Investigation on Spectrum Estimation Extrapolation Method of Antenna Measurement

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***Abstract* - Measurement precision of Low frequency antenna is poor for the apparent reflection from absorbers in anechoic chamber. According time-frequency transform theory, a certain bandwidth signal holds the ability of certain range resolution, so a time-domain antenna measurement model can be built. Based on real frequency bandwidth, extrapolating the frequency band to lower frequency and higher frequency by spectrum estimation, thus the broader frequency bandwidth is gained, higher range resolution can be realized, so multi-path reflection can be isolated and removed, as a result, measuring precision of antenna pattern will be improved apparently. Results from simulation and experiment show that the method is correct and effective.**

***Index Terms* —low-frequency, spectrum-estimation, extrapolating Antennas, propagation.**

I. INTRODUCTION

No matter for outdoor or indoor antenna test, in addition to the main signal from the transmitter to the receiver directly, some reflected signals of mutilpath propagation may be existed at the receiver. The reflected signals are added to the main signal, which may cause the error of amplitude and phase of received main signal. Therefore, the multipath propagation is an important reason to impact the precision of antenna measurement[1].

Normally, the multipath signals show the delay characteristics in time, thus the time domain antenna measurement methods are used to separate the main signal and mutilpath signals. The time domain antenna measurement methods can be divided into two ways: 1) the direct time domain measurement. The pulse source and the high-speed sampling oscilloscope are applied to transmit and receive time domain signals[2]. 2) the indirect time domain measurement. The frequency domain data are measured firstly, then the inverse Fourier transform is applied to transform them into the time domain data. A time domain gating can be added to the desired signal, and the other signals are removed. The latter method has the advantages of large dynamic range and high signal-to-noise ratio, which is widely used in antenna measurement[3].

However, the time-domain method is not appropriate to narrow band antenna, such as some airborne communication antennas. The working band decreases the time-domain resolution, thus some mutilpath signals near the received antenna cannot be distinguished. Accordingly, in order to distinguish the main signal and the multipath signals from the time domain response, the time domain resolution should be further improved. A super-resolution time domain measurement method is given in reference[3], but the method needs to predict the position of transmitting antenna. In this paper, an indirect time domain measurement method based on spectrum estimation is presented, the original frequency domain data are extrapolated to 50% of the bandwidth for each side, so the time-domain resolution is doubled improved than the real transmitting signal. The simulation and experiment show the method can be applied to the high precision antenna measurement.

II. SPECTRUM ESTIMATION EXTRAPOLATION TECHNIQUE OF NARROW BAND ANTENNA

As shown in Fig.1, a narrow band signal corresponds to the low time domain resolution. If the spectrum is extrapolated on both sides of the band, a wider frequency range can be obtained, so the time domain resolution after spectrum extrapolation is higher. Based on high resolution signal, more multipath signals can be accurately separated by the time domain gating.

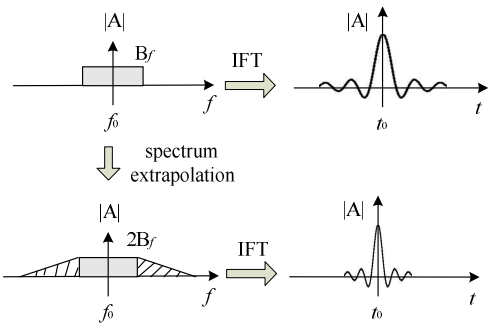

Figure 1 spectrum extrapolation principle of narrow band signal

The Burg algorithm is a modern spectrum estimation method. The auto regression model (AR model) of signal is constructed firstly, and the model's parameters are solved according to the measured data, then the spectrum out of band can be estimated from the model.

Assume the antenna normal working bandwidth is 50MHz from 300MHz~350MHz, by IFT the effect of the time-domain response is as follows Fig.2, after using spectrum estimation method to extrapolating bandwidth to

100MHz from 275MHz~375MHz, the time-domain resolution power has been significantly improved.

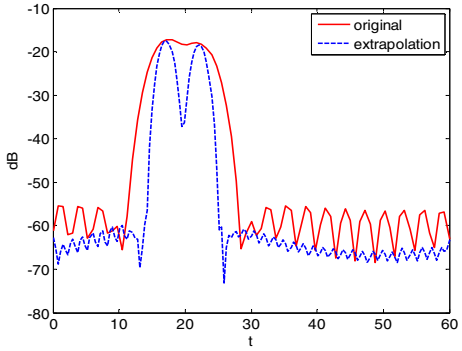

Fig.2 after spectrum extrapolation, the resolution is improved

A dipole antenna is measured in an anechoic chamber with a metal plate reflector as Fig.3, the sweeping frequency is from 285~335MHz, after Burg spectrum estimation, the bandwidth is extended to 265~365MHz , then adding time-domain gate, the dipole pattern is much more ideal than direct time-domain gating method as Fig.4.

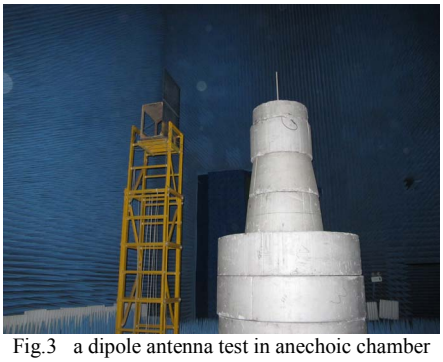

Fig.3 a dipole antenna test in anechoic chamber

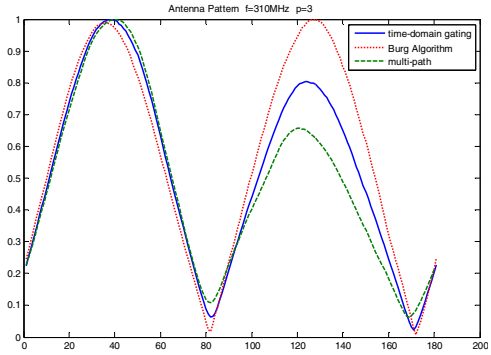

Fig.4 comparison of spectrum evaluation result and time domain method

III. Conclusion

Based on real testing frequency bandwidth, by extrapolating the frequency band to lower frequency and higher frequency according spectrum evaluation, the broader bandwidth is gained, higher range resolution can be realized, multipath reflection can be isolated and removed as a result, antenna pattern measuring precision can be improved. Results from simulation and experiment show that the method is correct and effective, and this method can be widely used in engineering practice of narrow band antenna measurment.

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