Anomaly-based Detector for Maritime Surveillance

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Abstract

Authorities such as the coast guard monitor our waters by means of maritime surveillance systems that are used to analyze vast amounts of heterogeneous sensor data collected from different sources such as radars, cameras, AIS (Automatic Identification Systems) receivers, and so on in order to find signs of smuggling, piracy, accidents, and oil spills. Automating the identification of anomalous vessel movements or suspicious situations that might need further investigation helps the operators in coping with the inordinate amount of data.

States that can be considered normal behavior determine the 'normal model' of the system and sufficiently large deviations from the normal behavior are considered as anomalies.
Even though the principle of anomaly detection does not seem to be complicated, several problems have to be taken into account in this regard; first, the understanding of the situation for which equivalents a normal behavior might well change over time, unfortunately even as a result of malicious behavior in case the background behavior model is updated uncritically. Second, data is rarely noise-free and noise may share characteristics with the anomalies we are trying to detect. Finally, not all anomalies are the same for all application domains or even for different problems within the same domain. As a result, it can sometimes be difficult to make a clear distinction between normal and anomalous behavior which makes the quality of classification being low.

The main research problem concerns the development of anomaly detection techniques with high detection rate and especially low false alarm rate, in order to aid the operators by pointing out the potentially problematic situations that merit further investigations.
The false alarm rate is the dimensioning factor and can be reduced by involving the operator in anomaly detection process and therefore using background knowledge and experience as well as enabling correct understanding of the operation of the detector, and as a result increasing confidence and trust in the system. In order to solve this problem, information visualization techniques combined with other strategies will be applied to detect anomalies in the maritime domain with a high degree of appropriateness, timeliness and accuracy in such a way that the human operator can get a proper image of how and why the detector reached its conclusions; furthermore by using the mentioned combined techniques the detector can be retrained so that it would perform better in the future.