A Low Cost Phase Correction Technique for Passive Radar

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Abstract — **This paper presents a novel phase correction technique for Passive Radar which uses targets of opportunity present in the target area as references. The proposed methodology is quite simple and enables the use of low cost hardware with independent oscillators for the reference and surveillance channels which can be geographically distributed.**

Keywords: passive radar, phase correction, low cost hardware.

I. EXTENDED ABSTRACT

There is currently very high research and development activity on the field of passive radars due to their potential interest, both for civilian and for military applications [1, 2, 3].

Passive radar is particularly interesting for Defense applications since this kind of system can work in a passive and covert mode by exploiting the transmitters of opportunity available in a given scenario.

Figure 1 presents the commonly considered geometry for passive radar. In this configuration, a transmitter of opportunity is used as a source of illumination. Two versions of the signal are then acquired. One version is directly received by the reference antenna, while the other version, which is scattered by the objects in the target area, is received by the surveillance antenna. Putted simply, both signals can then be down converted, digitized and cross correlated in order to detect the targets of interest.

In monostatic radar configuration, the time delay between the transmission of pulses and the receiving of the echoes determines ranges. For bistatic passive radar configuration, a system for synchronizing the reference channel and the surveillance channels is required.

Ground based transmitters with high power, such as broadcast FM radio, analog and digital TV, among others, are commonly used as transmitters of opportunity with some success [3, 4, 5]. However, the use of low power transmitters, such as space-based DVB-S illuminators, have been used in a very small number of publications such as [6, 7, 8], since their signals reach the Earth surface with very low power level.

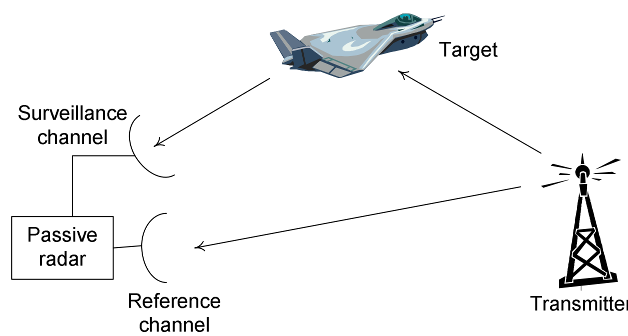

Fig. 1. Passive bistatic radar acquisition geometry. Direct signal from the transmitter is reflected on a given target. The receiver antenna processes both the direct and the reflected signal. These two signals exhibit high correlation between themselves..

In these scenarios which use very low power illuminators of opportunity, relatively long integration times are required in order to obtain reasonable values of SNR [6, 7]. This however implies that, besides frequency correction, the coherency of LO in the receivers need to be maintained during long time intervals, which can be very difficult.

A simple solution to this problem can consist in using a single local oscillator which is fed to all the receivers. This, however, has the limitation that receivers cannot be far apart [6] from each other. Another simple method of synchronization can use a physical link between both receiver oscillators. The major drawback of this solution, is the strongly limited distance between the receivers for the reference and the surveillance channels. In the situation where it is desirable, or necessary, to have dispersed receivers, such as in a multistatic passive system, this solution is no longer feasible and a more sophisticated and costly methods, such as those base on the GPS timing signal can be used as alternative [7].

In the present paper a novel methodology is proposed to obtain coherency between dispersed receivers using as references targets of opportunity that are available in the target area. The methodology, which further elaborates on [8], does not require any additional hardware being able to work with asynchronous receivers that are far apart from each other.

Let us consider a passive radar in the context of Fig. 2, using spaceborne reference signals.

The SCR, in each measurement, is very low since the system uses spaceborne signals. Under these circumstances the classical solution consists in coherently adding several measurements of the same area [6, 7] in order to increase detectability. However, since we are considering that the local oscillators are not synchronized between them, this solution cannot be used.

To overcome this situation, a very simple methodology is proposed. In order to correct the phase, the system uses a reference target which is present for all measurements. This way, since the reference target position is known, the signal phase, after pulse compression for each measurement, can be corrected and the signals summed coherently. Figure 2 presents the considered scenario.

The main idea is to use a stationary object with relatively high RCS present in the target area as a reference. Since the location of the reference target is known, the natural phase drift that occurs between the LOs on the reference and surveillance channels, as well as with the surveillance channel itself for different times can be corrected.

The full paper and the presentation will make the theoretical analysis of the proposed methodology and validate it with results both from simulations and from a real passive system using geographically distributed channels.

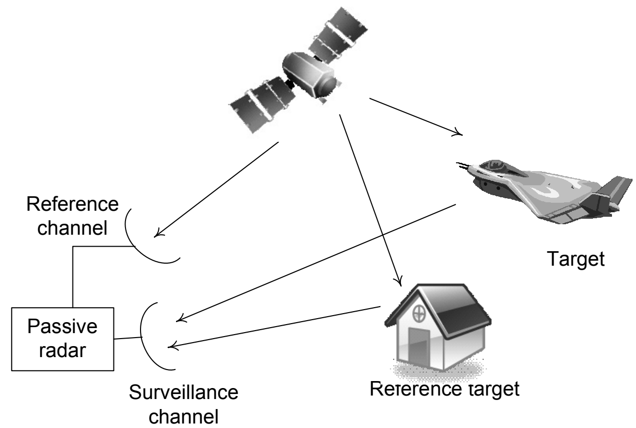

Fig. 2. Passive bistatic radar acquisition geometry using a reference target to correct the signal phase.

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