Sea ice surface morphology imaged with UAV and SfM-MVS photogrammety

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Measurement of sea-ice thickness is important for the monitoring of global environment change and navigation in ice-covered seas. However, the resolution of remote sensing is insufficient to detect the distribution of sea ice thickness in a local scale. On the other hand, field survey techniques such as drilling and electromagnetic induction device require labor and cost, being not suitable for widerange or repeated measurements. Recent technical advances of Unmanned Aerial Vehicle (UAV) and Structure-from-Motion Multi-View Stereo (SfM-MVS) photogrammetry enable the generation of low-cost Digital Surface Model (DSM) covering hundreds of meters aquare with an accuracy of cm units. We applied UAV and SfM-MVS photogrammetry to image sea ice surface morphology on the coast of Qaanaaq, NW Greenland. UAV flights for aerial photography were performed from 15th to 19th March 2018 under the condition of −34 to −25 degrees. The UAV contorolled by an automatic navigation application navigated 100 m high from sea ice surface at 13 km/h and photographed at intervals of 10 seconds. The UAV system experienced battery degradation due to extremely low temperature condition despite flight time per flight was restricted to 15 minutes. In addition, large magnetic dip peculiar to high latitude often caused compass error during UAV flight. These troubles were improved by enough battery warming and compass calibration before each flight, and a total of 941 aerial photographs covering an area of 1.3 km^2 were acquired for 5-days fieldwork. SfM-MVS photogrammetry ties these photographs characterized by white by snow cover and produces high-resolution images of sea ice surface morphology including deformed ice and icebergs (Fig. 1). Position errors at check points in the SfM-MVS images are up to several decimeter, which are enough small to estimate the height and volume of icebergs above sea ice surface (Fig. 2). As it is apparent that the position errors are mainly derived from the shortage of control points and inaccurate GNSS positioning in the field, improving these problems will enable to quantify detailed sea ice surface morphology.

Figure 1. Image of icebergs produced by SfM-MVS.

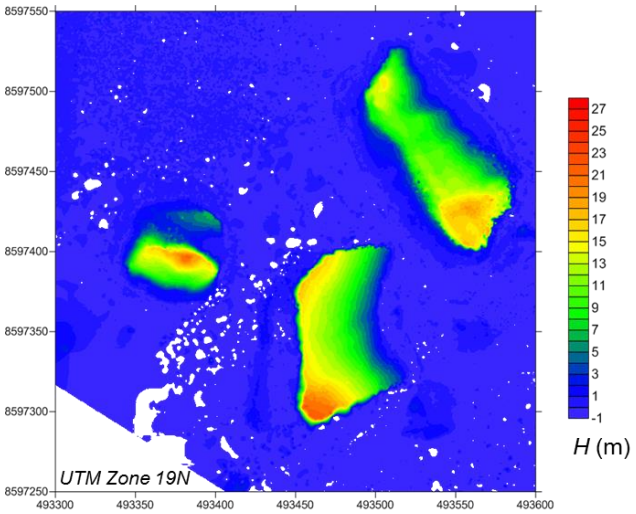

Figure 2. DSM of icebergs.