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Author: Ms. Jingwei Yang
Beihang University (BUAA), China, y.jingw@foxmail.com

Prof. You Song
Beihang University (BUAA), China, songyou@buaa.edu.cn
Mr. Juntao Pu
Beihang University (BUAA), China, pujuntao@buaa.edu.cn
Ms. Xiangyue Liu
Beihang University (BUAA), China, liuxiangyue@buaa.edu.cn
Prof. Li Deng
National Space Science Center, Chinese Academy of Sciences, China, dengli@nssc.ac.cn
Ms. Xinyi Fei
Beihang University (BUAA), China, feixy72@163.com

AN OPTIMIZATION ALGORITHM OF BASELINE DENSITY DISTRIBUTION FOR AN ULTRA-LONG WAVE ASTRONOMICAL OBSERVATION ARRAY

Abstract

article

Low frequency exploration on the back of the moon is becoming a research hotspot. Chang'e project, a Chinese lunar exploration project has taken a step forward for this research. On March 1, 2018, the Chinese Academy of Sciences launched the Ultra Long Wave Astronomical Observation Array Background Model Project, a linear formation composed of 1 main star and 5-8 sub-stars, to carry out observations on the ground behind the lunar orbit. Directed line segments formed between satellites and satellites are called baselines. Formation satellites use baseline changes and image inversion algorithms brought about by coordinated observations of formations and orbital evolution. Low-frequency sub-satellites acquire high-resolution sky image and spectra in the $1 \sim 30$ MHz band. High-frequency satellites acquire high-precision all-day average radiation spectrum in the $30 \sim 120$ MHz frequency band, opening a new window for ultra-long wave astronomical observations.

When satellite formations move around the moon, sampling points from trajectories formed by different baselines will obtain a baseline density distribution map. The optimization of baseline density distribution to maximize the utilization of observation data will provide a solid foundation for the ultra-long-wave astronomical observation array plan to obtain high-quality sky image.

An optimal solution search algorithm based on particle swarm optimization algorithm is described in this paper, which optimizes the baseline density distribution by continuously adjusting the initial deployment position of satellite formations. First, extract the number of points in each bright temperature interval from the known sky image to obtain a standard distribution curve. Then use the dynamic time warping algorithm as the curve similarity determination method and refer to the absolute value distance. Apply the particle swarm optimization algorithm, repeatedly adjust the parameters, and search for the most Excellent solution. Experiments show that the sky image quality calculated by the optimal solution is the best, and this method can better meet the needs of the project.

In summary, the thesis implements an optimal solution search algorithm suitable for baseline density optimization, which is of great significance for the ultra-long wave astronomical observation array plan.