Electric Field Strength Reconstruction based on Compressed Sensing in Ascending Order

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Abstract

In order to solve the problem that the electric field strength data change drastically, it is difficult to reconstruct the electric field with compressed sensing(CS) using the discrete wavelet transform (DWT) basis. This paper proposes a method of electric field strength data reconstruction based on compressed sensing in ascending order. Which sorts the electric field strength data in ascending order, and then use the discrete wavelet transform basis of compressed sensing to reconstruct it. When the electric field strength data are sorted in ascending order, the sparsity of the electric field strength in the discrete wavelet transform domain has been significantly improved. We conducted simulation experiments on the electric field strength data of the half-wave dipole antenna in free space. The experimental results show that the electric field strength reconstruction effect after ascending sorting has been greatly improved.

A. Field Reconstruction model of Compressed Sensing

In field reconstruction, we convert the 2-D electric field strength data into a 1-D vector x of column stacking. In Fig.1, the $\boldsymbol{\Phi}$ is the random measurement matrix, the black squares of denote 1 and the white squares denote 0.

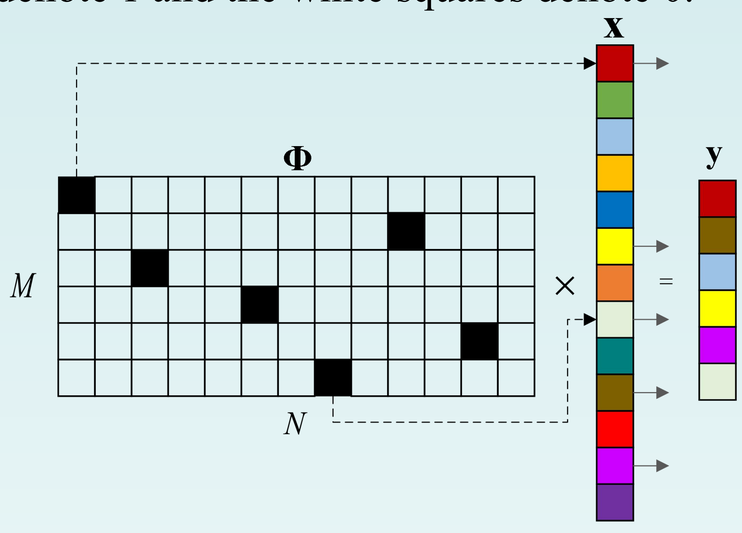


Fig. 1. Field reconstruction model of compressed sensing

B. Sparsity of electric field strength data before and after ascending order

The half-wave dipole antenna in free-space, f is 1GHZ, it is located in the center of a square with a side length of 500m, 49m from the ground, and the observation surface height is 0m, the calculation step is 5m. Which is shown in Fig. 2.

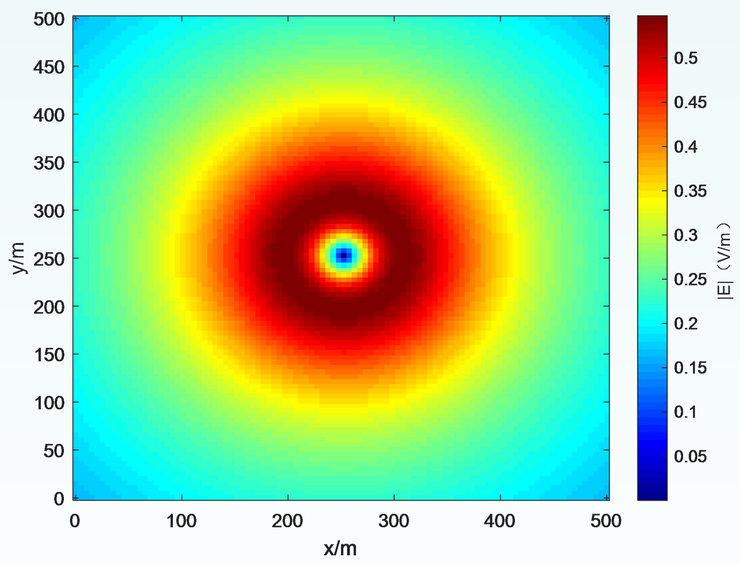


Fig. 2. Distribution diagram of the Electric field strength (N = 10000).

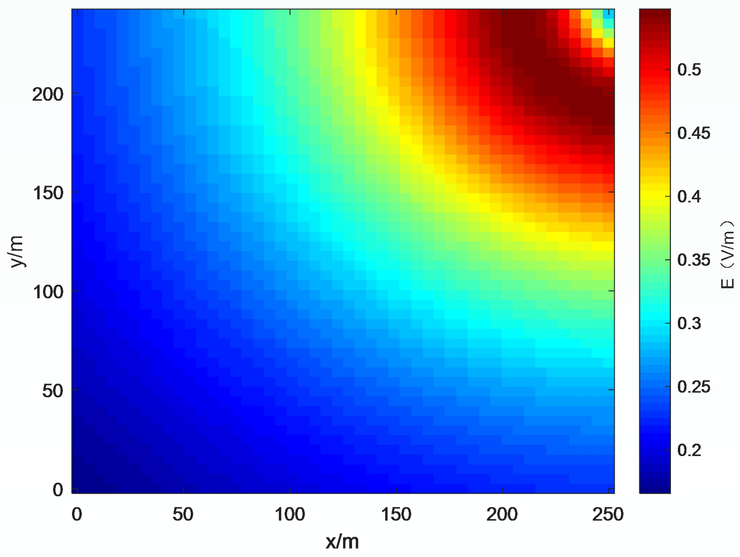
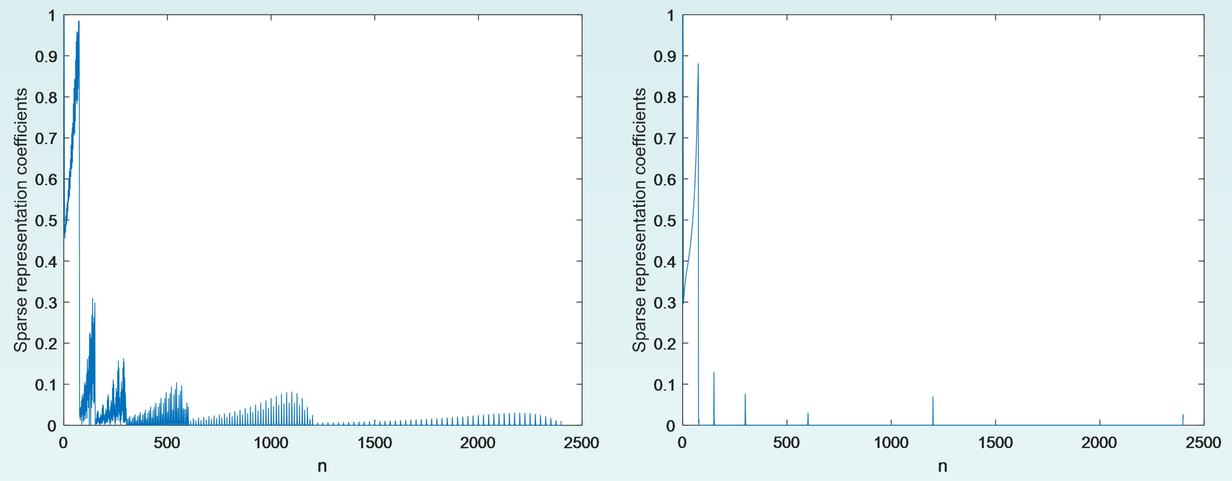


Fig. 3. Distribution diagram of the original electric field strength (N = 2400).

In this paper, a total of 2400 electric field strength data in the 240m*250m area of Fig.2 are selected as the original electric field data. Which is shown in Fig. 3.

The normalized sparse coefficients of the original electric field strength data in the DWT(Daubechies-4, level 5) domain before and after ascending order are shown in Fig. 4.(a) and (b) respectively.

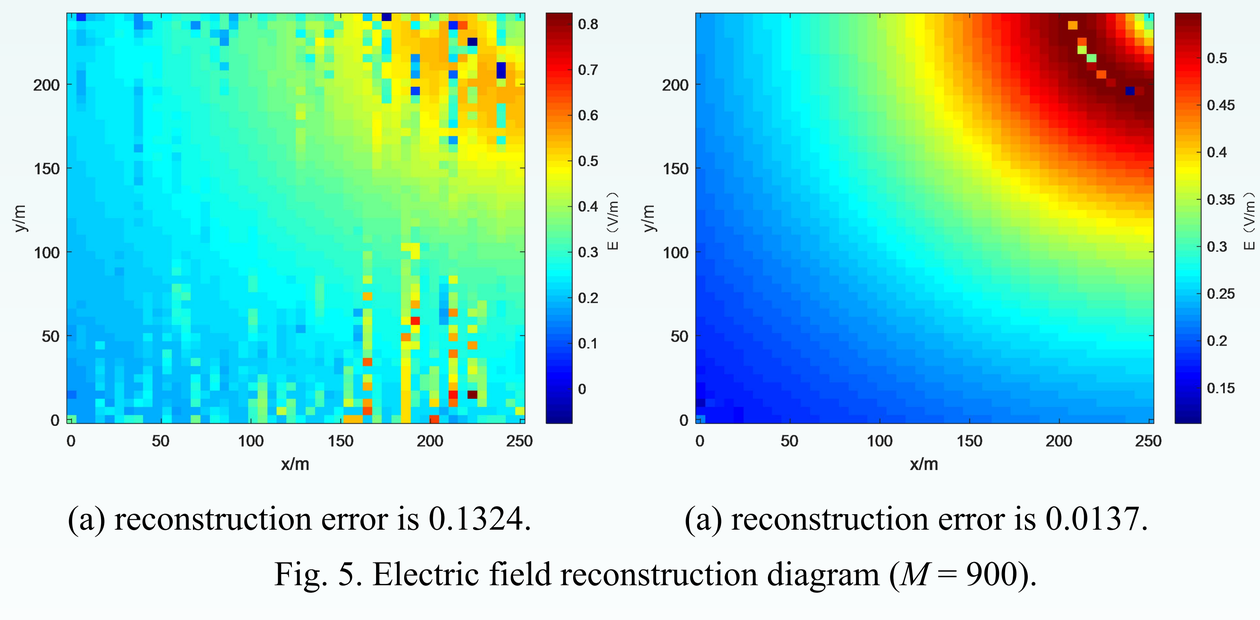


(a) Sparsity= 256. (a) Sparsity= 75.

Fig. 4. Normalized sparse coefficients diagram.

C. Reconstruction effect

When the number of measurements is 900, the reconstruction effects of original and ascending electric field strength data are shown in Fig. 5(a) and (b) respectively.



(a) reconstruction error is 0.1324. (a) reconstruction error is 0.0137.

Fig. 5. Electric field reconstruction diagram (M = 900).

Conclusion

This paper proposes a method to sort the electric field strength data in ascending order before field reconstruction. Which enables DWT matrix to be used as a sparse basis. The sparsity of electric field strength in the DWT domain has been significantly improved after sorting in ascending order. The electric field strength simulation experiments of the half-wave dipole antenna in free-space prove which has a better reconstruction effect than original electric field. This method also has shortcoming that is difficult to achieve in practical applications, but it can be used as a compressed transmission of electric field strength data, which can effectively reduce the amount of storage and transmission of electric field strength data.