Scan-to-scan sea-spikes filtering for radar

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***Abstract*— High range resolution radars are often a solution to the problem of small target detection in the presence of sea clutter, however this solution leads to a high density of sea-spikes echoes. The number of false plots can be very high and need to be regulated in order to be able to control the tracking load and limit the number of false tracks. In this paper a solution for the Coast Watcher 10 and Coast Watcher 100 products is derived. The new patented scan-to-scan algorithm used to filter plots before tracking is presented. It uses the position and Doppler information of the plots on several scans to regulate the number of false plots at tracking level.**

I. INTRODUCTION

In the radar context of the detection of small targets in a sea clutter environment, one is usually limited by the clutter power. In order to reduce the clutter power received by the radar a way is to increase the spatial resolution. This comes from the fact that to a certain extend the clutter is spread and the target is considered a point. A drawback is that when the range resolution is increased the clutter received by the radar seems less and less gaussian and the statistical distribution tail is longer [1].

One of the main problems is then to reduce the false alarm due to sea-spikes. To deal with this problem one needs to use as much information as possible to separate a target from a false alarm. Usually on one scan there is no clear distinction between a small target and a breaking wave on the received signal, one then needs to use the information from one scan to the others to make the distinction.

Assuming the targets have a straight-line movement during the observation time and that the false alarms are randomly distributed over the space independently from scan to scan, one can remove some of the false alarms filtering out the plots that do not form a coherent movement from scan to scan. Filtering the plots means here to select only the plots with a valid movement relative to the straight-line hypothesis.

A known method to realize this scan-to-scan filtering is to create chains of plots. However this approach leads to an algorithm with a computing time very dependent on the number of plots at the input. In a tracking system every plot at the input is considered as a potential target.

Instead, the idea is to create multidimensional tubes corresponding to different movement hypothesis and observe if enough detection are in those tubes during time; one of the benefits from this approach is to create an algorithm more robust with respect to the processing capacity.

A further reduction in processing load can be achieved by using the instantaneous velocity information provided by the radar, using the Doppler effect, to reduce the different movement hypotheses possible for each plot.

II. RADAR SEA-SPIKES REAL DATA ANALYSIS

An example of raw recording on an X-band pulsed radar with a range resolution of 5m (range bin of 3m) is given fig.1. The display shows many sea-spikes echoes of received power higher than the boat's echo. The small boat and the sea-spikes are point echoes and distinguishing sea-spikes from small target does not seem obvious using the range and azimuth information on one scan.

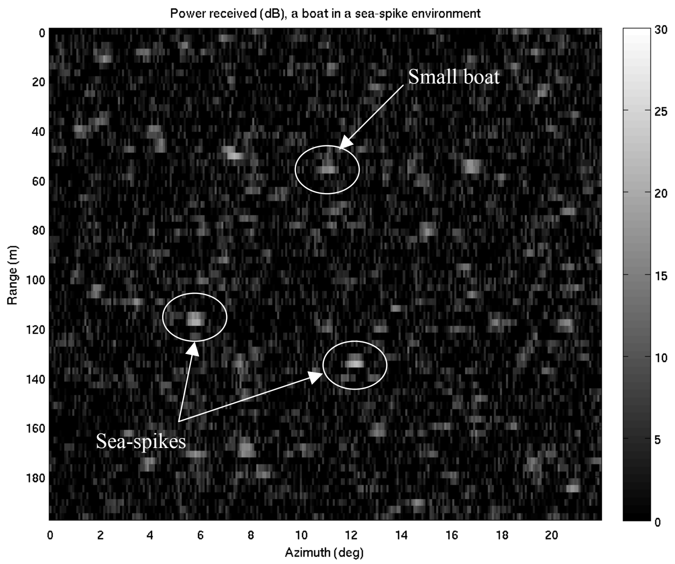

Fig. 1 Raw data showing a azimuth range map of a small boat in a sea-spikes environment

However the Doppler information already gives a way to discriminate between a mobile boat and sea-spikes if the boat appears in the visibility Doppler zone as shown on fig.2. Given the Doppler resolution, distinguishing sea-spikes from small target using the Doppler shape of the echo does not seem obvious either.

This analysis shows that if the boat Doppler is in the non-visibility Doppler zone then there seems to be no obvious way to distinguish a small boat from sea-spikes on one scan only.