Automated analysis of ice properties from glacier borehole images

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Optical televiewing provides a continuous, true-colour, orientated 360° optical image of a borehole wall. The recent application of this technology in ice boreholes has yielded far more detail relating to the internal structure of ice masses than has been previously available using traditional borehole TV video or acoustic televiewers. From the optical televiewer logs, which are allied to true orientation, the dip and strike of each planar structure that intersects the borehole can be calculated.

We present a number of methods which aid the user in the annotation and analysis of glacier borehole images by automatically detecting layers and inclusions present in borehole image logs. The techniques used include a modified version of the Canny Edge Detector to highlight edges in the image, and a number of edge processing and fitting algorithms to extract sinusoidal layers from these edges. Active Contours have also been used to provide a semi-automatic inclusion detection tool. These techniques have been implemented as part of a software tool designed to allow the manual and automatic annotation of borehole features. A Genetic Algorithm has also been developed as part of a separate tool which allows for the fine tuning of parameters in the above algorithms. Results to date have shown good correspondence with manual operators in terms of layering and inclusions present in borehole images from a number of ice masses including Dronning Maud Land, Antarctica; the NEEM deep borehole, Greenland; Midre Lovénbreen, Svalbard; and Tsanfleuron Glacier, Switzerland.