



CFAR Detection in Heterogeneous K-Distributed Sea-Clutter Background

Introduction

Radar systems create a picture of the surrounding environment by transmitting an electromagnetic pulse and receiving echoes produced by reflecting objects. If the echoes exceed a threshold, the radar declares a target. Similarly, if radar declares the target without the target, it is called a false alarm.

Sea Clutter

Unwanted reflections from the surroundings are called clutter. Specifically, reflections from the surface of the sea are termed sea clutter, which can impact radar performance. The characteristics of sea clutter differ for every look, known as heterogeneity. Due to these variations, false alarms are occurring along the clutter edges.

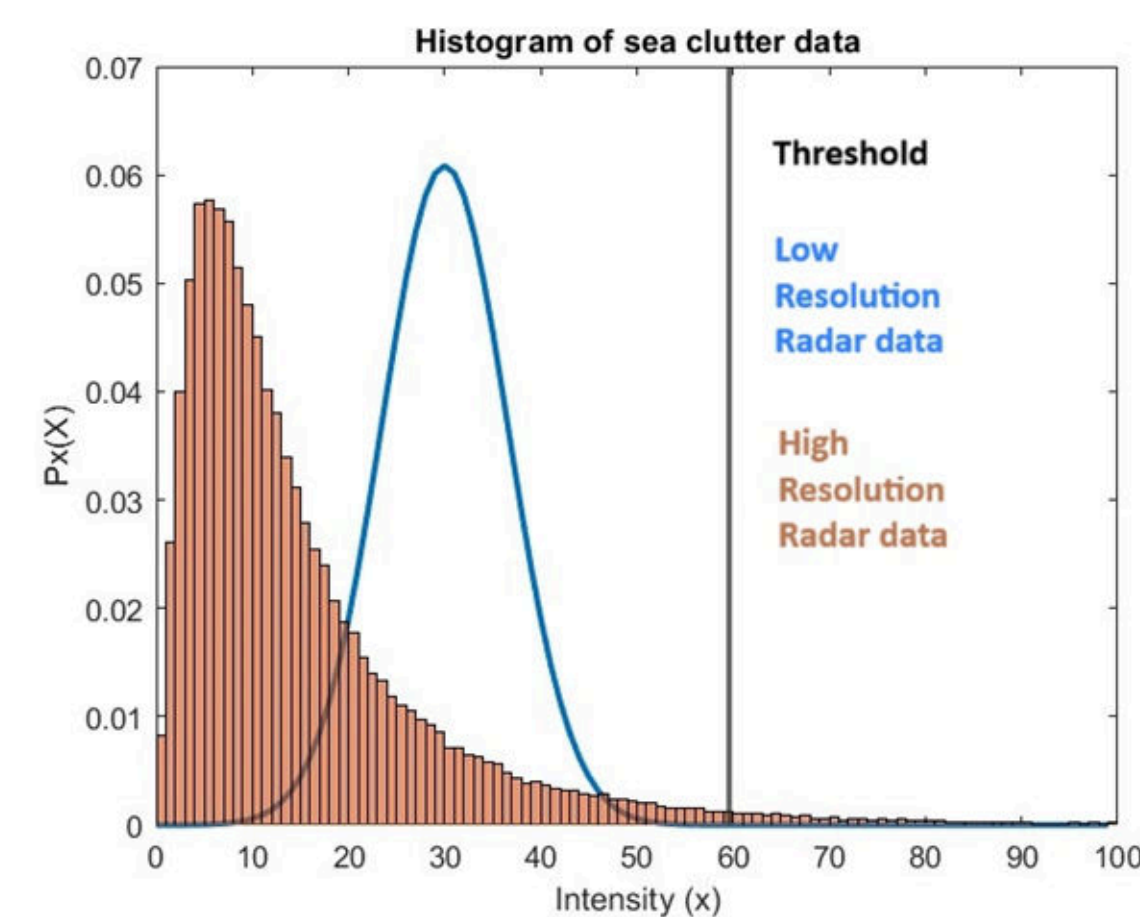
Radar Evolution

- Previously radars had low range resolution as a result adjacent clutter cells had the same amplitude distribution with fixed mean intensity.
- Modern radars have high-resolution capability and can resolve sea waves and swell patterns:
 - Local variations in sea surface slope
 - Shadowing from waves
 - Changes in surface roughness due to the wind
 - Breaking waves

As a result, variations in the mean intensity of the backscatter from one patch to the next.

Statistical modelling of sea clutter

Low range resolution radar sea clutter data were effectively modelled as Gaussian distribution. However, data collected by modern radar no longer be modelled with a classic Gaussian distribution. Log-normal, Weibull, K-distribution and Paetro distribution are some popular statistical models to characterise the high-resolution sea clutter.

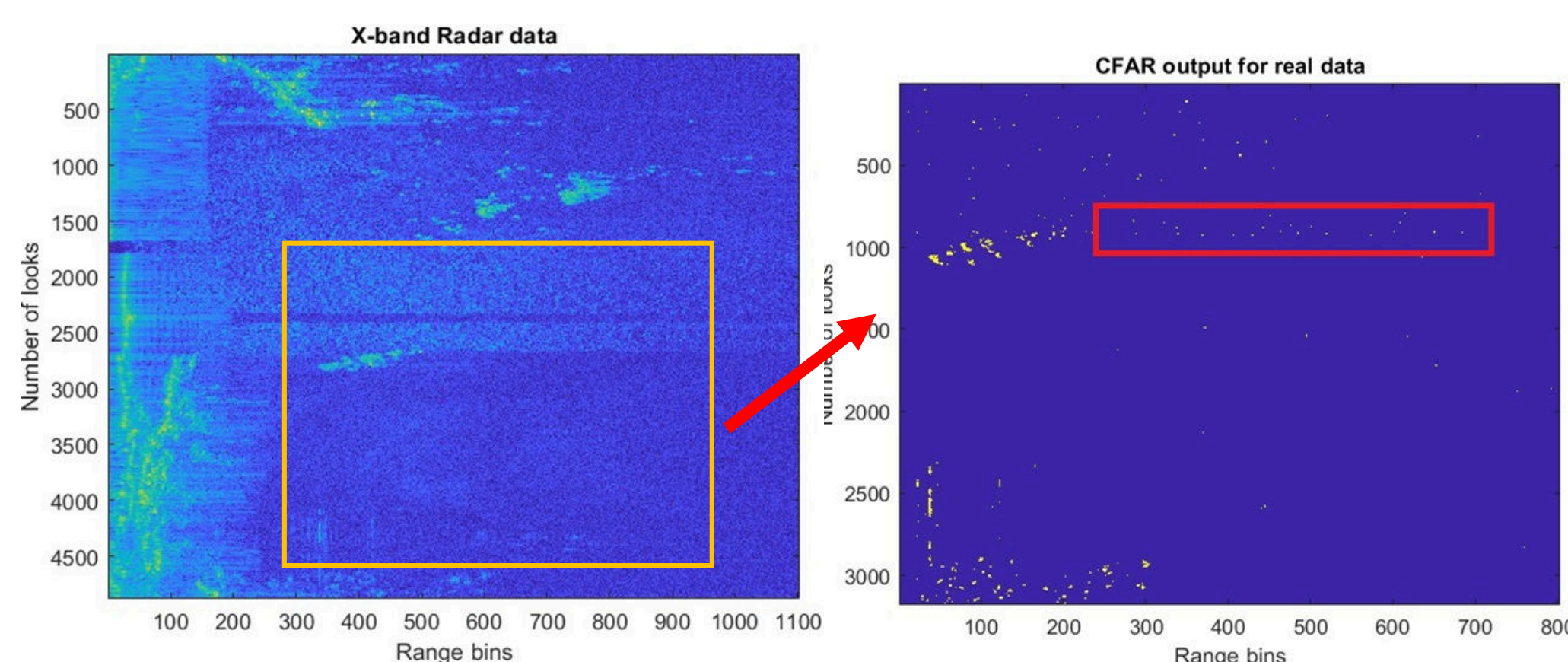
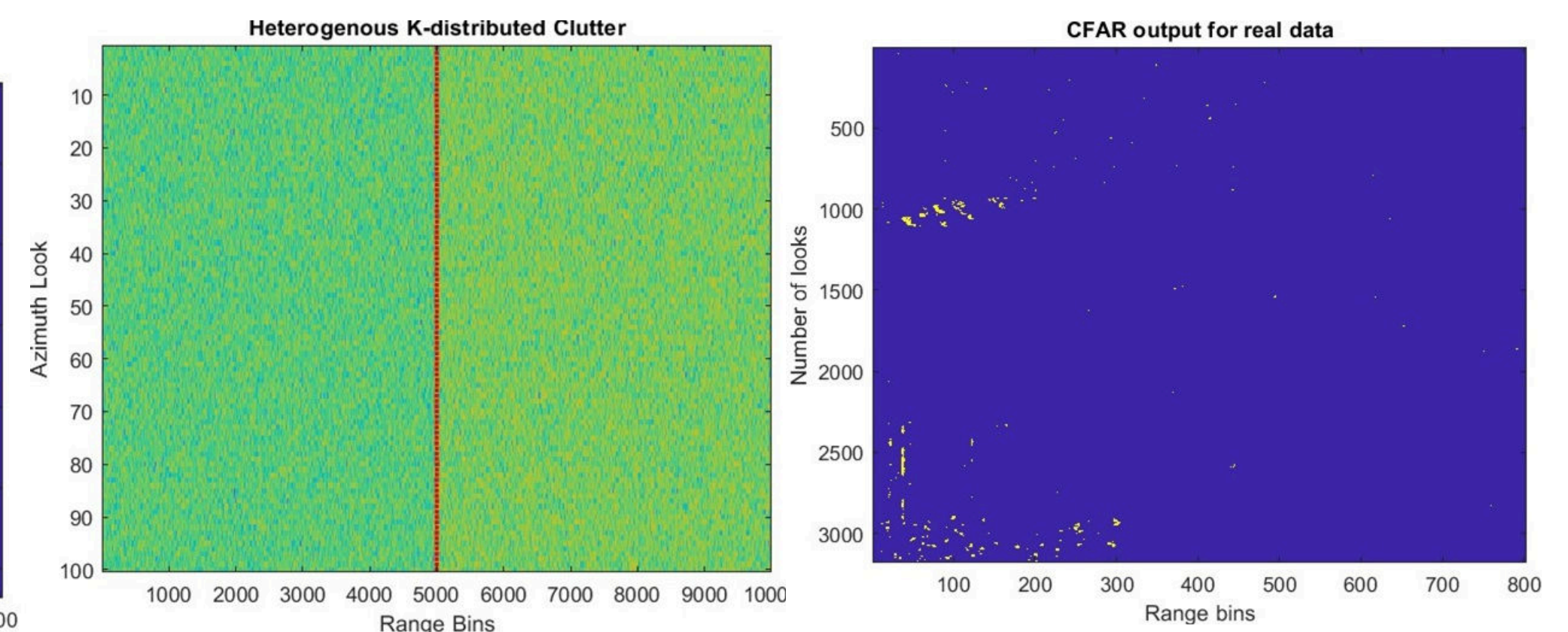
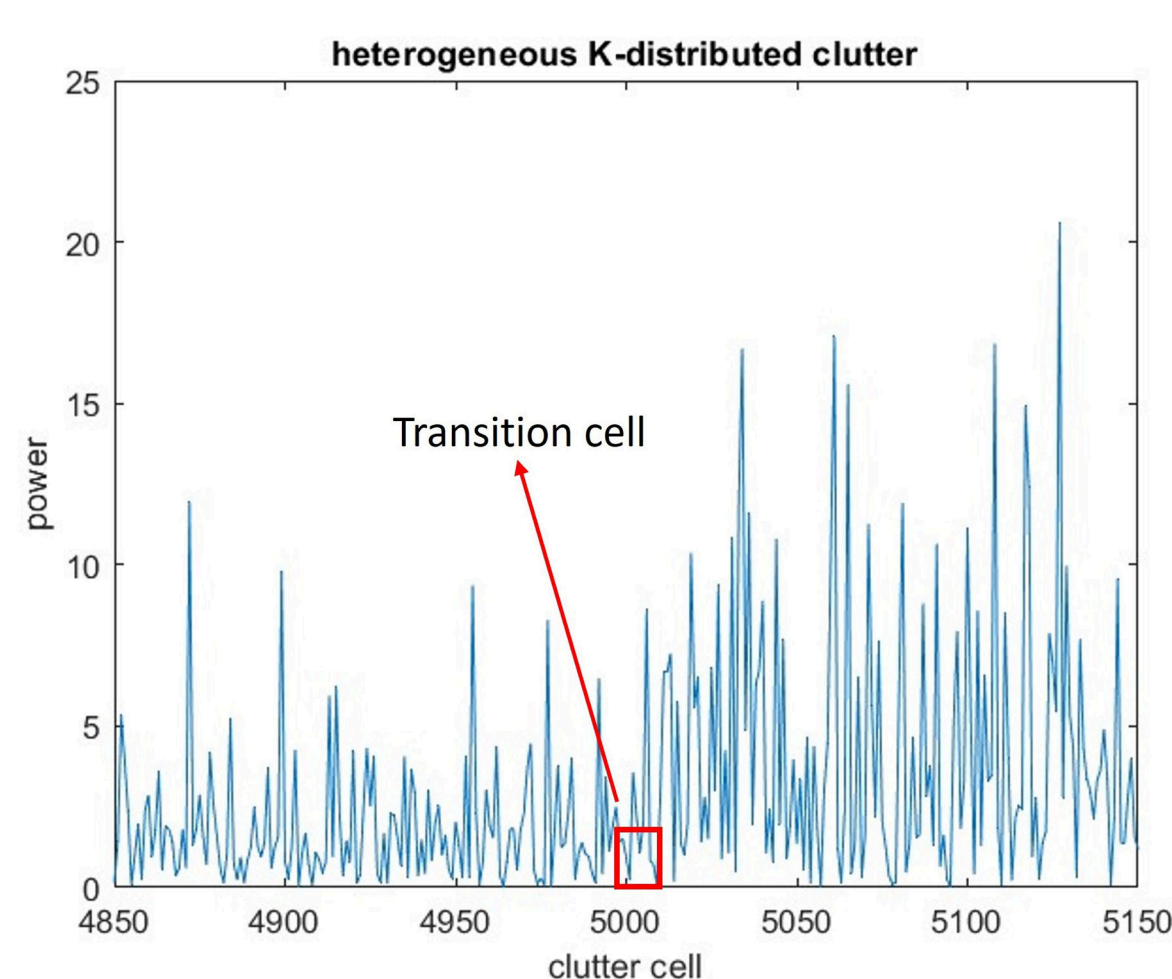


When high-resolution clutter data is modelled similarly to low-resolution clutter data **HIGH FALSE ALARMS!!!**

Methodology

Sea clutter is modelled as fully correlated K-distribution. The clutter maps are built by dividing the heterogeneous clutter into homogeneous regions by maximising a log-likelihood function, from which a transition point is estimated. The Cell-Averaging CFAR (CA-CFAR) is applied separately on both regions.

$$T = \alpha_{ca} \left(\frac{1}{N} \sum_{i=1}^N x_i \right)$$



Conclusion

- K-distribution effectively models the sea clutter data.
- CA-CFAR is implemented after taking the prior information of the transition region. As a result, false alarms along the clutter edges are suppressed.

Future work

- Modelling the sea clutter data with better statistical model
- Oceanographic models to characterise the sea clutter and estimate the parameters.
- Adaptable CFARs for spiky sea clutter

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