Rapid assessment of manganese nodule abundance

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Interest in deep benthic manganese nodule exploitation has generated the need to rapidly assess not only the abundance of resources but also the state of the abyssal habitat. While high-resolution multibeams and sidescan sonars provide a large overview over areas of mining interest, visual images can link these acoustic data to ground truth observations using physical sampling gear (BoxCorer, MultiCorer).

Measuring nodule abundance is important to determine profitable mining areas as well as to link this information with environmental parameters. Geologists and geochemists require to link localized measurements with nodule coverage. Biologists are interested in large area nodule abundance overviews to assess habitat connectivity and to link species distributions with nodule coverage. Possible protectorates, where mining would be prohibited, would need to be selected by species abundance and thus also based on nodule abundance to allow for re-colonization of mined areas.

Assessing nodule abundance is can by done manually with only a few images. Large aerial overviews of nodule coverage can only be determined using (semi-)automated methods. Several algorithms have been proposed that rely on field expert knowledge (e.g. by a geologist), a computer scientists or are fully automated. While these methods can extract nodule abundance data from images with sufficient accuracy, the computation times can slow down the data extraction process, especially when modern AUVs are employed that can acquire visual image data at a rate of 1 image per second.

To allow for real-time processing of the acquired visual data, a rapid image processing algorithm has been implemented that makes use of massive parallel data processing on common desktop computer graphics cards. The algorithm was tuned for images created with the new DeepSurvey Camera system on board the GEOMAR AUV Abyss and showed to be applicable to other data sets, obtained by towed camera platforms as well.
Using the new algorithm allows to assess nodule abundance over square kilometer scales in reasonable time. It can be used on board research vessels to determine important sampling locations during expeditions and will be applied to all image sets acquired during the JPIOceans expeditions (SO239, SO242/1 and /2).

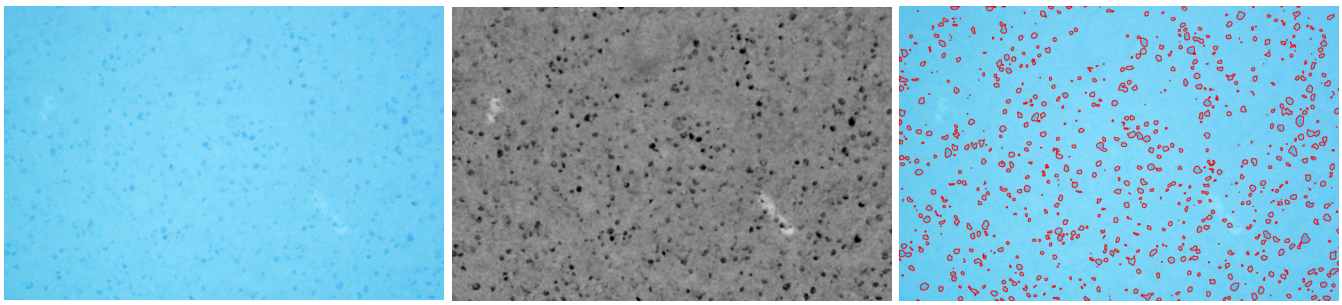

Figure: To the left, the input image for the algorithm. Shown is the central part of an image acquired by the camera on board the AUV (which flew at 8.3m altitude; the image crop has a footprint of 43.8 m^2). The middle part shows an intermediate result of the algorithm after contrast enhancement. The right part finally shows the detection result by outlining the individual nodules. By knowing the pixel-to-centimeter ratio for each image, nodule size can be measured in square centimeters, allowing to assess not only nodule coverage (here: 723 nodules, coverage of the seafloor 5.6%), but also nodule size frequencies per square meter (here: median nodule size 14.4 cm^2, maximum size 143.4 cm^2).