Cartography with drones and MDRS drone monitoring

The pertinence of the use of drones in a space mission

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Abstract

This report presents two research projects to be carried out at the Mars Desert Research Station (MDRS) in March 2018. These projects are mainly related to the use of drones in the difficult environment of a space mission simulation. A first study will establish a detailed and interactive mapping of the area near the research station.

The second project is related to the role of the crew engineer during the mission. The use of a drone could make its missions more efficient and fast. The objective is to evaluate the relevance of the use of drone to carry out certain control tasks and to establish a procedure for the missions of the engineer.

Figure 1: Drone DJI Phantom that will be used during the mission. Source : https://dji.com

1 The projects

Geomatics with drones

The first project involves the use of a drone in the field of geomatics for a mission at the Mars Desert Research Station. Establishing a detailed and interactive mapping of the environment close to the station is a relevant objective. Indeed, it is possible to carry out efficient and secure missions by knowing the relief, the gradients and the zones of interest of the surface of Mars.

The combined use of drone (Figure 1) imaging and satellite imagery provides a complete mapping. The satellite images give an overall and coherent view of a relatively large area. The photos taken by drones are more detailed and give additional information. These data will be digitally processed in order to obtain a complete map of the area surrounding the MDRS.

MDRS drone monitoring

The crew engineer function could be made more efficient by using drones. The crew engineer is responsible for the maintenance and integrity of the research station. Therefore, we will study the relevance of drone's use in the monitoring and maintenance of the station.

The objective of the project is to evaluate the utility of drones to access unreachable areas and to take photographs to ensure the integrity of the base. We will analyze the feasibility of such a project in the difficult conditions of a space mission on Mars. What equipment is needed, which functions are "drone-compatible", what are the limits of such a procedure? Drones could avoid unnecessary extra-vehicular activities (EVAs) for the engineer and therefore remain a maximum in the simulation. This could also speed up and systematize the maintenance of the station.

2 Objectives and motivation

The common objective of these two experiments is to evaluate the relevance of the use of drones for a Mars mission. These experiments may be useful for such a simulation for several reasons.

First, the technology in the field of drones is advancing rapidly and their usefulness is becoming more and more evident. It is even more evident in the field of space exploration. They provide access to areas that are not accessible to humans. Their size and lightness are optimal to be easily transported. Finally, their camera takes pictures that are impossible by other means and the processing of the collected data is easy. It is likely that the next lunar or Martian missions will use these drones intensively for exploration missions.

The Mars Desert Research Station provides an ideal environment to test procedures by drones in a rough environment: total isolation, limited outdoor missions, rough terrain, temperature, lack of support technique ... These conditions are close to those of a space mission and will provide relevant results in the exploration of Mars.

3 Experimental plan

The two projects described will follow a rigorous implementation plan, a provisional version is listed below.

3.1 Cartography

Before the start of the MDRS mission

Before arriving at the MDRS, several tasks must be carried out. Firstly, a collection and synthesis of the data collected by the crew UCL to Mars 2017 (Crew 178) will be made. After a first treatment of these results, we can delimit the exact mapping area and consider areas for improvement.

Secondly, a detailed schedule of the EVAs with or without drone will be written considering the autonomy of the drone (20-30 min) and the charging time. For each outdoor activity, the zone to be processed will be delimited according to a mesh and the approximate time will be evaluated.

At the MDRS

First, the mesh of photographs will be refined according to the reality of the field on the spot. Any inconsistencies between the plan defined upstream and the ground will have to be dealt with before the start of operations.

Following the schedule, we will go outside the base with our spacesuits to take the necessary shots in the predefined areas. These EVAs will also make it possible to take punctual and manual measurements on certain control points.

The image processing phase by GIS software (ArcGIS, Virtual Terrain Project, see Figure 2) is also carried out during the mission. It consists in combining the different images to establish the detailed and interactive map.

Using both types of data, altitude and terrain can be determined for the search area.

3.2 MDRS drone monitoring

Before the start of the MDRS mission

The first step will be the establishment of an exhaustive list of all the tasks performed by the crew engineer during a mission at the MDRS. These missions include the control of various tanks, repair of damaged systems, etc.

Following this first list, we will choose the tasks that will be most likely to be "drone-compatible" and that will be tested during the mission. For example, visual inspection of a system would be more relevant than a heavy repair.

Finally, we will carry out a schedule of tests for these tasks taking into account the daily check-up of the engineer as well as the capabilities of the drone.

At the MDRS

During the mission, the engineer makes a daily check-up of the systems that equip the base:

- Outside: check the water and fuel levels in the different tanks, refuel ATVs, control the telescope and the greenhouse.
- In the station: check the correct functioning of the various electromechanical systems and devices of the base. According to the schedule, tests will be carried out on some of these control missions with the drone. A daily report of the state of the station is written and must be sent to the Capcomm. A parallel report will describe the results obtained regarding the use of the drone for the missions carried out, it will include the gains made by the drone, the limitations observed and the areas for improvement.

4 Results and perspectives

This first report presents the prcess of the research projects to be carried out at the MDRS. A global vi-

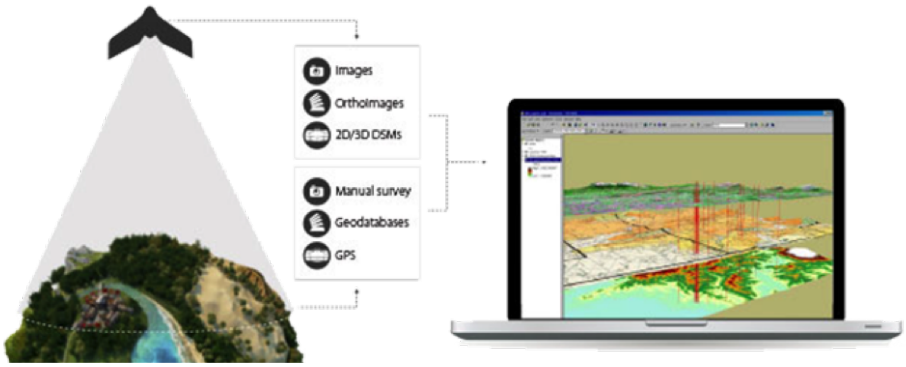

Figure 2: Drone GIS workflow. Source: https://www.sensefly.com/applications/gis.html

sion of the 2 projects has been described. The technical and practical aspects of the experiments were also briefly described.

The two experiments have in common to be pragmatic and deliver results directly applicable for the next crews while drawing inspiration from what has already been done.

For the geomatics experiment, the result will be a detailed and interactive map of the base and its direct surroundings. The MDRS drone monitoring experiment will establish a drone-compatible task list with recommendations and an operating procedure for crew engineer's missions. The results will also confirm or deny the relevance of drones in the context of space missions. The critical analysis that will be made may be the subject of subsequent documents and reports.

5 Equipment

The necessary equipment includes

- 1 DJI Phantom drone
- A computer with the appropriate softwares (GIS, image processing, ..)
- (GPS / altimeter tag)

About the author

Bastien Baix has been selected as crew engineer of the team UCL to Mars 2018. Currently following a Master's Degree in Civil Engineering and Environment at the Université catholique de Louvain, he has a strong interest in drones and their applications in the field of civil engineering. His passion for space exploration led him to initiate 2 experiments related to the drones at the MDRS.