to allow for further processing. The GCS maintains a telemetry link to monitor the status of the MM-UAV, while also allowing the operator to give general operational commands. The commands sent from the GCS were specified as a position at which to hold (latitude, longitude, and altitude), and a relative position to this position that is the target for the manipulator (X, Y, Z, in meters). All on-board functionality outside of these inputs was determined on-the-fly, with no input from the operator. The MM-UAV utilizes an Odroid U3 for the on-board processing with a combination of the Robotic Operating System and a Pixhawk Autopilot managing the platforms autonomous functions. Figure 1 demonstrates the manipulator moving to the inspection position.

The results obtained from the first test act as a reference for the application of using the mobile manipulation platform to perform advanced monitoring tasks, namely, performing an internal inspection of a drain pipe. Further uses would include automatic recognition of specimens to be collected for off-site analysis.



Figure 1. Demonstration of an in-flight manipulation.

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