Evaluation of a UAV-enabled Magnetometer for Geophysical Survey in Volcanic Areas

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We have been developing a drone magnetic survey system for geophysical survey in volcanic areas these years. At the initial stage, we developed such a survey system with a portable Cs magnetometer though it is relatively heavy (4 ~ 5 kg). Through the experiences of practical tests in volcanic areas, we learnt difficulties to fly such a system using a drone in a stable attitude mainly from its weight.
Recently a UAV-enabled magnetometer "MagArrow" has been developed by Geometrics, USA. This is an innovative laser pumped Cesium vapor magnetometer based on MEMS technology. The system comprises internal electronics including two Cs sensors, GPS and IMU in an aerodynamic carbon shell and works at a sampling rate of 1 kHz. It weighs only around 1 kg and is suitable for UAS surveys.
In 2019, we introduced the system to conduct some practical tests of the magnetometer for geophysical survey in volcanic areas. First, we confirmed a necessity to get meaningful measurements by averaging signals at a sampling rate of 1 kHz. We also made a rotational test on a plate to confirm the system's directional error with an amount of ±5 nT. The system was hung from a hexacopter, PRODRONE PD6-AW2/PD-FC1 on which a differential GNSS receiver and its data logger were additionally installed. The payload of the drone (8 kg) is big enough to accommodate both a MagArrow (1 kg) and the additional equipment (1.65 kg).
Some preliminary tests flights were conducted beforehand in drone parks in Fukushima and Ibaraki Prefectures, north of Tokyo. It took some time to find a suitable way how to hang the MagArrow from the drone since it has been turned out that the system is susceptible to wind probably because of its shape and light weight. We found a compromise procedure to make the system's flying attitude more stable. Then, we applied the system to test flights inside the caldera of Izu-Oshima Volcano, south of Tokyo. Unfortunately, many typhoons attacked Izu-Oshima Island in 2019, causing difficulties in surveying on calm days with a wind speed less than 2 m/s. Because of the harsh weather, the flights covered only a half of the provisional survey area. However, the system itself worked well to observe total magnetic field with a precise positioning by the differential GNSS receiver.

Keywords: magnetic survey, drone, UAS, drone magnetic survey, volcano, Izu-Oshima volcano

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