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Sparsity-Based Motion Detection Using Distributed Radar Systems

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1. Extended Abstract

Compressive sensing and sparse signal reconstruction have been studied extensively in many areas, including radar. Sparsity-based scene recovery techniques have been shown to outperform least squares and backprojection methods when producing a radar image of the scene being investigated. The scene can be sparse in space and/or Doppler. The former includes sparsity in range and cross-range, and for the latter, the sparsity can be in velocity and acceleration.

Sparse reconstruction techniques can be applied when electromagnetic (EM) sensing is performed using co-located or distributed sensor configurations. A network of distributed radar systems offers the advantage of flexibility, high accuracy and fault tolerance over a co-located configuration [1]. In this paper, we present a sparsity-based motion detection scheme for a network of distributed radar systems. We assume each radar system is equipped with a limited number of transmitters and receivers and employs the same bandwidth. The radar units within the network are assumed to be widely distributed around a region of interest and both centralized and distributed processing are considered. The former assumes that the radar measurements from all radar systems are combined in a single central processing station, whereas the latter assumes the radar systems to cooperate with one another with the processing carried out in a distributed fashion across the various systems. The decentralized approach provides a more fail safe and reliable overall system as compared to the centralized approach. This is because several nodes compute and share information in order to provide improved motion detection performance with the least possible amount of communications. Since no central data fusion is necessary and the computation depends on several nodes, such a system has no single point of failure.

We formulate the received signal model relating the radar measurements with the scene being interrogated and the sparsity-based motion detection problem for both the centralized and distributed processing schemes. Since the target is viewed by each radar within the distributed configuration from a different aspect angle, the measurements from each radar unit cannot be combined in a coherent manner for the centralized processing scheme. Instead, the radar measurements are combined in a noncoherent manner to account for the variations in the target radar cross sections from one radar unit to another. In case of the decentralized processing, we consider various distributed sparse recovery methods for motion detection [2-4] and evaluate the communication requirements for each considered algorithm. Detailed analysis and supporting results will be provided in the presentation, comparing and contrasting the motion detection performance of the centralized and decentralized schemes for distributed radar systems. Both simulation and real radar measurements will be employed for performance validation.

2. References

1. Y. Teng, H. Griffiths, and C. Baker, "Fundamental aspects of netted radar systems," in *RTO set-095 specialists meeting on bistatic and multistatic radar and sonar systems*, La Spezia, Italy, June 2006.

2. G. Li and R. Burkholder, “Hybrid matching pursuit for distributed through-wall radar imaging,” *IEEE Transactions on Antennas and Propagation*, vol. 63, pp. 1701–1711, Apr. 2015.

3. T. Wimalajeewa and P. Varshney, “Cooperative sparsity pattern recovery in distributed networks via distributed-OMP,” in *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, (Vancouver, Canada), pp. 5288–5292, May 2013.

4. W. Dai and O. Milenkovic, "Subspace pursuit for compressive sensing signal reconstruction" *IEEE Transctions on Information Theory*, vol. 55, pp. 2230-2249, May 2009.