Indoor Sensing with UWB OFDM Radar: Experimental Frequency-Domain Approach

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In this work an alternative method to ultra-wideband (UWB) radar detection and target scene assessment is investigated. A traditional UWB radar system usually operates with very short pulses and the signal is processed in time domain; a traditional method of target detection afforded by this approach is, e.g. generalized likelihood ratio test (GLRT). We propose a viable novel method aimed at reducing computational complexity and at exploitation of inherent frequency diversity of many complex target scenes. Instead of utilizing short-pulse UWB radar, we designed and built a software-defined UWB sensor based upon orthogonal frequency division multiplexing (OFDM) signaling. Using OFDM allows us to design waveforms with different spectral composition on a pulse-to-pulse basis, thus providing for a measure of covertness. Additionally, as each UWB OFDM pulse is, essentially, a linear combination of relatively narrowband RF pulses with arbitrary amplitude and phase, centered at prescribed sub-carriers (and orthogonal to one another), we can process each such sub-carrier individually, thus obviating the need for complex electromagnetic analysis of typical UWB signals propagating in realistic environments.

In our previous work (D. Garmatyuk, B. Jameson, et al, IET Radar, Sonar & Navig., vol. 8, no. 9, 1247-1254, 2014) we introduced a frequency-domain method (frequency profile matching, or FPM) of target detection in simple indoor scenarios (e.g. a corner reflector behind a drywall), and tested this approach in single-look, static experiments. FPM was shown to have equal or better performance compared with adaptive GLRT, and lower computational complexity. In this presentation we will discuss an enhancement of this method, designed for a moving sensor – in it, frequency profiles will be combined with angular profiles to create 2-D target scene patterns in frequency-angle domain. We will then present approaches to analyzing these profiles for the purpose of extracting target scene information when no previous knowledge of the scene exists. Experimental results collected using the software-defined UWB OFDM radar sensor (with baseband bandwidth of 600 MHz) will be discussed. Conclusions regarding the viability of this approach compared with traditional short-pulse UWB and time-domain signal processing will be drawn.