UAVs and Geophysics: The Way of the Future

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***Abstract*— In the modern-day advent of new technologies and methodologies in mineral exploration, agriculture, radioactive reconnaissance and remote sensing in general, geophysics has become more important than ever before in acquiring better data from the Earth's subsurface, thus resulting in a better understanding of the Earth we live on. This advent has yielded a somewhat predicted fusion in the way geophysical data is acquired, by combining the power of Unmanned Aerial Vehicles (UAVs) and smaller, more hardware-integrated sensing equipment. Traditionally, airborne geophysical surveys have been undertaken using large manned aircraft, whether fixed-wing or rotor-wing, typically with a crew of two or more. Safety and cost considerations very play in the cause and effect of this culture shift in the realm of geophysics, whereas drones are more capable of flying closer to the ground, have greater vertical gradients, require less power for flight, and most evidently, the nonnessecity of human collateral. Ultimately, drones should be, and to an extent is becoming, at least in geophysics, the way of the future.**

***Index Terms*— UAV, Geophysics, Mining, Agriculture, Airborne.**

I. Introduction

Unmanned Aerial Vehicles (UAVs) are increasing significantly in popularity in both the commercial and industrial senses. In the geosciences, airplanes and helicopters can be used to undertake geophysical surveys investigating the subsurface in search of resources such as minerals and water, and to monitor ground exploitation for agriculture. Aerial methods in geophysics is not new by any stretch of the imagination, however there are many sets of technological advancements that now allow for the miniaturization of these devices required to undertake surveys. This paper will discuss the benefits, and make an argument with the goal of presenting a possibly inevitable future in the geosciences that will exploit Unmanned Aerial Vehicle (UAV) technology in tandem with new miniaturized devices.

II. Traditional Methodology

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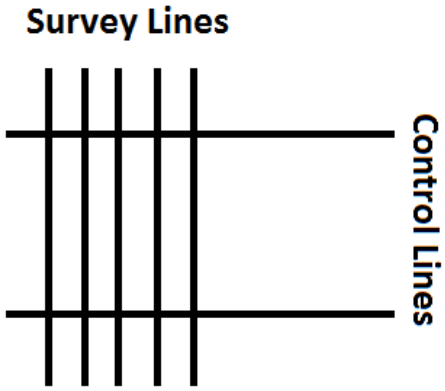

Fig. 1. Traditional **Survey Configuration**

The drawbacks of using manned aircraft can be numerous, however there are some main considerations. First and foremost, the safety of the crew members on board the vessel. The aircraft is operating lower than in normal flight operations, and the crew may be exposed to very rough terrain in very remote regions of the World. Another drawback of using traditional methods is the cost of operation. Given the number of crew members on board and considering their required skillset, there is a financial burden of employing staff, mobilizing them to the field, and other individual expenses potentially making up a large portion of the cost of performing a survey. These two considerations are reasonably the more malleable given the nature of the technological advancements that now exist in the realm of geophysics, and therefore an alternative, or multiple alternatives, can and have been developed to account for this malleability, creating an oasis for research and development in the desert of high cost and high safety concerns.

Another physical concern of manned flight is the vertical gradient allowance of fixed and rotor wing aircraft, which are 5% and 30% respectfully [1]. This can cause issues for very rugged terrain, such as the fjords in Norway, or the Rockies in the western part of North America. The altitude error can result in poor data being collected by virtue of a vessel too high above the ground surface to gather reasonably good enough data.

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III. From Manned to Unmanned Flight

Unmanned Aerial Vehicles (UAVs) have existed for several years now and are more accessible than ever to a consumer market. The availability of these vehicles has stirred innovation in airborne geophysics. Industrial and educational researchers are working on optimizing the use of drones in geophysics. A case in point is the work being currently undertaken at Carleton University in Ottawa Canada. One may refer to their current work by looking at the Carleton UAV Research Group website (http://2014uav.mae.carleton.ca/).

There are obvious benefits to using UAV technology in geophysical surveying. For now, we will focus on addressing the two drawbacks as presented in the prior section. For the matter concerning the cost of operation and executing an airborne geophysical survey, commercial drones are generally less expensive than manned aircraft, however this is only valid for smaller drones, and not the very large military grade ones [2]. Be that as it may, the relative excess cost taken on by having more sophisticated equipment is, to a variable degree, offset by the savings accrued by not having to hire on board crew for the UAV. Subsequently, the lack of human collateral on board the aircraft now means that the safety factor is significantly greater. This ultimately means that the aircraft can perform more risky maneuvers, and as a direct result of this, can have greater vertical gradient allowances compared to manned aircraft.

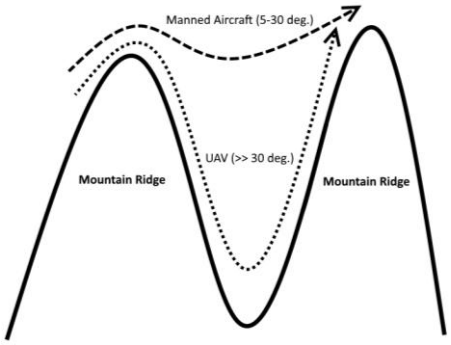

Fig. 2. Vertical gradient of a UAV versus a manned aircraft in a mountain ridge, modified from (Salman, 2016).

The use of drone technology for such undertakings requires heavy scrutiny, and rightfully so, to assert the feasibility of its performance in the field. A reasonable concern in field work is the endurance of the drone, and how many line kilometers can be flown per flight, as in, "how much production per unit time is ultimately achieved?". While smaller/lighter drones require less thrust from the engines to produce lift, it is also regretfully the case that these drones are equipped with smaller batteries, or smaller fuel cells resulting in shorter flight times, and ultimately lesser line kilometers flown per flight.

IV. New Technologies and Their Drawbacks

Additionally, to the concerns of flight operations of the UAV itself, the geophysical technology that has been miniaturized to satisfy the payload criteria of the UAV is still short of delivering full capabilities given the sacrifices made to the accuracy, or even depth of penetration for active systems, such as electromagnetism. For mineral exploration, the equipment requires more development, thus rendering the equipment currently useless, hence companies are still forced to use manned aircraft to conduct the geophysical surveys. For agriculture, gamma ray spectrometry can be used to estimate soil moisture and soil composition, however, the accuracy of the measurements can decrease as the UAV systems are generally smaller than what is typically used on manned-aircraft.

V. Conclusion

In conclusion, using droneborne technology and geophysical methodologies to accomplish surveys investigating the subsurface of the Earth is not only a realistic thought, but one that has been applied and has produced convincing results that push for more research to advance the use of such combination of small devices and UAVs. Addressing the core issue of the importance of using UAVs in geophysics is just the tip of the iceberg, and still requires much development to yield an efficient, safe, and profitable method to execute airborne geophysical surveys, and this brief overview has presented why it is very reasonable to believe that using UAVs alongside geophysical technology is the way of the future.

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