Layer Detection in Radar Sounder Images

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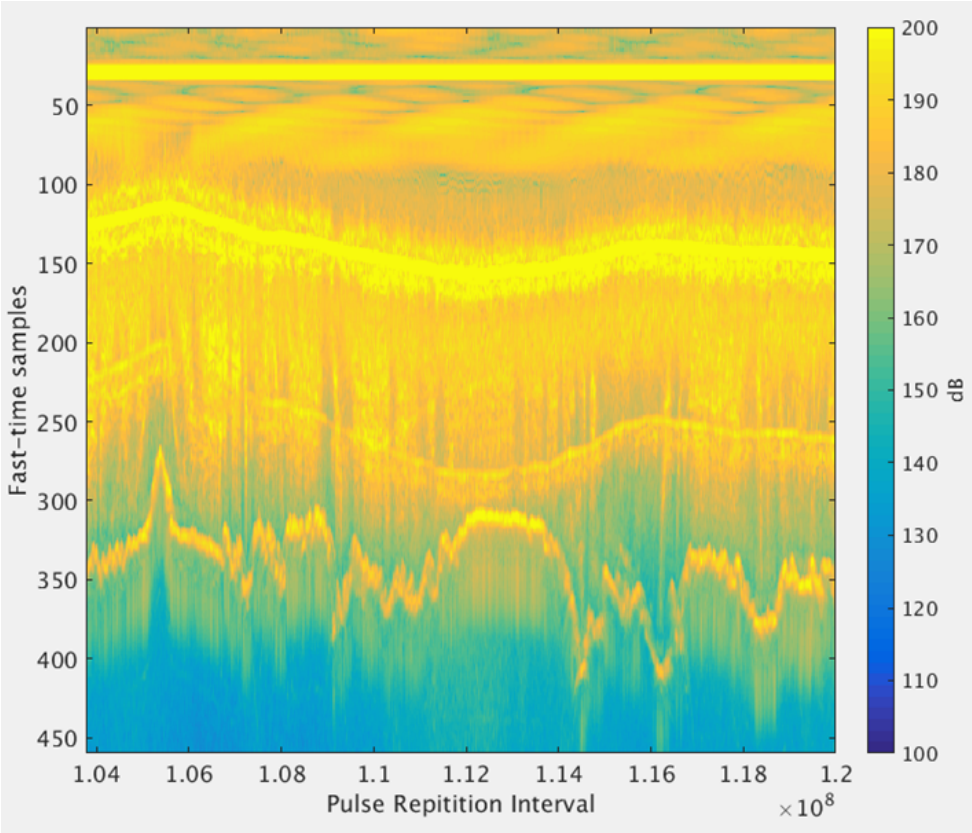

Motivation
In an era of higher temperatures and thinning ice sheets, understanding Earth's polar regions is increasingly important. To better predict the response of sea levels to this change, many scientists have modeled glacier responses. However, these models are poorly constrained because of limited understanding of boundary conditions at the bedrock of the glacier. Whether a glacier sits on frozen bedrock, loose glacial till, or a layer of thawed water significantly impacts that glacier's rate of change.

To better understand subglacial conditions, researchers have conducted hundreds of thousands of kilometers of radar surveys. Although these surveys have succeeded in mapping subglacial topography, much work remains in understanding englacial processes and subglacial conditions. One prerequisite for analyzing radar surveys is identifying features (e.g.., surface, bed, englacial layers) from the radargrams. Identifying these features (often referred to as

“picking”) is time consuming and can require hundreds of person hours, even with layer tracing GUIs designed specifically to facilitate this task.

Goals

We propose applying image processing techniques to identifying surface, bed, and englacial layer features. We will first work on identifying the surface (ie air-ice transition) because this is the brightest signal. We will then proceed to identifying the bed (ice-ground transition) because this return has the highest scientific usefulness. The surface return is associated with ghost reflections at a lower apparent depth (due to internal reflections), so detection of the surface return will decrease false positive recognition of the bed. As a stretch goal, we will attempt to recognize internal layers, which are the dimmest features.

Dataset characteristics

We have access to thousands of kilometers of synthetic aperture radar (SAR) surveys collected by the University of Texas at Austin and the British Antarctic Survey during the 2004/2005 survey of West Antarctica’s Amundsen Sea Embayment. We have access to processed radargrams, which already have human-verified bed and surface picks. The radargrams are available in log-detected magnitude form (analogous to a grayscale image), as well as post-processing complex samples.

Techniques

We will use image processing techniques including linear filtering (particularly band pass filtering as in [1]; edge detection, such as a Canny edge detector or a Hough transform as in [2]; and layer tracing as in [3]. We will also consider supervised machine learning techniques. We will not use an Android device.

References

[1] https://live.ece.utexas.edu/publications/2010/gjf_ssiai_may10.pdf
[2] http://www.mdpi.com/2072-4292/10/1/43
[3] https://www.igsoc.org/annals/55/67/t67A048.pdf