OBTAINING 3D MODELS OF PENITENTES WITH AN XBOX KINECT SENSOR

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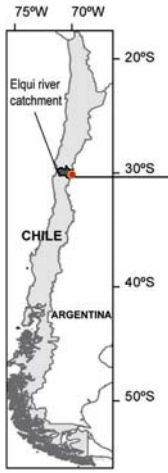
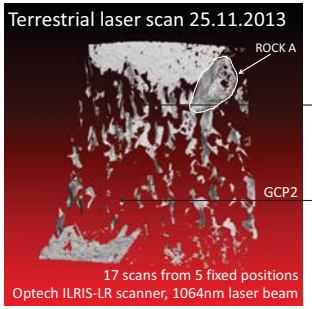
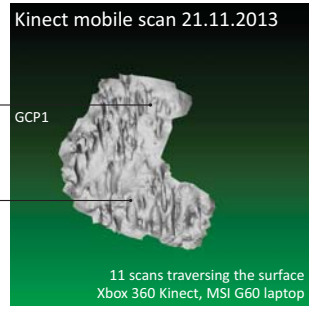


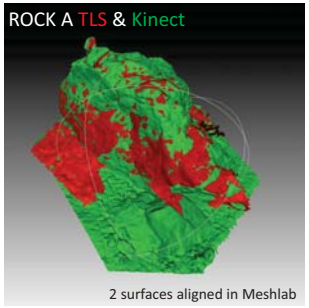
Penitentes are snow or ice spikes up to several metres high.

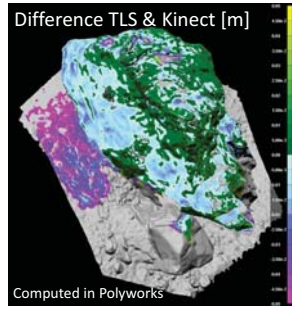
They are common in the semi-arid Andes as their formation is favored by very low humidity, persistently low temperatures, sustained high solar radiation and low latitudes.

How can we measure volume changes on such surfaces in order to evaluate the performance of runoff models used to predict hydrological resources in the area?









While the long range terrestrial laser scanner (TLS) can cover a much larger area, it is restricted by its viewing angle and even scanning from a vantage point onto snow penitentes in a stream bed, the Kinect has the advantage of mobility which enables the whole surface to be scanned.

Comparison of the TLS and Kinect data on a static subject such as this rock shows that the differences where mesh data are available in both data sets is within 2cm. This includes error associated with mesh alignment as well as the native error in both instruments.

Can an Xbox Kinect sensor be used to map the surface topography through time?

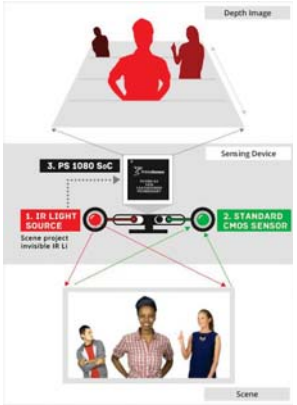
Sensor emits a pattern of dots by infrared (IR) beams & records the pattern with an IR camera.

Distortion of pattern is used by onboard software to generate depth map.

ADVANTAGES:

Using tracking software the sensor can be moved around the complex topography of the penitente field to cover the whole surface.

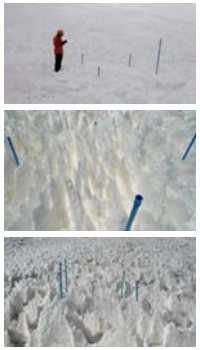
→ Used ReconstructMe ™ software to give real time feedback of surface meshing.

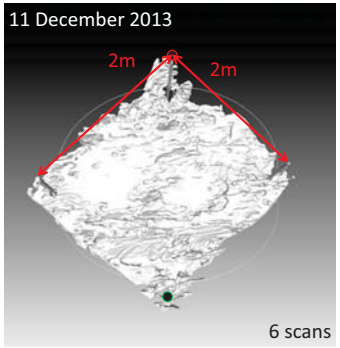


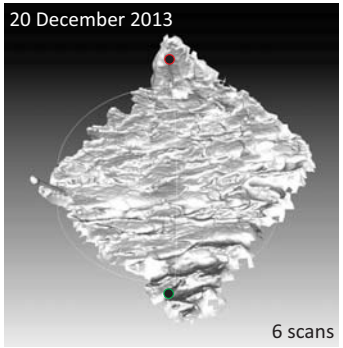
DISADVANTAGES:

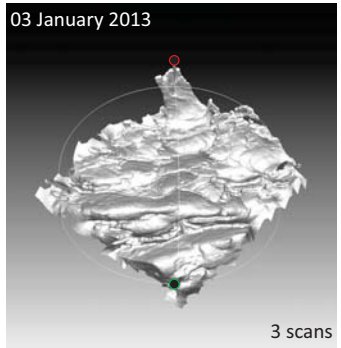
Needs low light conditions, has limited range and needs steady motion to maintain tracking – all pose difficulties on a glacier.

→ Scanned after dusk
→ Need to stitch many small scan parts to cover the sampled site if tracking lost









Kinect surface scans were aligned by picking pairs of points in each scan in Meshlab and running an ICP algorithm. This results in surfaces that capture all the metre-scale relief of this sample plot of penitentes.

Alignment of multiple scans introduces error. Alignment is better if (i) there is significant overlap between scan sections and (ii) the edges of the scan sections where noise increases can be discarded.

Next steps are to (i) georeference the surfaces to allow the first detailed mapping of penitente morphology with respect to solar geometry, and how the morphology changes through time (ii) compute geometrical surface roughness lengths for various wind directions over the penitente field and (iii) compute volume change between dated surfaces to provide a dataset for evaluating the performance of snow and ice ablation models over these surfaces.

The conclusion is that the Kinect sensor can be used to map small scale morphology on glaciers with applications for determining roughness length and its change in time. However, as this field is developing rapidly alternative structure sensors or structure-from-motion photogrammetry may prove more practical.