The minimum sample region required to predict the far-field RCS from the bistatic near-field data

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***Abstract* - For complex targets, a full bistatic near-field scattering data is required for measuring the far field radar cross section (RCS) in principle, but the acquisition time and the computational effort may be prohibitive.In this paper, we consider the far-field monostatic RCS is presented by exploiting only the near-field data relative to an angular region centered on the direction of interest, this area is the minimum sample region. Since the corner reflector is a typical multiple scattering structure, the size of the surface scanned from the near-field depends on scattering characteristics of the target. Analyses were conducted on the near-field data, we can found a zone which contains mutation of scattering characteristic. When collecting the bistatic near-field scattering data, most of the scattering information of the target can be obtained as long as the mutation zone is covered. Therefore, a fast and efficient algorithm is obtained through the analysis and simulation.**

***Index Terms* —near-field, far-field, extrapolation method, truncated angular sector .**

1. Introduction

Techniques for exploiting a subset of monostatic near-field measurements to estimate the monostatic far-field RCS have been formulated and demonstrated in [2]–[5]. In principle, the full bistatic near-field scattering data is required for measuring the far field RCS, but for large objects, the acquisition time and the computational effort may be prohibitive .Therefore, a development of efficient RCS evaluation algorithm is required. In general, the extending scope of the scattered field is relatively wide. Objectively, the range of the scannering surface should be wide enough to reduce the truncation error.

However, actually the range of the scanning surface is always limited in bistatic near-field scattering measurement. In this case, in order to ensure the accuracy of the measurement, the way choosing the range of the scanning surface and processing data has become significantly. This issue is also the core issues to be addressed in this article. In the aspect of accurate evaluation of the monostatic RCS, the requested near-field measurement data is lower than the theoretical one, and will decrease as the measuring distance separates toward infinity. So only the bistatic data obtained in a limited angular sector around the direction of interest should be relevant. The main purpose of this paper is to solve these fundamental problems with a dihedral model.

2. Description of the method

Considering the particularity of concave target, when a location is illuminated by the incident wave, the received data mutated apparently. Assuming that it is the mutation zone of the scattering characteristic, then it can be found via a series of analyses to the near-field data.

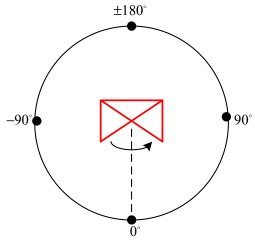

Fig.1. The geometric model

As is shown in figure 1, the transmitter is located at 0°, and the data is received from -180° to 180° at an interval of 1°.Consider that the target is contrarotating by 1° step-by-step, if the target is symmeteical, only half of the data is necessary. At first, the bistatic information of the target under all the angles received from -180° to 180° is obtained. Then the variation trend of the data received from the adjacent angles as the target rotated for half a round can be observed from the result of bistatic scattering data minus the data 1° before rotated. Finally, each of the row vectors is taken out and the scattering variation trend of a certain row corresponding to an angle range from 0° to 180° is obtained. Since the received near-field data is about the effective coverage of the central angle when cutting off the near-field measurement, searching out the location where the saltation happened and figuring out the relative angle between the location and the target center, so the relative angle is considered to be the range boundary of the truncation angular domain we concerned. When gathering the bistatic near-field scattering data, most of the scattering information of the target can be obtained as long as the truncation angular domain is covered.

3. Simulation analysis

In order to verify the proposed method, we established a straight dihedral scatterer using the FEKO simulation software. The dihedral formed by two orthogonal rectangular plates 0.5m. The angle between the two plates is equal to 90°. The aperture's radius r equals to 0.355m. Emission frequency is 1.5GHz,and the radius R of the measuring circle is 2m.

Firstly horn antenna transmitted at 0°, the data is received from -180° to 180° at an interval of 1°. Then the horn antenna transmitted at 1°, the data is received from -180° to 180°. The measurement did it as the rule until the 180° transmitted to get complete bistatic scattering near-field information of the dihedral.

According to section 2 of the analysis, we select a few representative figures from the 179 results:

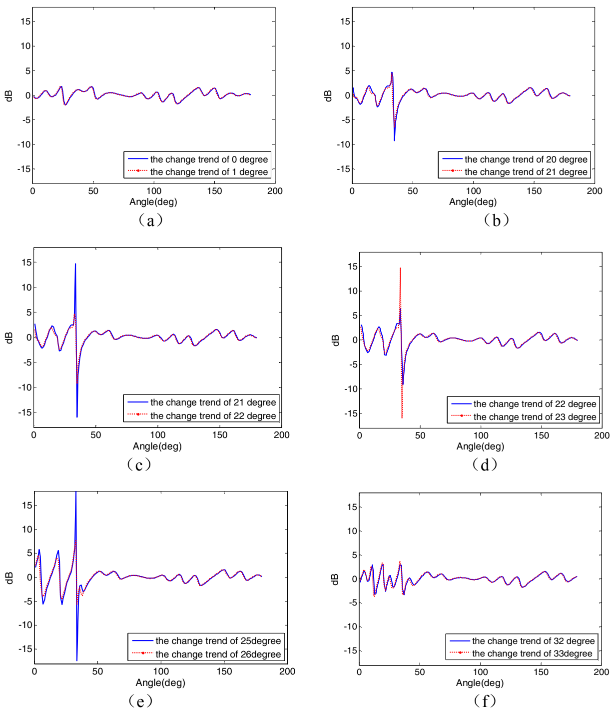

Figure 2: The trend of change in scatter values for different reception angle

The abscissa represents the scattering variation value of the target rotating from 0° to 180°, and the ordinate represents the trend of change in scattering values for different reception angle. The continuous line represents the trend of change that the target rotating from 0° to 180° and the receiver at 0°, as shown in figure 2(a), the dot line represents the trend of change that the receiver at 1°,the two curves fit well. So it can be induced the change of scattering values of target remains stable at any rotate angle of receiver. With the increment of reception angle, the target characteristic remained stable until the receiver located at 20° that curves began to mutate, as shown in Figure 2 (b-e). After a period of instability mutation, the curve keep the coincidence again at 32° of the receiver and keep go on, as shown in figure 2 (f). It means the target scattering properties restore stability. After many times calculation for mutation, it can be obtained that the mutation has a certain relationship with the location of target. Through the analysis of calculation of all position for each mutation, it appears approximately to give the same results. Therefore, we can draw a conclusion that all mutation are occurred within the angle of $\pm14^\circ$ reference to the center of the dihedral angle. On this basis, the near-field acquisition truncation error analysis near angle domain selected $\pm14^\circ$ as shown in figure 3 (a), it can be seen that the minimum average error is 0.46 dB when truncation range of near-field scanning plane is 20°, and the corresponding extrapolating results as shown in figure 3 (b).

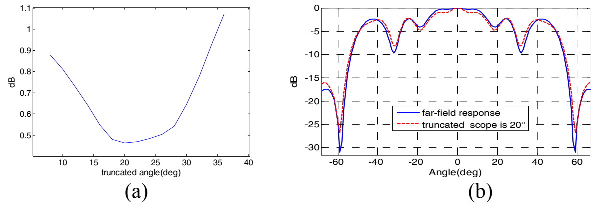

Figure 3(a): Error in different truncation angular domain (b): Continuous line: far-field response; Dotted line: far-field response from near-field dada

4. Conclusion

With a review to the scattering characteristics of cavity targets, the minimum number of bistatic near-field measurements required to evaluate the monostatic RCS of an scatterer has been presented. In particular, it is shown that the evaluation of the monostatic RCS requires the measurement of the near-field bistatic RCS only in a limited angular region, whose extension depends on the scattering characteristics of the target . This result allows to reduce both the measurement time and the computational effort to evaluate the monostatic RCS from near-field measurements. Through simulating a dihedral reflector scaterer, it is proved that the method has high accuracy when calculating the far-field RCS of complex targets.

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