Research on Integrated Sensing and Communication Based on Linear Frequency Modulation

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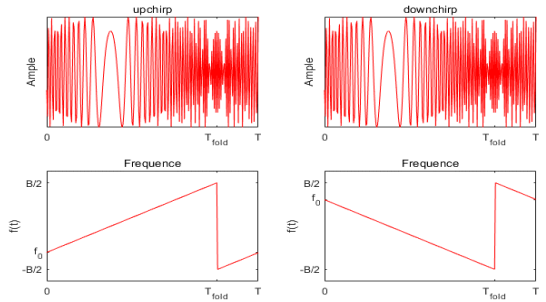
1. Introduction

With the bandwidths of communication system and sensing system are getting closer and closer, they are more possible to work in the same system. We propose an integrated waveform for radar and communication based on frequency shift chirp modulation (FSCM), and also propose the relevant algorithms.

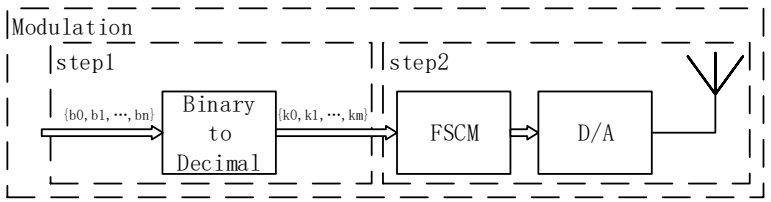
2. FSCM

FSCM uses the chirp wave to transmit information, a chirp wave sweeps the bandwidth in a period from the initial frequency to half bandwidth and folds.



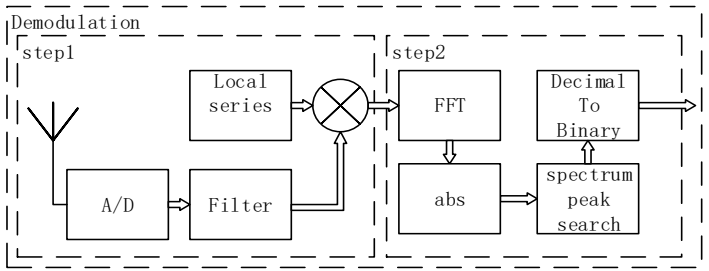
2.1 The modulation steps as below:

1. The binary information {b0,b1,…bn} is encoded to decimal sequence {k0,k1,..,km}.
2. The elements of decimal sequence are mapped to different initial frequencies $f_i = k_i B/N$, modulated to FSCM wave and transmitted.



2.2 The demodulation steps as below:

1. After filtered, the received signal is multiplied with local series.
2. We use FFT to get the signal initial frequency. Analyze the frequency and de-mapping to get the decimal sequence. Decode the decimal sequence to binary.



3. Integrated waveform

The integrated waveform is composed of preamble and payload. The preamble is used for timing, frequency-offset estimation, radar range and velocity measurement.

4. The algorithms

For Communication: 1.while detecting signal, we do timing adjustment. 2.If the upchirps and synchronization words are almost with no offset after timing adjustment, it indicates the doppler and time delay are coupled. 3.Use the downchirps to estimate doppler and do timing adjustment.

For radar: The same as communication, we use downchirps to estimate velocity, however the result before do timing adjustment contains time delay and doppler, and the time delay is relevant to distance.

5. Simulation

In fact, the sensitivity of demodulater is relevant to the gain of DFT and bandwidth. We simulate the spreading factor is 16, bandwidth is 300MHz, carrier frequency fc = 76.8GHz. The result shows that the velocity and range smaller, the BER is better.