Joint Doppler Estimation and Mitigation of Intercarrier Interference in Wireless Communication System

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Abstract :

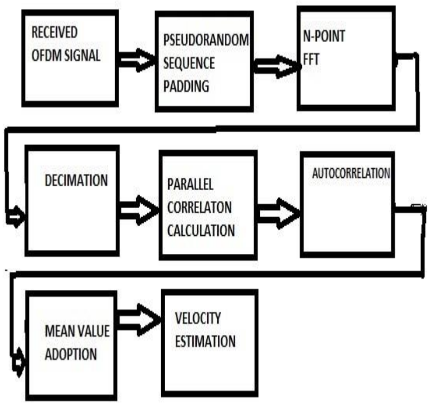
In the presence of intercarrier interference (ICI), conventional orthogonal frequency-division multiplexing (OFDM) radar exhibits serious performance degradation when estimating the Doppler frequency of a target. In this letter, a two-step Doppler estimation scheme is proposed for OFDM radar. In order to mitigate ICI, a sequence with a good correlation property is assigned to the subcarriers to generate an OFDM signal, and oversampling is applied to the received OFDM signal in the frequency domain. Then, Doppler estimation with coarse and fine estimating steps is performed to achieve accurate Doppler estimation. Autocorrelation and mean value adoption is done for Doppler shift estimation. Pseudorandom padding is included. Finally, for ICI mitigation adaptive filter is used. The project deals with pseudorandom sequence for padding. Two tire Doppler estimation is done through autocorrelation and mean methods. Next is to mitigate intercarrier interference by using adaptive filters.

I. INTRODUCTION

An orthogonal frequency-division multiplexing (OFDM) signal is one type of multicarrier radar signal that has been actively studied because it has many advantages, such as good detection performance, frequency agility, and Doppler tolerance, compared with the conventional radar systems. Communication today mainly face this Doppler shift. As each signals get varied and interference is much high large signal loss clearly affect the margins. As an extension of the scheme in this letter, a two-step Doppler estimation scheme utilizing sequences with a good correlation property and oversampling in the frequency domain is proposed for OFDM radar. The proposed scheme effectively mitigates intercarrier interference and performs very accurate Doppler estimation by sequentially performing coarse estimation and fine estimation. In addition, it is shown that parallel calculation of correlation values in the proposed scheme makes it possible to implement a receiver more efficiently and reduce the estimation latency.

Orthogonal frequency division multiplexing (OFDM)-based schemes have been adopted for several current communication systems globally . In an OFDM-based system, a serial symbol stream is converted into a parallel stream and each symbol is modulated with different orthogonal subcarriers. Orthogonal subcarriers and cyclic prefix (CP) usage provide robustness to OFDM-based systems against the frequency selectivity of wireless channel. However, OFDM-based systems have relatively longer symbol durations compared with single-carrier systems. Longer symbol duration leads to weakness against the time variation of the channel, i.e., Doppler spread, which causes loss of orthogonality between the subcarriers.

II. FIRST STEP OF DOPPLER ESTIMATION (AUTOCORRELATION)



Block Diagram 1

In this autocorelation estimation step, we estimate to obtain . For each , we calculate as where and denote the real and imaginary parts, respectively. Note that the th decimated symbol must be shifted by using obtained in . By compensating OFDM symbols using the IDF obtained in the first step, the phase ambiguity is eliminated, and the remaining fractional Doppler shift can be accurately estimated. Finally, the FDF is estimated by averaging as Now, the radial target velocity is obtained by combining (7) and (9) as follows: where denotes the wavelength of the

OFDM radar signal assuming a narrowband OFDM signal, i.e., the operating (or carrier) frequency is much larger than the OFDM signal bandwidth. Note that the average operations reduce the effect of noise to improve the estimation performance. The purpose of the second step is to estimate the phase shift more precisely by using .A block diagram of the proposed Doppler estimation.

III. SECOND STEP OF DOPPLER ESTIMATION (MEAN VALUE ESTIMATION)

Autocorrelation, also known as serial correlation or cross-autocorrelation,[1] is the cross-correlation of a signal with itself at different points in time (that is what the cross stands for). Informally, it is the similarity between observations as a function of the time lag between them. It is a mathematical tool for finding repeating patterns, such as the presence of a periodic signal obscured by noise, or identifying the missing fundamental frequency in a signal implied by its harmonic frequencies. It is often used in signal processing for analyzing functions or series of values, such as time domain signals.

The figure 1 shows the simulation result of different methods. After the analysis of graph we can easily find that minimum norm with eigen value has the maximum Doppler estimation capacity.

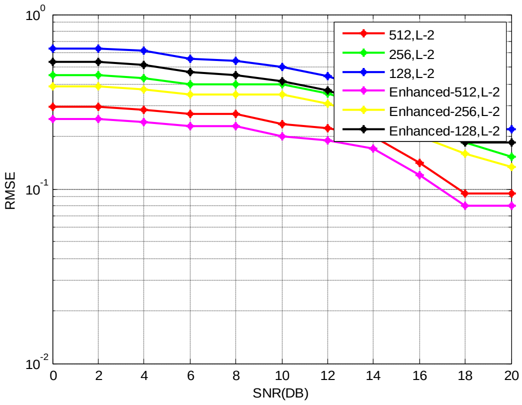
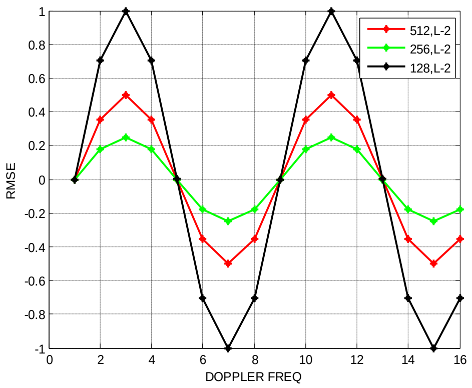


Figure 1

IV. INTERCARRIER INTERFERENCE MITIGATION BY ADAPTIVE FILTER.

An adaptive filter is a system with a linear filter that has a transfer function controlled by variable parameters and a means to adjust those parameters according to an optimization algorithm. Because of the complexity of the optimization algorithms, almost all adaptive filters are digital filters. Adaptive filters are required for some applications because some parameters of the desired processing operation (for instance, the locations of reflective surfaces in a reverberant space) are not known in advance or are changing. The closed loop adaptive filter uses feedback in the form of an error signal to refine its transfer function.

Generally speaking, the closed loop adaptive process involves the use of a cost function, which is a criterion for optimum performance of the filter, to feed an algorithm, which determines how to modify filter transfer function to minimize the cost on the next iteration. The most common cost function is the mean square of the error signal. As the power of digital signal processors has increased, adaptive filters have become much more common and are now routinely used in devices such as mobile phones and other communication devices, camcorders and digital cameras, and medical monitoring equipment



V. CONCLUSION

In this letter, a two-step Doppler estimation scheme that effectively mitigates ICI is proposed. During the coarse estimation step, we take advantage of good correlation property of the sequence used. By using the results of coarse estimation, additional fine estimation is performed to do more accurate Doppler estimation. Furthermore, oversampling and decimation in the frequency domain allow parallel calculation of correlation values, which enables more efficient receiver implementation and reduces estimation latency. It is clear that the proposed two-step Doppler estimation scheme is very effective for system requiring very accurate Doppler estimation

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