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Using EisNet to Extract Bedrock and Internal layers from Digital and Analog Radiostratigraphy in Ice Sheets

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The radar detection of bedrock interface and internal ice layers is a widely used technique for observing interiors and bottoms of ice sheets, which is also an important indicator of inferring the evolution of glaciers and explaining subglacial topographies. The conventional methods, such as the filtering denoise, are limited by the low contrast in ice radar image with noise and interferes and thus the automatic method in tracing and extracting layers' features is trapped. The manual and semiautomatic methods are widely applied but with large time-consuming especially for the large-scale radar image with continuous bedrock and internal layers. To extract and identify the bedrock interface and internal ice layers automatically, we propose EisNet, a fusion system consisting of three sub neural networks. Because of the limitations of conventional manual methods, it is relatively rare that the high-precision extraction of layer features, which can be applied as labels in training. To obtain sufficient radar images with high-quality training labels, we also propose a novel synthetic method to simulate the not only visual texture of the bedrock interface and internal layers but also the artifact noise and interference to match the feature in field data. EisNet is first verified on synthetic data and shows capacity on the extraction of multi types of layer targets. Second, the application on observational radar images reveals EisNet's generalized performance from synthetic data to the CHINARE data. EisNet is also applied to extract bedrock interfaces from the radar film from the Antarctic. EisNet is now open open-accessing. We hope that EisNet could be applied in more ice radar images from other regions and different forms to promote glacial research.