

# Improving Image Area Estimation from a Deep Towed Camera System with a Flat View Port

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Australia's Marine National Facility vessel has recently taken delivery of a new deep towed camera system. The system is capable of being deployed to depths of up to 4000m. It was designed to provide vision of seabed terrain scaled with paired lasers. We have developed a method to scale the field of view and enable abundance (density) of benthic organisms to be estimated.

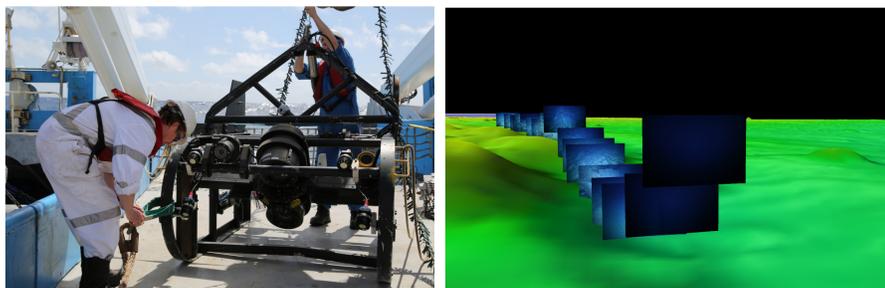


Figure 1: MNF Camera is prepared for deployment (left) Images after processing being viewed in 3D visualisation package (right)

## Camera System

The towed camera system is shown in Figure 1. The main imaging system consists of a Canon C300 high definition video camera paired with a Canon 1DX stills camera with a 18mm lens set at an oblique angle. Still images were taken every 5 seconds. All images were transmitted to the surface via a fibre-optic cable and recorded on ship-board hard-drive in real-time. A pair of lasers with a known separation distance (10cm) is used as a reference for scaling objects and aligning video and stills in time.

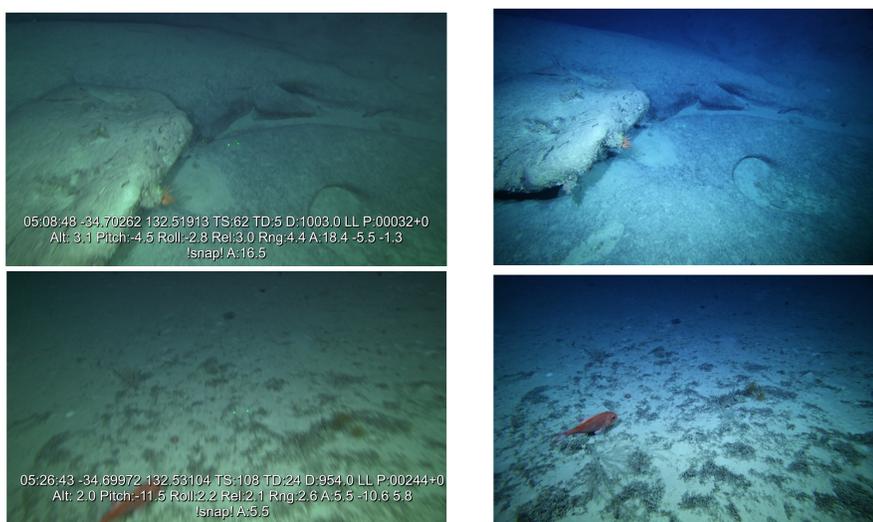


Figure 2: Comparison of video and still alignment: Rocky outcrop with corals, brisingid seastar and other fauna in cracks and on the overhanging edge. Depth: 1003.3m (top). Orange roughy and octocorals on dead coral matrix, partially covered by muddy sediments. Depth: 953.8m (bottom) at Adam's Apple Seamount, GAB

## Sensor Alignment

Data from the towed video camera system is post-processed using an in-house application developed in Python. Kalman filters are applied to the USB positions and package altimeter data to improve positioning of the instrument. The output of the sensor alignment is verified by producing a closed caption file. Most modern multimedia players support the use of closed caption files through a simple text file format. The timing of the captions proved highly accurate as can be seen in Figure 2. This system allows for great flexibility in the types of data overlaid.

## Estimation of Seabed Slope

The pitch of the camera and seabed slope both have a significant effect on the imaged area. Camera pitch can be accounted for using pitch sensor data. The seafloor cannot be assumed to be flat – many of our camera tows were steeply sloping seamounts. Seabed angle can be estimated using pressure sensor and altimeter data (Figure 3).

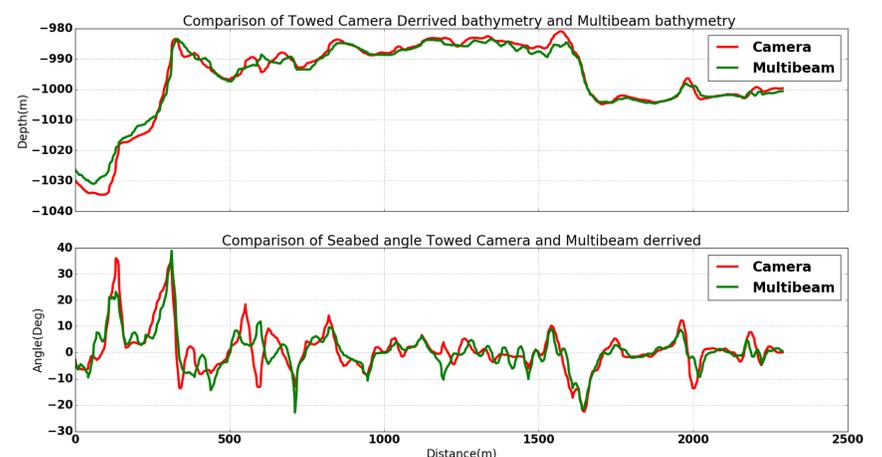


Figure 3: Comparison of seabed angle derived from towed camera data compared with multi-beam sonar data (mean depth offset removed)

## Calculation of Image Area

The camera housing has a flat viewing port. This distorts the image due to refraction of the light as it passes through the portal. A model of the camera was developed using CCD sensor geometry and lens focal length. Ray tracing from the parameter pixels of the CCD through the portal by applying the vector form of Snell's law enabled the imaged seafloor area to be calculated. This method can also be applied to cropped images – Figure 4. The results were compared to a pool calibration and proved to be within 5% of measured values. The estimate of final imaged area is made by combining altimeter and pitch data with the estimated seabed slope.

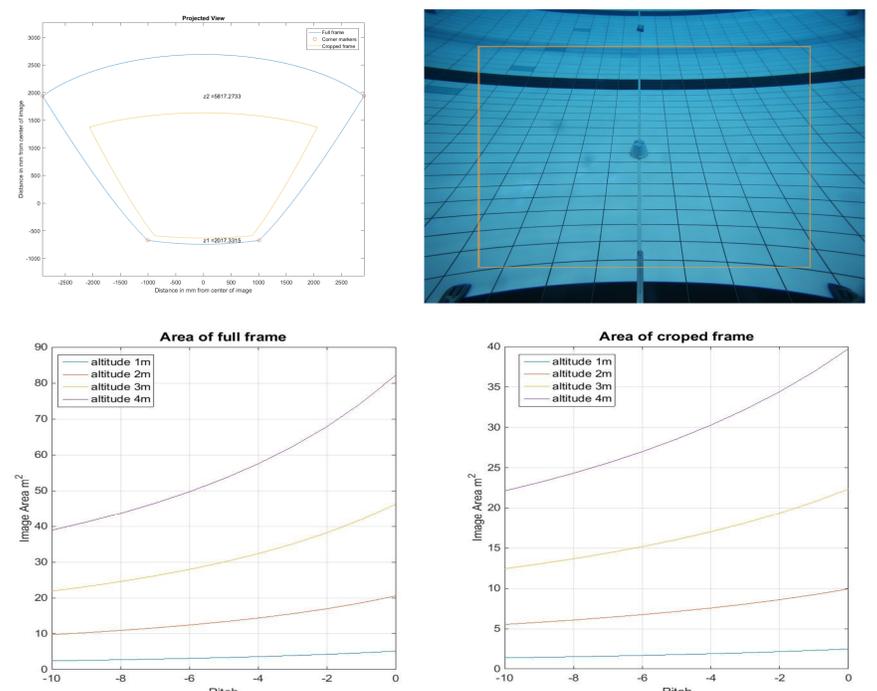


Figure 4: Projected outline of image using ray tracing (left). Pool calibration: 1.6m elevation -38 degree pitch (right).

## Conclusion

- Close caption titles provide accurate and versatile annotation
- Seabed slope can be retrieved from towed camera data
- Viewed area in images can be estimated to a useable accuracy
- Density of seabed fauna is measured with an estimate of error

FOR FURTHER INFORMATION

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