Paper ID: 6934

Single Antenna Joint Radar and Communication Prototype

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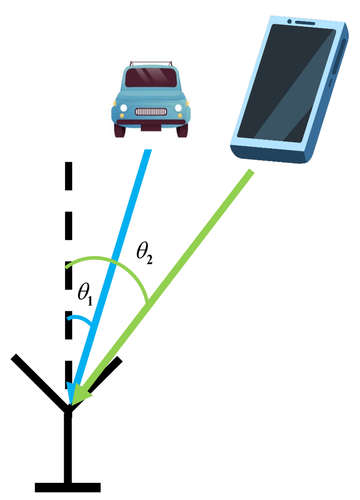
Introduction

Background

- We consider a single-antenna radar and communication system in which the radar echo (chirp) and communication (QPSK) signals overlap in time and frequency domain
- Gap: Currently, most joint radar and communication (JRC) methods cannot be applied in single-antenna scenarios
- We propose a method based on sparse Bayesian learning (SBL) to separate two signals simultaneously



Single antenna

Contributions of This Prototype

- Radar detection: Improved robustness against the communication signal intensity (compared to CS-L1[1] and pulse compression method)
  - CS-L1 is an algorithm based on l_1-norm minimization
  - Pulse compression is a classic method in radar detection
- Communication BER: Approaches the theoretical limit under an additive white Gaussian noise (AWGN) channel
- The method has higher time complexity, but also better performance

Method

- Received signal model

$$y = y_r + y_c + n$$

  - Where y_r are radar echoes, y_c are communication signals and n is Gaussian noise

- Gaussian mixture model (GMM)
  - Model communication signal plus Gaussian noise as interference whose distribution is described by GMM

$$\varepsilon = y_c + n$$

- Sparse Bayesian learning

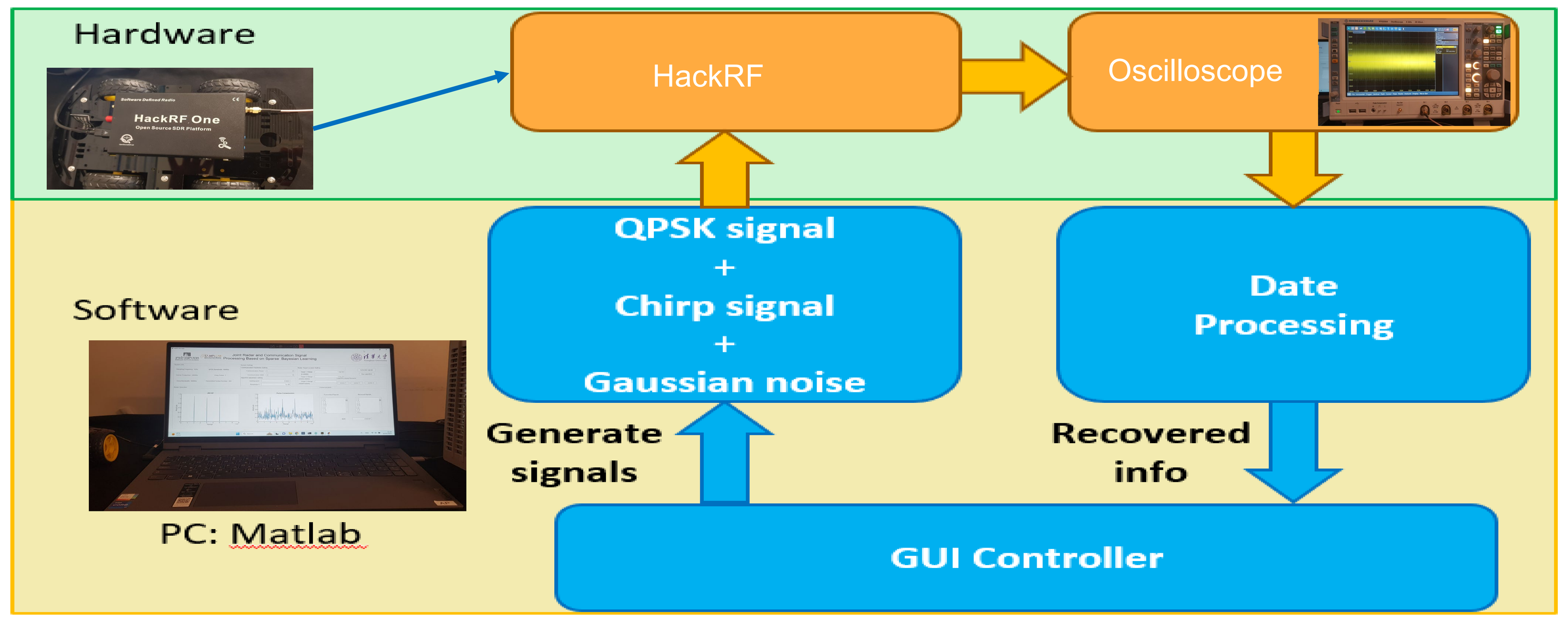
$$y = y_r + \varepsilon = \Theta x + \varepsilon$$

  - x is unknown representing the complex reflection coefficients of the targets. For the scenario that includes Q targets, Q entries are non-zero in x
  - Recover sparse vector x under GMM interference using SBL

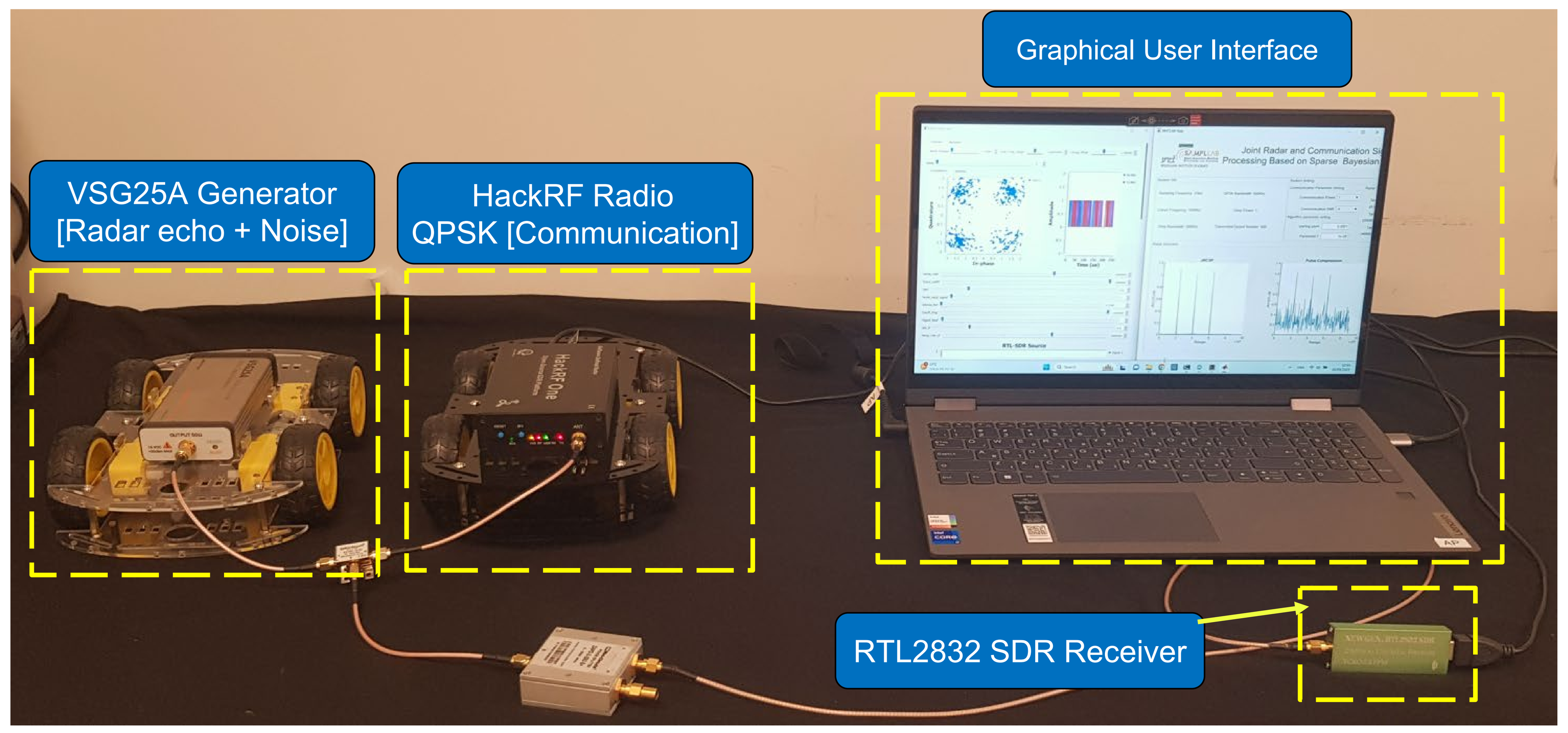
[1] Zheng L, Lops M, Wang X. Adaptive interference removal for uncoordinated radar/communication coexistence. IEEE Journal of Selected Topics in Signal Processing, 2017, 12(1): 45-60.

Hardware Implementation

Architecture of the Present Prototype



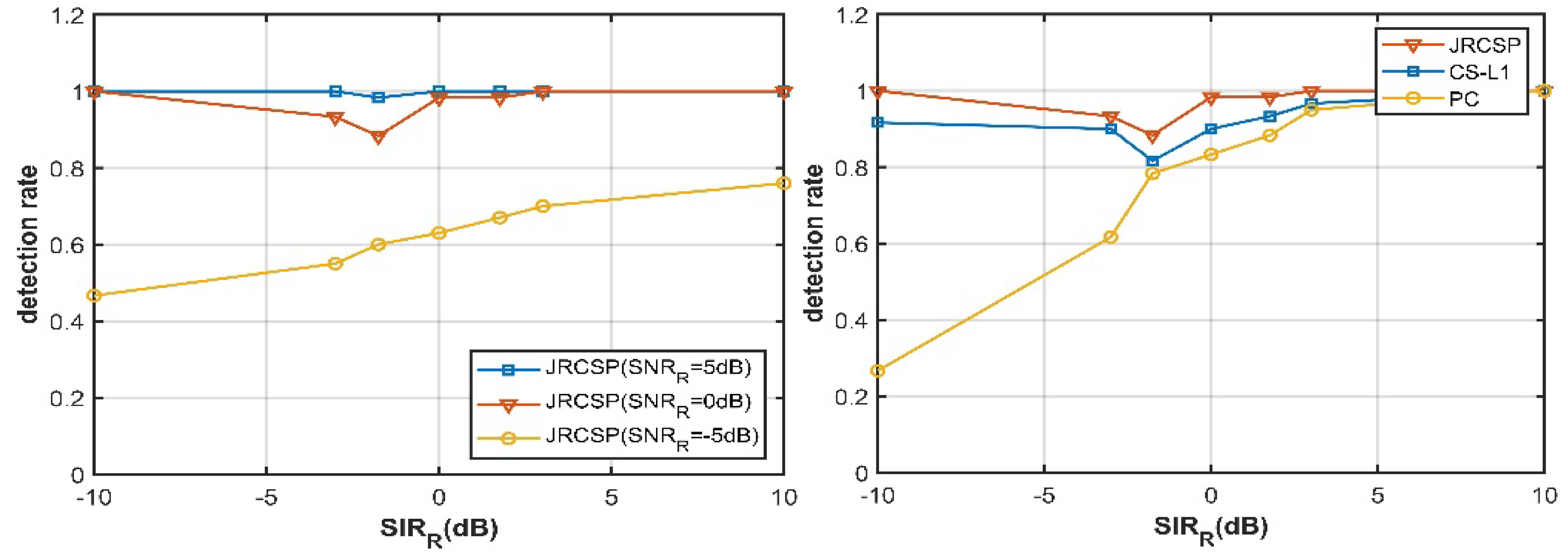
Final Design of the Prototype



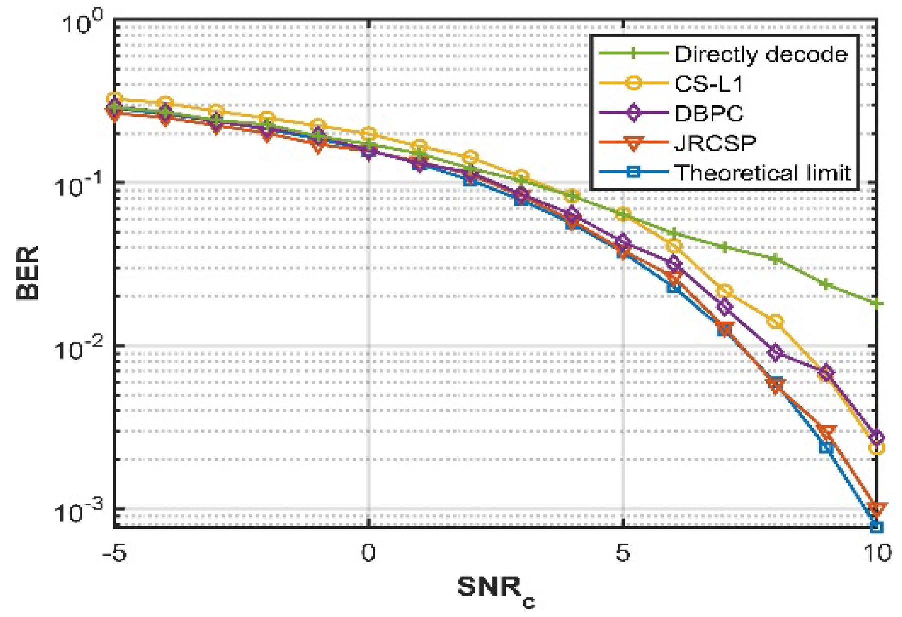
Graphical User Interface

Simulation Results

Radar Detection



Communication BER



- The algorithm outperforms other methods
- The gap becomes significant with the increase of SNR_C