

Development of methods and algorithms for abnormal event detection for underwater object recognition and scene analysis

The aim of the project is to do research on development of methods and algorithms for abnormal event detection for underwater object recognition and scene analysis, based on a system containing visual cameras with lighting and a sonar camera. Development of such methods can find broad applications in search systems for lost objects, inspection of underwater constructions, but also for assessment of water environment by biologists, etc. Currently used methods and systems require human intervention what greatly limits their operation range, but also in some cases can be impossible or even dangerous. Finally, realization of this project will lead to important answers, as well as will contribute to development of new algorithms and methods enhancing our knowledge. These are the main reasons for choosing this research topic.

The planned tasks have been divided into a number of steps. The first one is to build a front-end for underwater signals acquisition. It will be able to move underwater, under control of an operating diver. However, in this project we assume that further data processing will be done exclusively on the land in the laboratory conditions. Nevertheless, in a future, all computations and decisions can be done on board of an underwater vehicle with no need of full signal transmission to the shore and only with transfer of the detected events and images and positions of the searched objects. We assume that the system will be able to recognize both, objects which examples are known and can be used for training, but also unknown objects, which have not been seen before, but whose characteristic features are known beforehand. The system can operate statically and analyze a selected underwater regions, or dynamically, moving and collecting data.

Research on underwater signal processing methods assume development, implementation and examination of a series of methods, which will be based on modern algorithms for multi-dimensional data processing, so called tensors, ensembles of classifiers, as well as classification methods with kernel functions. One of the planned methods will be detection of the characteristic features of the signal, which can be used for its content assessment (classification). The next method will be responsible for scene segmentation into static background and moving foreground objects. Those objects can be then recognized as belonging to one of the known (trained into) groups of objects, thanks to development of the neural networks with deep structures, as well as ensemble of one-class classifiers. The latter can be further used for automatic learning of a model of changing underwater scenes, and then for detection of abnormal events which can indicate observation of an unknown object. Search for such objects will be also possible thanks to the development of an innovative detector of features characteristic to the human made or manufactured things. These can be characteristic colors, regular edges or arcs, or detected text fragments, etc. Such features can indicate retrieval of a lost object.

We are convinced that the project will provide many interesting solutions and developments, interesting both, from the scientific point of view, but also ones which can soon find many practical applications.