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TOMOGRAPHIC RECONSTRUCTION OF CODED APERTURE IMAGES BY SIMULATED ANNEALING

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Abstract. *In this paper, we propose a new heuristic algorithm for three-dimensional image reconstruction from coded aperture images based on simulated annealing (SA). Since coded aperture can view an object with a large solid angle, it can provide some tomographic resolution for three-dimensional object. We propose to use a heuristic algorithm to remove the defocused artifacts and to improve the tomographic resolution. We also propose a fast algorithm to reduce the large computation cost of the heuristic algorithm.*

Keywords: Uniformly redundant array (URA), Simulated annealing (SA), Tomographic reconstruction, Coded aperture imaging, Fast algorithm, Defocus artifact

1. **Introduction.** A number of coded aperture imaging (CAI) techniques have been proposed or used for radiological imaging [1,2]. The advantage offered by CAI lays in its large photon collection efficiency due to its large open area. So it is possible to obtain an image with a high signal-to-noise ratio (SNR) even for a weak radiation source by using CAI. Uniformly redundant array (URA) is one of the CAI techniques [2]. In URA coded aperture imaging, the pinhole is replaced by multi-pinholes arrays arranged in m-sequences [2]. Since the autocorrelation function of the m-sequence is a delta-function with a uniform background [3], the point spread function of the URA for a two-dimensional object which is parallel to the aperture will be a delta function by using balanced operator as a decoding operator. Furthermore, since CAI can view the object with a large solid angle, it can also provide some tomographic resolution for a three-dimensional object with only one projection [4,5]. Compared with the conventional medical CT (Computed Tomography), the main advantage of the CAI-based CT is that it can be applied to various practical cases where the viewing angles are very limited, such as online defect inspections of industrial parts.

The basic concept of CAI for tomographic imaging is that sources more distant from the detector cast smaller aperture shadows than closer sources and the size of the shadow depends on the distance to the point, while the location of the shadow depends on the lateral displacement of the point. By correlating the recorded image with decoding patterns of different sizes, images of the source distribution at different depths (tomographic images) can be reconstructed. The limitation of CAI is that the tomographic images are usually degraded by defocus artifacts and the tomographic resolution is very limited.