High Range Resolution DVB-T Passive Radar

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***Abstract*— Passive Radar systems, also referred to as Passive Coherent Location systems (PCL), exploit reflections from illuminators of opportunity (IO) in order to detect and track objects. Digital waveforms like DVB-T and UMTS [1] signals offer wide bandwidth channels which allow achieving good spatial resolution. Moreover, they have spectral properties which are nearly independent of the signal content. Such waveforms exhibit an ambiguity function with a thumb-tack shape and bandwidth that is constant in time. This paper focus on the usage of multiple channels of the same IO (e.g.: DVB-T or UMTS channels) in order to improve range resolution and make target recognition and radar imaging feasible. Specifically, two different architectures based on the exploitation of multiple DVB-T channels have been considered. A DVB-T transmission system has been simulated with a Simulink® model compliant to [2]. Simulation results are presented and discussed in order to evaluate the system performance in terms of spatial resolution.**

I. Introduction

Passive Radar systems [3], [4], also referred to as Passive Coherent Location systems (PCL), exploit reflection from illuminators of opportunity (IO) in order to detect and track objects. A PCL receiver generally presents two receiving channels denoted as reference channel and target channel. The reference channel is used to capture the direct signal from the transmitter and provides a reference signal to be compared with the target return.

The comparison is usually carried out by cross-correlation between reference signal and target signal. The characteristics of radar signals are generally studied through the ambiguity function (AF), mathematically defined as:

$$|\chi(\tau,\nu)| = \left| \int_{-\infty}^{+\infty} s(t)s^*(t-\tau)\exp\left[j2\pi\nu t\right]dt \right|$$

Where *s(t)* is the complex envelope of the transmitted signal, τ is the time delay and ν is the Doppler frequency shift. The AF cross-section at ν=0 is the signal autocorrelation function (ACF). The IO can be divided in two main classes: analogue transmitters like FM radio [5], [6], [7], analogue TV [8], and digital transmitters as DVB-T [9] and UMTS. Passive radars based on analogue signals show detection performance strongly dependent on the signal content. On the contrary, digital waveforms, thanks to specific signal coding, have spectral properties which are nearly independent of the signal content. Such waveforms exhibit an ambiguity function with a thumb-tack shape and bandwidth that is constant in time.

The goal of this paper is to propose two approaches to achieve a high range resolution profile (HRRP) exploiting multiple adjacent DVB-T channels of the same IO.

The first architecture, named *multichannel HRRP*, is based on the usage of multiple narrow-band receivers, specifically four receivers with 8 MHz of bandwidth. The second one is obtained with a 32 MHz bandwidth receiver and is named *wideband HRRP*. Firstly, an overview of the DVB-T standard is presented. Secondly, the two architectures are defined and finally, simulation results are presented and discussed in order to evaluate the system performance in terms of spatial resolution.

II. DVB-T Signal Model

Fig. 1 shows the simplified block diagram of a DVB-T transmission system. The processing applied to the output transport stream of an MPEG-2 multiplexer consists of error coding interleaving and orthogonal frequency division multiplexing (OFDM). The combined processing is abbreviated as COFDM.

OFDM transmission technique is robust against multipath propagation, therefore the usage of OFDM should imply more robustness of the radar system with respect to multipath propagation.

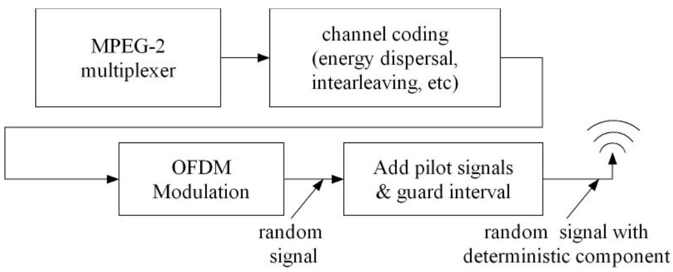

Fig. 1. DVB-T transmission system

The transmitted signal model is expressed in the following equation: