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短文与研究通讯

共形阵列天线振动条件下稳健的DOA估计及位置误差校正

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摘要：

共形阵列天线比传统的线阵和面阵具有更优良的空气动力学性能、更宽的波束扫描范围、更小的雷达散射截面积和更大的阵列天线孔径等优势。然而共形天线载体受到飞行惯性和空气动力负载的相互作用很容易发生共形表面的变形和单元位置的扰动。更为重要的是平台的机械振动通常还会导致单元位置扰动的时变性，严重影响了共形天线的分辨测向性能。因而针对此类载体共形天线设计稳健的DOA估计算法和位置误差校正算法十分必要和有意义。本文提出了一种共形天线振动条件下的稳健DOA估计和位置误差校正算法。在给出共形线阵振动的数学模型基础上，得到修正的时变阵列导向矢量。采用时变的阵列导向矢量在一个振动周期内计算MUSIC谱，搜索空时二维的MUSIC谱的谱峰，得到本次采样快拍数据时阵列振动位于振动周期中的时刻和信源方位的联合估计。根据阵列振动的数学模型就可以进一步预测下一次采样快拍数据时刻阵列各阵元的位置误差，从而实现振动条件下的阵元位置误差校正和稳健的DOA估计。计算机仿真结果表明了提出算法的有效性。

关键词： 共形阵列天线； 阵列校正； 振动；位置误差校正

Robust Direction Finding and Position Errors Calibration for Conformal Array Antenna in the Presence of Vibration

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Abstract:

Compared to classical linear and planar arrays, conformal array antennas possess some potential advantages including reduction of aerodynamic drag, wide angle coverage, space-saving, potential increase in available aperture, reduction of radar cross section, elimination of radome-induced bore-sight error and so on. They will find their promising applications in a variety of fields ranging from space-borne, airborne, ship-borne, missile-borne radar, space vehicles and wireless communications to sonar, etc. However, conformal array antennas integrated onto aircrafts and some other supporting structures are usually subjected to static deformations and vibrations caused by inertial forces and aerodynamic loads. Furthermore, its position errors and orientations of the elements are time varying due to the platform’s mechanical vibrations. As a result the performance of high-resolution direction finding algorithms such as MUSIC degrades severely. So this makes it essential to design robust DOA estimation algorithm and position errors calibration algorithm taking into account the influence of deformations and vibrations for such kind of conformal array antennas. This paper presents a robust direction finding algorithm and position errors calibration algorithm for conformal array antennas with time varying position errors. To obtain the modified time varying steering vector, mathematical model of vibrations for conformal linear array is given beforehand. The MUSIC spectrum is calculated with the time varying steering vector within a vibrating periodicity. By searching the peaks of the two dimensional (2-D) MUSIC spectrum, the ambiguous initial value of time in the mathematical model of vibration are estimated together with the DOAs. To resolve the ambiguity of initial value of time estimation, repeat the previous process with the snapshots data sampled after a very short time interval. Accordingly the time varying position errors of the elements can be predicted with the mathematical model of vibration and calibrated as well. Computer simulation demonstrates that the proposed algorithm is effective.

Keywords: Conformal Array Antennas Array Calibration Vibration;Position Errors Calibration

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