CCD non-linearities in MTI receivers

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ABSTRACT

The influence of CCD non-linearities on the performances of an MTI (Moving Target Indicator) receiver is examined. Clutter Attenuation (CA) and Improvement Factor (IF) are evaluated using the non linear characteristic of a CCD delay line both for a single and a double canceller.

The analytical technique adopted can be used for more complex MTI's. Some experimental results are then shown.

INTRODUCTION

An MTI is a circuit able to detect useful moving targets in a ground (or sea or weather) clutter environment whose power is 40-60 dB above the signal power using the different doppler spectra of clutter and signal.

Later, no doppler carrier is thought present in clutter spectra; as a point of fact widely known techniques (f.i. adaptive MTI) are used to cancel this carrier, if present, and can be adopted also when CCD's are used.

It is useful to remember that nowadays MTI's, with 40-60 dB IF are implemented using digital devices in a transversal FIR configuration thus needing high resolution, high speed A/D converters (7-10 bits/200nsec).

In the early sixties MTI's were implemented analogically using quartz delay lines whose small dynamic range compelled the designer to cascade many stages with proper filters.

The same must be done with CCD's: dynamic range lower limits due to the device thermal noise, clock residues and residual transients, normally are declared by the factory;but upper limits due to non linearity are not known and they are the most important factor influencing the usable dynamic range in MTI's.

Abrupt non linearities has been studied (1) (2) to evaluate the best possible radar performances; the same has been done for an input hard limiter used to have clutter residues at noise level whichever the precessor.

These non linearities cause a spreading of clutter spectrum thus limiting the clutter attenuation. Recent papers have analyzed the influence of input quantization noise on the possible cancellation (3).

In this paper the influence of a typical CCD non linearity on the maximum allowable dynamic range is examined.

The parameter commonly used to describe the performance of an MTI is the Improvement Factor (IF) which is defined as the ratio between signal to clutter ratio at the output and the same ratio at the input of the MTI. The signal can have each possible speed so it is common to average signal

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