Radio-Location Techniques under Adverse Channel Conditions

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A wide range of services and applications become possible when accurate position information for a radio terminal is available. These include: location-based services; navigation; safety and security applications and others.

This paper addresses the problem of locating and tracking a low-power beacon signal in an adverse, multipath environment. We used a wideband signal because the impulse response allows us to reject some of multipath components in the environment. Orthogonal Frequency Division Multiplexing (OFDM) is a multi-carrier technique that has recently received considerable attention for high speed wireless communication. It has been under study to achieve more accurate mobile station positioning because OFDM is tolerant of frame timing error when using a cyclic prefix (CP), simple to generate and straightforward to use for channel estimation but it is sensitive to frequency offset error so we transmit a heavily coded OFDM signal that aids frequency offset estimation. We can then: estimate and correct the frequency offset error; estimate the channel; determine the impulse response; select the loudest and/or first-to arrive multipath component; hence reject most of the noise; can then determine Angle of Arrival (AoA) of the selected path; can also transmit heavily coded low data rate signal. In this paper we evaluate the technique by MATLAB simulation for a wideband transmission and direction finding system.

This approach takes advantage of delay discrimination to improve angle-of-arrival estimation in a multipath channel with high levels of additive white Gaussian noise. Frequency offset estimation is complicated by the poor SNR and represents the most significant challenge for effective operation. The simulation improves the performance of OFDM signal by mitigating the effect of frequency offset synchronization to give error free data at receiver, good angle of arrival accuracy and improved SNR performance. The simulation was run with ideal frequency offset estimation, the technique was found to perform satisfactorily in SNRs in the range -20dB to -38dB, however, the frequency offset estimation algorithm operated satisfactorily only over the range 0dB to -18dB. We conclude that further refinement of the offset estimation process is the key to obtaining satisfactory performance. We apply cross correlation of OFDM symbols signal with conjugate of second spread coding by using a trial fractional frequency offsets (δf). The peak of the autocorrelation function (ACF) indicates the whole number (of subcarrier spacings (Δf)) part of frequency offset as shown in Figure 1. The centroid of the distribution of peak values indicates which the best estimate for fractional offset is.

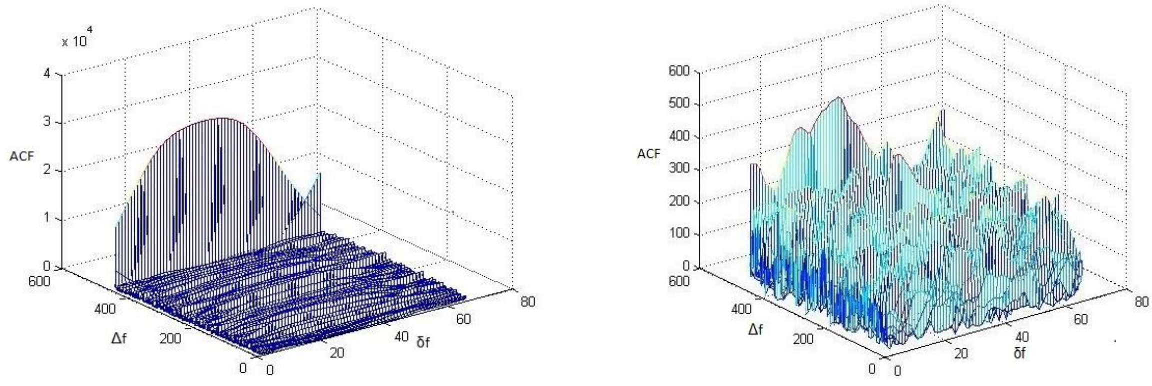

Figure 1: Extract ACF peak locations from noisy data with SNR -2dB (left) and -20dB (right).

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