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基于计算电磁学方法的旋翼雷达散射截面特性

Radar cross section characteristics of rotor based on computational electromagnetics method

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中文关键词: 武装直升机 旋翼 雷达散射截面 计算电磁学 翼型

英文关键词:armed helicopter rotor RCS(radar cross section) computational electromagnetic airfoil

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中文摘要:

以Maxwell方程组为主控方程，时间离散采用4步Runge-Kutta法，空间离散使用MUSCL（monotonic upstream-centered scheme for conversation laws）格式与Steger-Warming通量分裂结合的方法，建立了一套基于时域有限体积法的旋翼RCS（雷达散射截面）特性数值计算方法.采用代数方法生成围绕旋翼的O型贴体、正交网格.在验证方法有效性基础上，着重分析了旋翼平面和翼型RCS极化、入射角、电尺寸等影响特性，并给出了翼型几何特点对RCS的影响规律；然后运用线性加权和法进行了旋翼翼型隐身性能的综合筛选.研究表明：旋翼RCS动态包络线是一个强散射水平的连续振荡区域；选取3片桨叶旋翼的最大雷达探测距离为2片桨叶的82.2%，且有利于控制旋翼的散射最大峰值.同时，HH02旋翼翼型在4个重要的散射角域，最大探测距离分别为NACA0012翼型的105.1%，99.4%，86.6%和83.5%，表明综合雷达隐身性能最好.

英文摘要:

By taking Maxwell's equations as the governing equations, and employing four-stage Runge-Kutta method for the temporal discretization and Steger-Warming flux splitting scheme for the spatial discretization, the MUSCL(monotonic upstream-centered scheme for conversation laws) scheme was used to calculate the flux, and a numerical methodology for simulating the RCS(radar cross section) of rotor based on finite volume time domain method was developed. The O-type body fitted and orthogonal grid around rotor was generated using algebraic method. It has been demonstrated that the method is effective to simulate the RCS of the rotor. Firstly, calculations on RCS of rotor and airfoils about the polarization, angle of incidence and size have been conducted emphatically. Secondly, the influences of RCS on geometries of rotor airfoil have been investigated. Finally, the stealth of rotor airfoil has been obtained through linear weighted sum method. The results show that the RCS envelop of the rotor is represented by a continuous and oscillating area of strong scattering. The maximum radar detection range of the three blades rotor is 82.2% of the two blades rotor, helpful to control the maximum scattering peak. In four important scattering angle domains, the maximum radar detection ranges of HH02 rotor airfoil are 105.1%, 99.4%, 86.6% and 83.5% of NACA0012 airfoil, respectively, and the radar stealth performance of HH02 rotor airfoil is the best.

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