MOSAICKING DEEPWATER AUV PHOTOGRAPHY
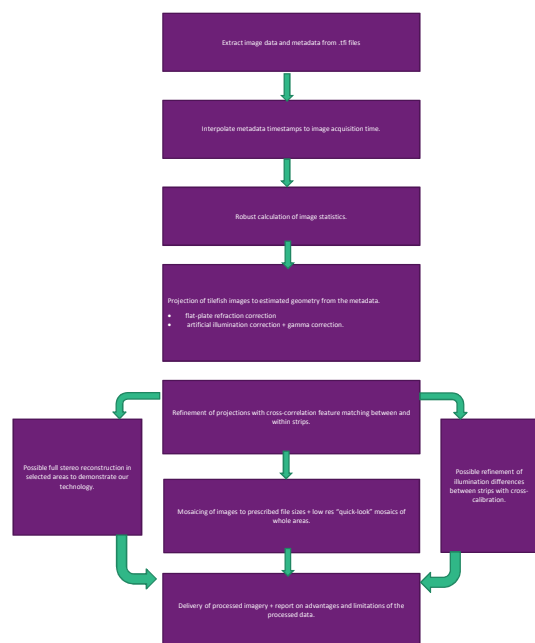
DATA 61

CSIRO

Geolocation, illumination and refraction correction of very deep underwater photography.

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The Kongsburg Hugin Autonomous Underwater Vehicle (AUV) is capable of employing a variety of different instruments at extreme depths of 4000m or more. High resolution, monochrome Tilefish Camera imagery from the Hugin is subject to effects from artificial illumination, image distortion due to the flat glass viewing port and navigational uncertainty at very large depths. We address those issues to produce seamless, well registered photographic mosaics.

Workflow for Tilefish Processing

Extract image data and metadata from .tfi files

Interpolate metadata timestamps to image acquisition time.

Robust calculation of image statistics.

Projection of tilefish images to estimated geometry from the metadata.
- flat-plate refraction correction
- artificial illumination correction + gamma correction.

Refinement of projections with cross-correlation feature matching between and within strips.

Possible full stereo reconstruction in selected areas to demonstrate our technology.

Possible refinement of illumination differences between strips with cross-calibration.

Mosaicing of images to prescribed file sizes + low res "quick-look" mosaics of whole areas.

Delivery of processed imagery + report on advantages and limitations of the processed data.

Figure 2: Radial distortion caused by the refraction from the flat viewing plate cause's straight lines to bow outwards.

Flat plate refraction correction

The Hugin AUV has a flat glass plate that separates the Tilfish Camera from the surrounding ocean. As a result the imagery is subject to a radial distortion effect due to refraction. A mathematical model allows us to undo these effects.

Between strip cross correlation matching and final illumination cross calibration

Accurate geolocation at depths is difficult because the of signal corruption by the constantly moving water column. The strips can be adjusted so they match up by optimising the cross-correlation scores.

Finally, between strip illumination differences can be removed by matching the grey levels in the overlapping region between the strips.

Illumination correction

Deep underwater photography must be artificially illuminated due to the absence of natural light sources. This has the effect of creating a "hotspot" where the centre of the image is significantly brighter than the edge. The effect is obvious when the mosaic is produced because the grey levels do not match on the edges. We use a robust averaging technique to correct for this effect.
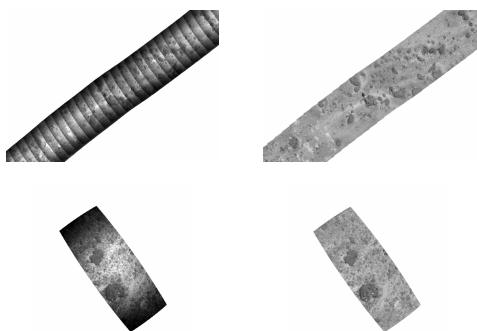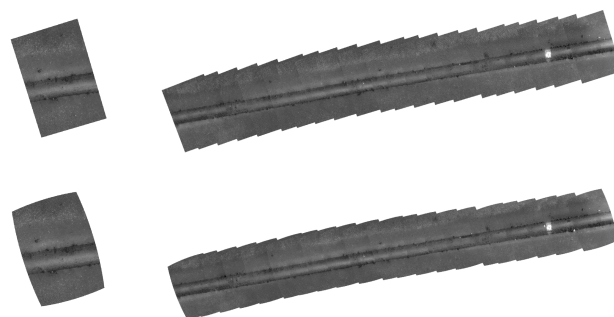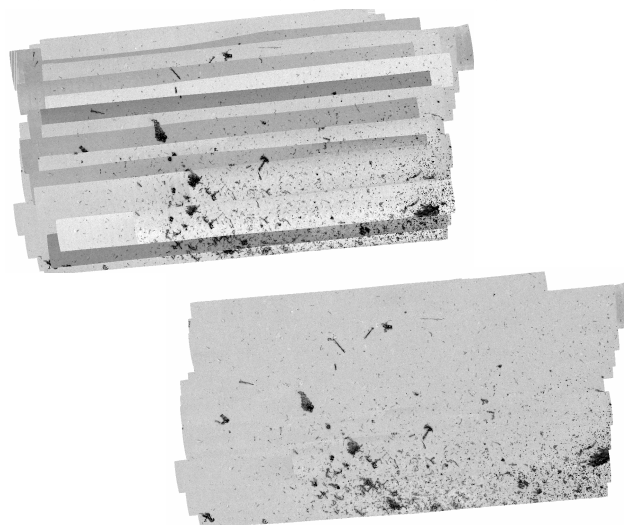

Figure 1: Illumination causes a noticeable brightness gradient from the centre of the image out.

Conclusion

A processing stream for creating seamless mosaics of very deep underwater photography provides a high quality product for qualitative or quantitative analysis.

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