Duplex Joint Radar-Communications System Based on FMCW MIMO Radar

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Introduction

● Duplex DFRC Systems for Vehicular Applications
  ➢ Future cars implement both radar and communications on the same platform
  ➢ Two implementing approaches
    • Use individual systems
    • Jointly design a dual function radar-communications (DFRC) system
  ➢ Benefits of full-duplex DFRC systems
    • Improve the spectrum efficiency
    • Reduce system size, weight and power consumption
    • High real-time: Detect the target, transmit and receive the communication signal simultaneously

Theory

● Index Modulation based duplex DFRC System
  ➢ Index modulation (IM)
    • Embed message into the combinations of radar waveform parameters
    • Possible domains: Spatial, spectral and time
    • Have minimal degradation to radar performance
  ➢ Full-duplex technique
    • Separate communication signals and radar echo from mixed echoes
    • Two-way communication in every radar pulse

Contributions

● Contribution of This Prototype
  ➢ Full-duplex design, realizes real-time information sharing and detection between users
  ➢ Implementing IM based DFRC system using low-cost commercial automotive radar
  ➢ Promising to be applied in future intelligent transportation applications

Hardware Implementation

● Architecture of the Prototype

Graphical User Interface

● Trade-off between Bit Rate & Radar Performance

\[
\text{bit rate} = \frac{\log_2 \text{Symbols}}{\text{T}_{\text{chirp}}} = R_{\text{res}} \frac{2^{\text{chirpSlope} + \log_2 \text{Symbols}}}{c} \text{ bit/s}
\]

Parameters in the prototype:

\[
\text{bit rate} = 28.82 \text{Kbit/s} \rightarrow \text{Range resolution} = 0.286 \text{m}
\]

Simulation Results

Communication BER

Radar Recovery