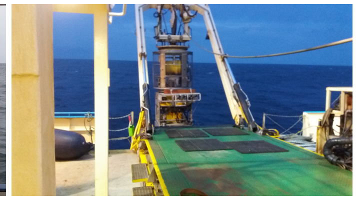
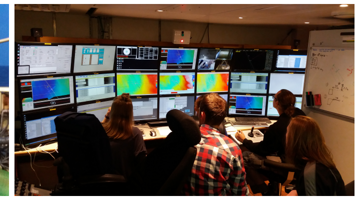
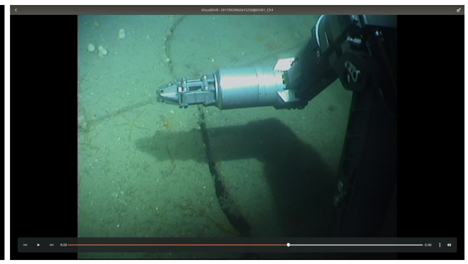
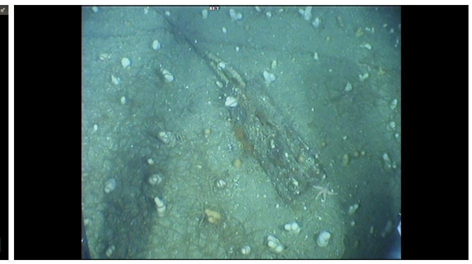
Projects in Underwater Robotics

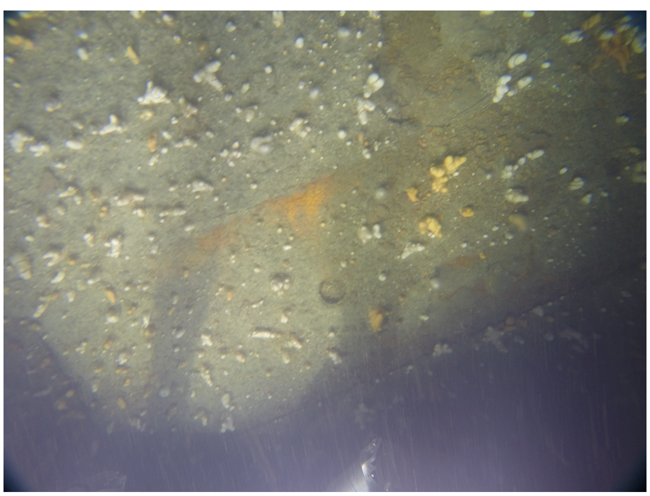
   

Project Visual Odometery:

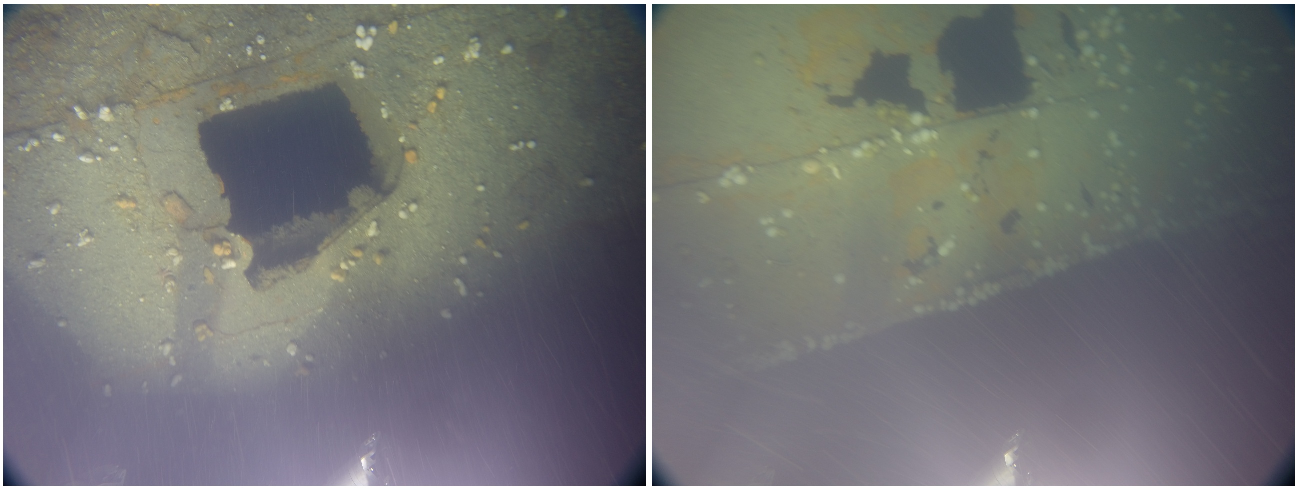
An ROV operator sees real time images such as those above but can easily become lost while doing a survey. The USBL system that exists is far from perfect. Visual odometry would therefore be very useful. We have images from underwater camera surveys. Options for doing this include traditional keypoint based methods, Dense reprojection based methods, or deep neural network based methods.

Project Visual Place recognition:

Same scenario as above the operator would like to remove the drift in position estimate by haveing the same place recognized in the images. This could be done for example, by bag of words type approaches using various feature destriptors for keypoints in the images or by a deep neural network approach.

Project Underwater Visual SLAM:



Combining the motion estimation sensors with camera to improve navigation under water in the scenario above would is a real need of industry and a successfull thesis here could be developed inot something actually used by MMT. This thesis would be very hands on and need to work with many kinds of data and sensors to minimize all artifacts that might degrade or destroy the navigation solution. The system should include some solution to the visual odometry and place recgnition but these could be standard open source solutions not optimized for underwater. (later to be replaced by better solutions). Similarly the 'back end' global optimization culd be for example G2O, iSAM, ORB SLAM or other open source package.

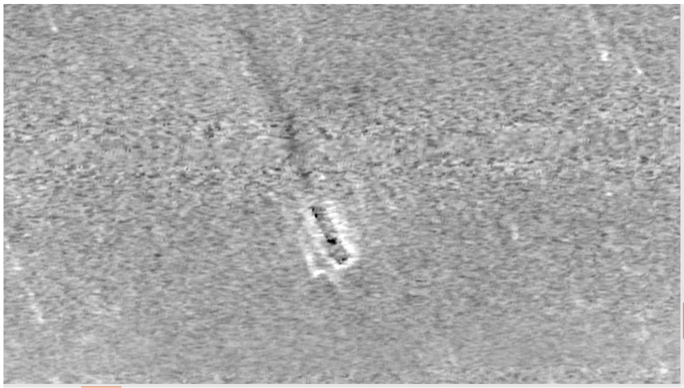
Project 3D Photogramic Reconstruction:

We have high quality images of underwater infrastructure that could be used to create 3D reconstructions. Currently the end user has the best software available which produce stunning results but only off line for small sections of a survey. What would be of benefit is a fast not as high quality real time reconstrution that could aid the operator.

Project Semantic labling of underwater sturctures:

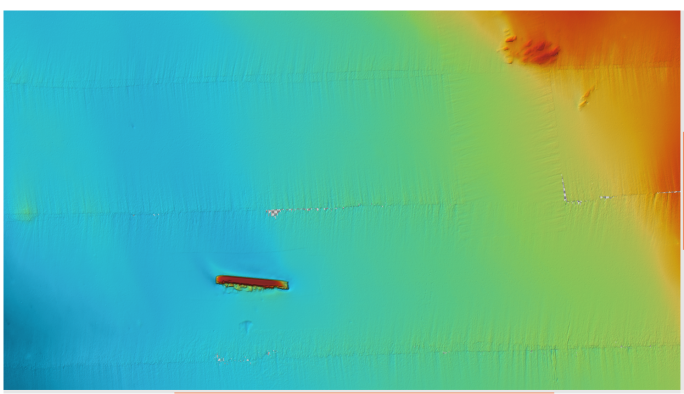
Long surveys of the sea floor require an operator to manually annotate frames when they contain things of interest. This could be automated using a deep neural network based semantic image classifier. We have large amounts of annotated images.

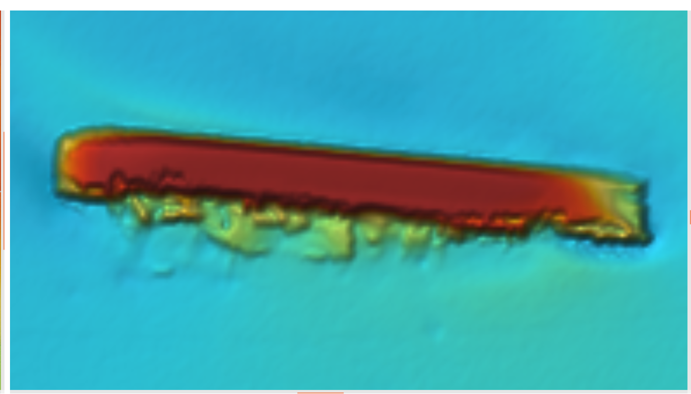
Project Sidescan Sonar Modeling:



Sidescan sonar allows one to survey a large swath of the ocean floor or under ice surface. However it is a difficult sensor to interpret. The same region seen from different distances and viewing angles will look very different. We would like to train a Deep Neural Net to learn to predict one sidescan image of the same region seen from another from a different sonar position. The biggest chanenge here is not designing the DNN or training it but rather generating and validating a simulated sonar model so that we could then simulate large amounts of training data and prove the concept. We have done a lot of the sonar simultor work already but it should be improved and then actual data should be collected and used to validate it.

Project predicting Sidescan data from Multibeam data:





When an AUV is operating under the Antarctic ice shelf it will need to reaquire a known position. The only way to do that is to recognize the under ice surface. A multibeam sonar can give a fairly good 3D resoulation to build a model of the ice surface. It however can only see a relatively narrow swath of the surface. When trying to reaquire the position it would be good if the sidescan data could be used to recognize the region previously mapped with the multibeam sonar. This is not an easy task but we can start on it by using data on the sea floor seen by both sensor to train a learning algorithm.

Project Sonar interferometry:

We would like to learn what can be done usign an 8 element sonar array configured as two rows of 4. We expect that the sonare can be focused into a diffration pattern of many separate beams but we do not have a good theoretical or empirical grasp of what the limitations will be. The student would model this in a simulation environment and characterise the sensor performance in different configurations. Eventually we may be able to use this type of sonar to map the dynamically changing surface of a glacier front in Greenland to better understand the calving process.

Other Projects??

New ideas are being generated as the research proceeds. We are building a complete syste to run on at least three very different AUV platforms. There is much work to be done.

For more information:

John Folkesson
johnf@kth.se
CVAP/CSC Teknikringen 14, floor 6