Jue WANG, Jun WANG, 2018. Joint compressed sensing imaging and phase adjustment via an iterative method for multistatic passive radar. *Frontiers of Information Technology & Electronic Engineering*,19(4):557-568.
https://doi.org/10.1631/FITEE.1601423

Joint compressed sensing imaging and phase adjustment via an iterative method for multistatic passive radar

Key words: Multistatic passive radar; Compressed sensing;
Phase adjustment; Fixed-point iteration technique

Corresponding author: Jue WANG
Email: xdwangjue@163.com
ORCID: http://orcid.org/0000-0003-1717-6750

Motivation

1. The resolution of the multistatic passive radar imaging system (MPRIS) is poor due to the narrow bandwidth of the signal transmitted by illuminators of opportunity.
2. The inaccuracies caused by the inaccurate tracking system or the error position measurement of illuminators or receivers can further deteriorate the quality of images.

Main idea

1. To improve the performance of MPRIS, an imaging method based on the tomographic imaging principle is presented.
2. A phase correction technique is developed for compensating for phase errors in MPRIS.

Method

1. The compressed sensing (CS) technique is extended to MPRIS to realize high-resolution imaging.
2. Phase errors can be estimated by iteratively solving an equation that is derived by minimizing the mean recovery error (MRE) of the reconstructed image based on the principle of the fixed-point iteration technique.

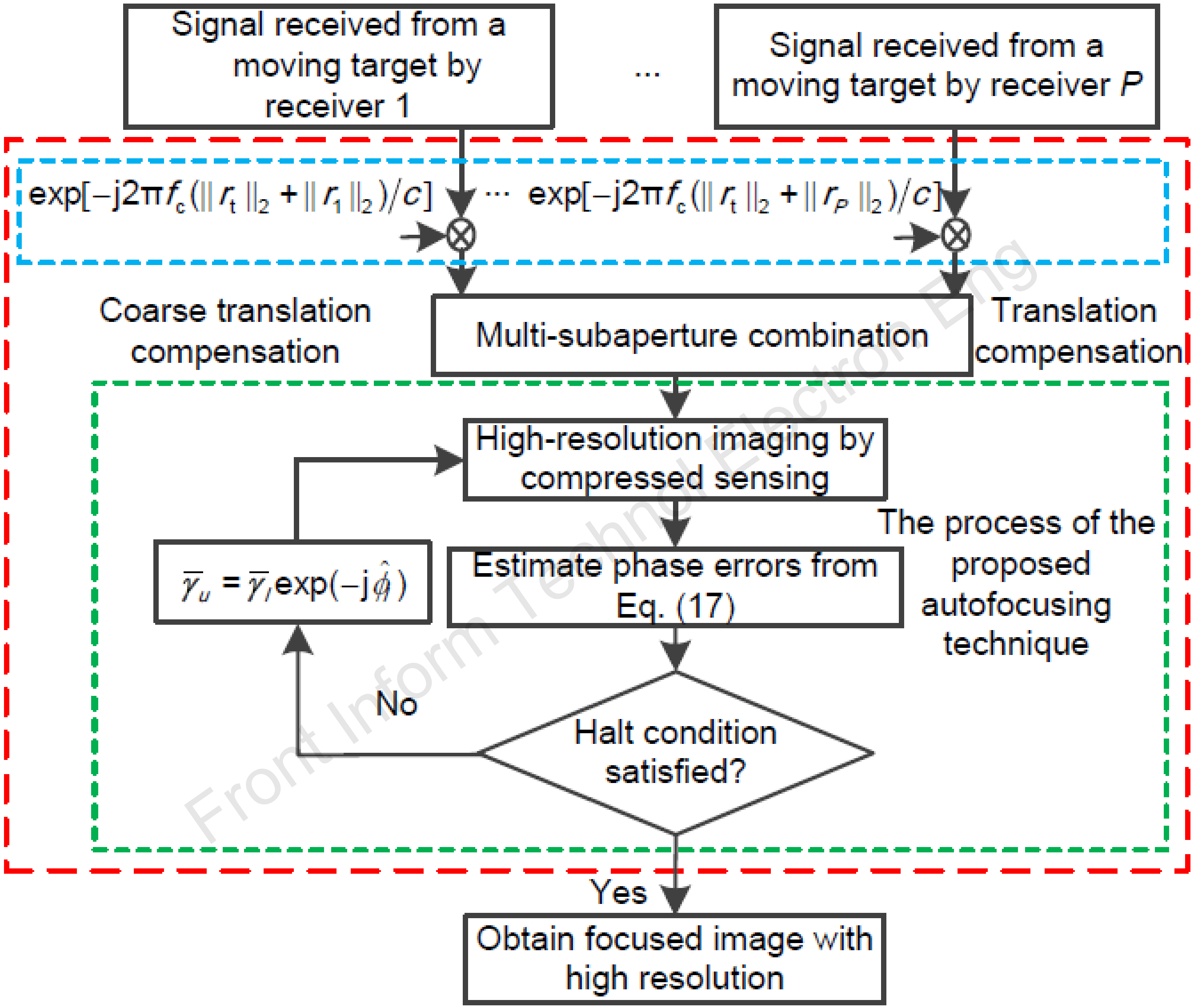

Fig. 3 Flowchart of multistatic passive radar imaging

Major results

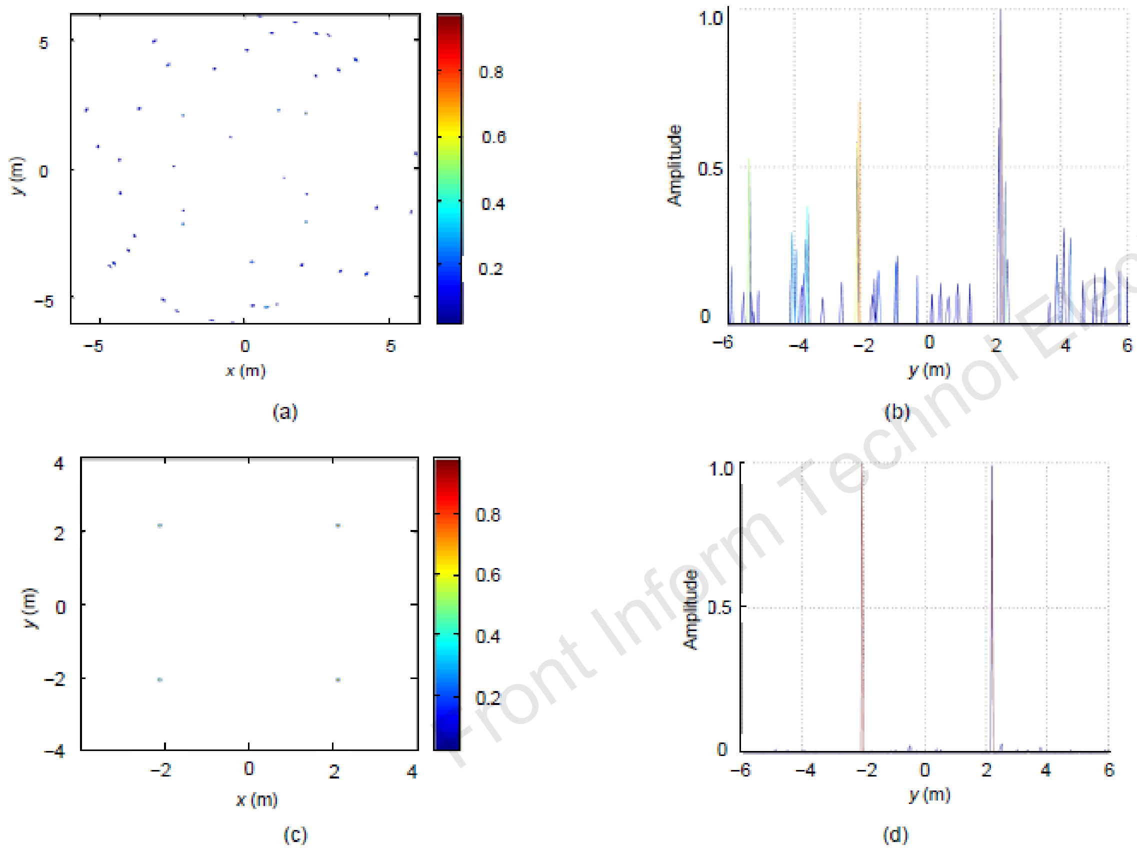

Fig. 6 Reconstructed image results before and after using the proposed autofocusing technique: (a) reconstructed image with the phase error; (b) profile of the defocused image; (c) image refocused by the proposed autofocusing technique; (d) profile of the refocused image (References to color refer to the online version of this figure)

The image result reconstructed by CS without phase error compensation when half of the sub-apertures are missing is shown in Fig. 6a. The profile of the image along *y*-axis is shown in Fig. 6b. We can see that the residual phase errors would deteriorate the quality of the reconstructed image seriously. Figs. 6c and 6d present the corresponding imaging results with our proposed autofocusing technique.

Major results

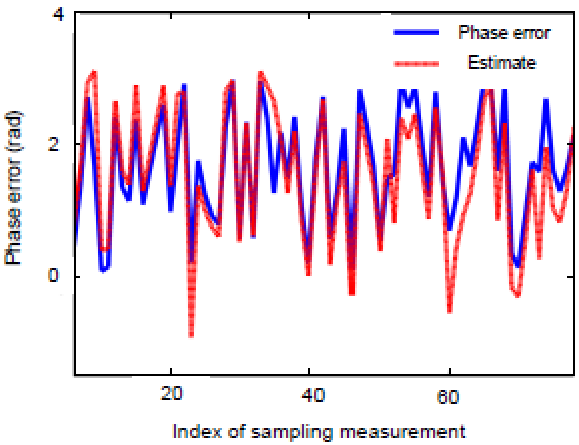

Fig. 7 Comparison of the estimates of phase errors and the true ones

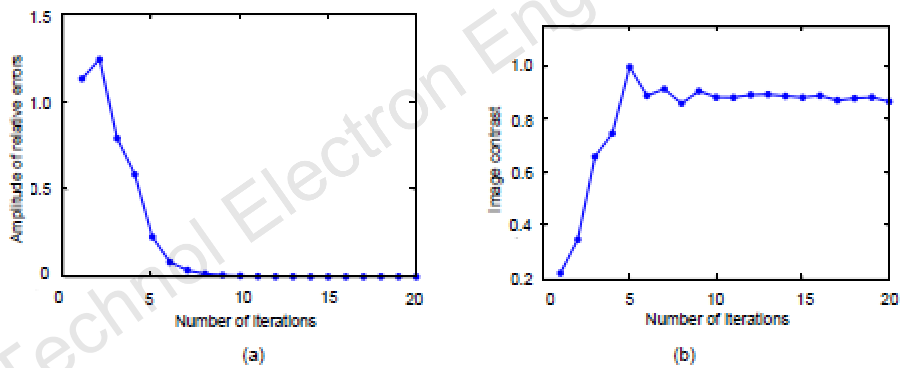

Fig. 8 Performance of the proposed autofocusing technique: (a) variation in the mean recovery error (MRE) according to the number of iterations; (b) variation in image contrast according to the number of iterations

The estimates of the phase errors (dashed line) coincide with the real ones (solid line) basically.

The MRE reaches its minimum after about eight iterations and remains unchanged afterwards. With the increasing number of iterations, the image quality is basically enhanced. After eight iterations, the value of IC remains unchanged. The proposed iterative algorithm obtains convergence.

Conclusions

1. An MPRIS is constructed with a single external illuminator. Since the signal transmitted by the illuminator has a narrow bandwidth and is non-cooperative, we present a polar format imaging algorithm to realize high-resolution imaging based on the tomographic principle.
2. A sparsity driven algorithm is extended to MPRIS and a super-resolution image is obtained even when several sub-apertures are missing.
3. An autofocus technique is developed to improve the performance of the imaging system based on a minimization of the mean relative recovery error of the reconstructed image. The effectiveness of the proposed approach is manifested in theory and by simulation results.