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Potential of Employing a Machine Learning Model for Glacier Motion Monitoring

Magdalena Łucka, Ryszard Hejmanowski, and Wojciech Witkowski
AGH University of Krakow, Faculty of Geo-Data Science, Geodesy and Environmental Engineering

Monitoring marine-terminating glaciers and their dynamics in the light of advancing climate change is a critical concern for many scientists. Observing marine-terminating glaciers in Greenland is especially significant because glacier calving and melting influence sea level. One component of glacier monitoring is velocity estimation, which can also be used as an indicator of climatic change and may reveal the existence of other underlying processes that cause speed changes on the surface. Using SAR images, this type of monitoring can be done permanently and at a minimal cost. However, present approaches that focus on offset-tracking algorithms have some disadvantages. Despite the rapid development of artificial intelligence, there is still some immense potential in the synergy of SAR datasets and machine learning models to determine rapid displacement, such as in the case of glaciers. This study demonstrates the feasibility of determining glacier displacement using Sentinel-1 satellite SAR information and convolutional neural networks (CNN).

The method proposed in this study uses pairs of SAR data to find the matching patterns on both images. The CNN with the AlexNET architecture is utilized to discover the corresponding areas, and data augmentation techniques such as rotation, filtering, or resizing of the SAR image are employed to extend the training dataset. Finding the appropriate areas on both images allows for the calculation of the displacement in radar coordinates, as well as the mean velocity and direction of the movements over the investigated period. This study examines the proposed method's results for two Greenland glaciers with varying speeds: Jakobshavn and Petterman. Furthermore, two different input datasets are evaluated and compared. The first strategy simply employs the amplitude obtained in HH polarization, while the second uses amplitude information from HH and HV polarizations, as well as the backscatter coefficient. Displacement values obtained for both glaciers and using various input datasets are compared to the velocities collected using the offset-tracking approach, which is extensively used for glacier monitoring.

The potential of using machine learning models to determine glacier displacement values utilizing SAR datasets is presented in this study. The results' reliability is further validated by comparison with well-known processing procedures. In addition, different input datasets are examined for two glaciers with different dynamics to determine the utility of the proposed approach for monitoring glacier motion. The proposed method's adoption could benefit glaciological society by providing an alternate method for detecting ice motion.