Subsea Pipeline Tracking Using a Forward-Looking Imaging Sonar for Autonomous Underwater Vehicle

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SUMMARY

A worldwide network of subsea pipelines supplies energy to several countries. One associated risk is a pipe rupture on one of the pipelines. Such a scenario leads to the leakage of the transported medium and thus to enormous ecological and economic damage. To prevent this, the pipelines must be regularly monitored and maintained. However, monitoring with a survey vessel involves increased fuel consumption and significant impacts on marine life. To avoid the need for monitoring with a surveying vessel, an autonomous underwater vehicle (AUV) is being developed as part of the research project CIAM (Comprehensive integrated and fully autonomous subsea monitoring). Using various sensors like a multibeam echosounder or a sub-bottom profiler, autonomous inspection will be performed. A central task is the automatic detection and tracking of a pipeline. This requires an algorithm that automatically detects the pipeline in the recorded measurements. A major challenge is the limited visibility underwater. In clear water, good results can be achieved with optical systems such as a camera-laser system. In turbid waters, these systems are severely limited. A promising alternative for working in these hard conditions is the use of an imaging sonar, which provides acoustic images. An alignment of this sensor towards the direction of travel even offers the additional advantage that the course of the pipeline is known at an early stage. This can be considered when planning the further route. Using acquired data sets of a forward-looking sonar, a promising approach is developed to identify a pipeline in imaging sonar measurements. The concept underlying this approach assumes that a pipeline represents an elongated, contiguous set of points. Selected segmentation methods (model outlier Removal and cluster extraction) and a following geometric analysis of all remaining features reliably filter out these objects. Subsequent comparison with the approximated nominal pipeline size detects point clusters that have a high probability of representing a pipeline. Based on the developed concept, an algorithm is implemented and tested in the robot operating system (ROS). The algorithm continuously and reliably detects a pipeline in imaging sonar observations.