An Improved Channel Estimation Scheme for DVB-T Passive Radars

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***Abstract*— The terrestrial digital video broadcasting (DVB-T) transmission is an attractive source of illumination for the passive coherent location (PCL) radars. The DVB-T based PCL radars can benefit from the possibility of the reference signal reconstruction which enhances its signal-to-noise ratio. The propagation channel estimation is essential for the reference signal reconstruction. This work investigates the impact of the channel estimation accuracy on the DVB-T based PCL radar performance. To do so, the least-squares (LS) channel estimation method is compared to an improved method employing Monte-Carlo simulations and the detection probability as a comparison criterion.**

I. Introduction

Passive coherent location (PCL) radars exploit non-cooperative transmitters for target detection and tracking. The terrestrial digital video broadcasting (DVB-T) transmitters are widely employed as illuminators of opportunity for PCL radars. The DVB-T signal structure provides the possibility of reconstructing the reference signal to enhance the signal-to-noise ratio (SNR). The reference signal reconstruction requires a propagation channel estimate which is employed to equalize the received quadrature amplitude modulation (QAM) symbols [1]. Besides the reference signal reconstruction, the channel estimate can be employed for the static clutter suppression of the surveillance signal [2].

In the literature, the least-squares (LS) method for the propagation channel estimation is employed for the DVB-T based PCL radars. The LS method induces interpolation errors for the estimated propagation channel, which degrades the efficiency of the reference signal reconstruction and affects the static clutter suppression. In this work, we propose an improved channel estimation method which reduces the interpolation errors. To illustrate the impact of the channel estimate accuracy, we consider a single-receiver PCL radar; in this case, the channel estimate affects simultaneously the reference signal reconstruction and the static clutter suppression.

II. Proposed Method

For the LS channel estimation method, the received signal is divided into DVB-T symbols. For each DVB-T symbol, the cyclic prefix is removed and an FFT is applied on the useful part and then the channel response for the pilot subcarriers is calculated. The full channel response is obtained by the interpolation of the channel response for the pilot subcarriers. To reduce the noise impact, an averaging of the channel estimates over M DVB-T symbols is applied.

The LS channel estimate is affected by the interpolation errors since the channel response is interpolated between pilot subcarriers. The interpolation gap for one DVB-T symbol is $12\,\Delta F$ with $\Delta F = 1116\,Hz$ is the subcarrier spacing for the $8k - mode$. It follows that the reduction of the interpolation gaps can improve the channel estimation accuracy. The pilot subcarrier distribution includes four overlapping patterns [3]. We propose to calculate the averaged channel response for each pilot pattern; the concatenation of the four patterns reduces the interpolation gap to $3\,\Delta F$.

III. Simulation Results

Figure 1 presents the results of the Monte-Carlo simulations employing DVB-T signals of 10^5 samples length, a false-alarm probability of 10^{-2}, and a clutter-to-noise ratio (CNR) of $30\,dB$. We can notice the detection probability improvement for the proposed method compared to the LS method. Hence the importance of the channel estimation accuracy on the detection performance.

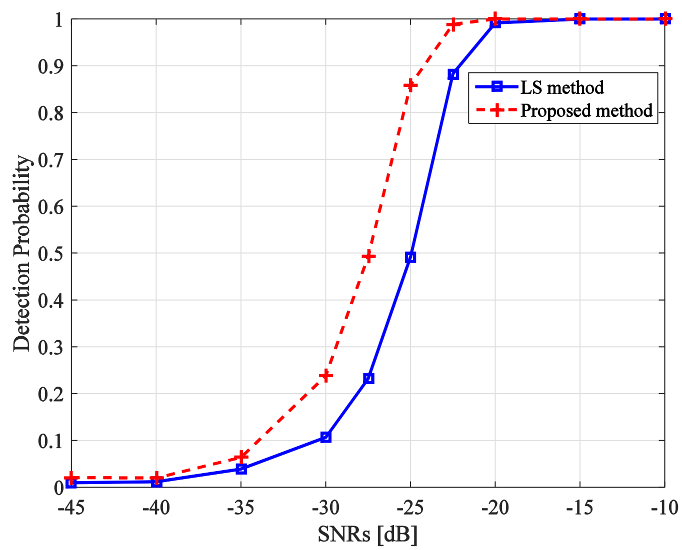

Fig. 1. Monte-Carlo simulation results for $CNR = 30\,dB$, $N = 10^5$ and $PFA = 10^{-2}$. SNR_s is the signal-to-noise ratio for the target echo.

References

[1]. J. E. Palmer, H. A. Harms, S. J. Searle and L. Davis, "DVB-T Passive Radar Signal Processing," in *IEEE Transactions on Signal Processing*, vol. 61, no. 8, pp. 2116-2126, April15, 2013.

[2]. G. Chabriel, J. Barrère, G. Gassier and F. Briolle, "Passive Covert Radars using CP-OFDM signals. A new efficient method to extract targets echoes," *2014 International Radar Conference*, Lille, 2014, pp. 1-6.

[3]. ETSI EN 300 744 V1.6.2 (2015-10) Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television. ETSI, 01/2017. [Online] Available: http://www.etsi.org