STC IMPLEMENTATION ON MARINE RADAR VIDEOS

Report 1

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Furkan Mert Algan

Elif Begüm Çığ

Yarkın Hocaoğlu

Yiğit Süoğlu

Supervised by Müjdat Çetin, İlker Hamzaoğlu

1) Definition of STC

In the presence of high waves radar traces reflected from short distances exhibit high amplitude whereas those from long distances exhibit low amplitudes. Under such circumstances radar traces reflected from short distances saturate the receiver preventing observation of traces a longer distances. To prevent this, Sensitivity Time Control Function has to be introduced. In a typical application, the attenuator is set to maximum attenuation during the period of the transmitter pulse. At the end of the pulse the amount of attenuation is reduced in a controlled way according to system requirements.

2) Theory

Land based radar have permanent echoes. These are the reflections of nearby objects such as buildings etc. There is nothing one can do with them except learning and being aware of them. On the other hand marine radar exhibits sea clutter (Patel et al, 2013, p. 89). Sea clutter refers to backscattered signals from the sea surface. Traditionally sea clutter has been modeled as a stochastic process. When the pulse duration of a radar is sufficiently short, the amplitude distribution of sea clutter has an extended tail, compared to the Rayleigh distribution that follows from Gaussian noise theory (Haykin and Puthusserypady,1998, p.1224). To prevent clutter, received signal is attenuated in a controlled way. To accomplish STC requirements the attenuation is taken as maximum and assumed to be constant up to a certain range known as the range offset. Until reaching this offset, a predefined constant value that is dependent on the environmental factors is retained. After reaching to this offset value, attenuation decreases exponentially (Meena and Prakasam, 2008, p.244).

3) Literature Search

Literatures found about STC:

- An Automatic Sensitivity Time Control System, Krueger, 1964, *IEEE Transactions on aerospace,* vol. 2, number 2, p. 145-150
    - This paper illustrates that ground mapping radar system imagery can be considerably improved by utilizing STC to control receiver gain. This paper discusses about STC on airborne radars. However, it gives a slight intuition on marine radar applications as well.
- Automatic Gain Control Methods, Retrieved at 1/12/2016 from http://www.radartutorial.eu/01.basics/Pulse%20Repetition%20Frequency%20%28PRF%29.en.html
    - This website generally informs the reader about STC and basic radar functions.

Literatures found about FPGA with respect to STC:

- FPGA Based Real Time Solution for Sensitivity Time Control, Meena D and LGM Prakasam, 2008, *Electronics and Radar Development Establishment(LRDE)*, p. 244-248
    - This paper mainly focuses on the digitization of STC for radar receivers using FPGA.
- Real Time Implementation of STC and FTC Radar System Based on FPGA, Patel and Pandey, 2013, vol.2, issue. 09, pp. 89-93
    - This paper presents another implementation of STC and FTC for FPGA in real time.

Literatures found about Sea Clutter:

These papers we have found are for sea clutter generation. While searching literature we have found many different methods to model/generate sea clutter.

- Detection in Sea Clutter Based on Non-Linear ARCH Model, Zhang et al, 2016, *Digital Signal Processing 50,* pp. 162-170
- Analysis of X-Bands SAR Sea-Clutter Distributions at Different Grazing Angles, Fiche et al, 2015, *IEEE Transactions on Geo-Science and Remote Sensing,* vol. 53 no.8, pp. 4650-4660

- A Sea Surface Fractal Model for Ocean Remote Sensing, Brezzi et al, 2004, *International Journal of Remote Sensing,* vol. 25, no. 7-8, pp. 1265-1270
- Sea Clutter Constituent Synthesis Approach Based on a New Composition Model, Zhang et al, 2015, *EURASIP Journal on Advances in Signal Processing,* vol. 78
- Uncovering Nonlinear Dynamics – The Case Study of Sea Clutter, Haykin et al, 2002, *Proceedings of the IEEE,* vol. 90, no. 5, pp. 860-881
- A Statistical Model for Correlated K-Distributed Sea Clutter, Li and Xu, 2008, *Congress on Image and Signal Processing,* pp. 408-412
- Sea Clutter Modeling Using and Autoregressive Generalized Nonlinear – Asymmetric GARCH Model, Zhang et al, 2017, *Digital Signal Processing 62,* pp. 52-64
- Correlation Analysis of X-Band Sea Clutter in Complex Domain, Cheng et al, 2016, *Oceanic and Coastal Sea Research,* pp. 613-618
- Simulation of Sea Clutter at Various Frequency Bands, Arikan and Vural, 2015, *Journal of Electromagnetic Waves and Applications,* vol. 19, no. 4, pp. 526-542
- Chaos, Sea Clutter and Neural Networks, Haykin and Puthusserypady, 1998, pp. 1224-1227

Literatures found about DSP and C/C++ Implementaion:

This source we have found is a library for DSP and C/C++ implementation

- http://aquila-dsp.org/

We could not find any resource about Matlab and Simulink implementation.