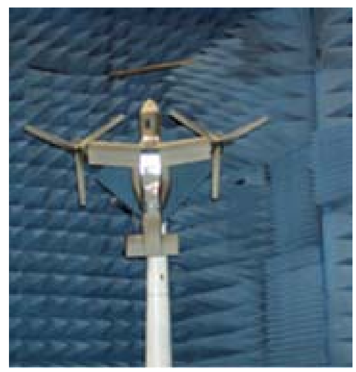
Electromagnetic Modeling and Measurement of the V22

Project duration: 04/01/2002 - 06/30/2003

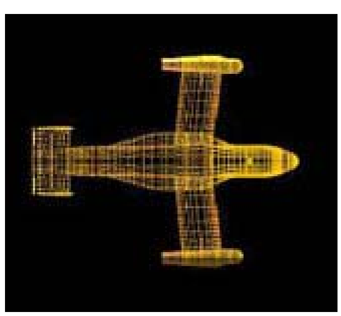
Project Summary

- The Electromagnetic model of Boeing's V22 aircraft is performed by using the Method of Moment Based Numerical Electromagnetic Code (NEC). Symmetry and non-uniform meshing are used to reduce the memory and CPU time.
- Modeling and measurement of the radiation performance of various communication antennas on V22 in the frequency range of 30-400 MHz.
- Investigation of stabilizers, propellers and other scattering effects on the performance of a GPS antenna and optimizing its location on the V22 fuselage.

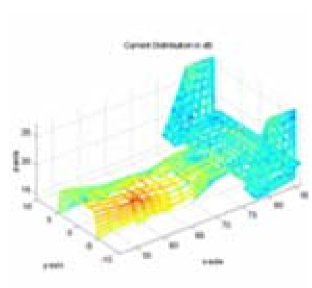


Project Description

The Boeing Company, Philadelphia, has solicited the CAC to experimentally measure and test various antennas on a 1/15-scale model of the V22 Aircraft that was recently built in collaboration with Villanova University and NSWCCD, Philadelphia. In addition, these measurements are compared and verified by numerically modeling the full-scale aircraft using electromagnetic simulations. Extensive numerical modeling of the full-scale aircraft using a Method of Moments based simulation code is conducted. The electromagnetic modeling is performed for selected frequency ranges and antenna positions. Both modeling and measurements are of major interest to the Boeing Company.



Full NEC Model of V22



Current Distribution on the Fuselage due to the GPS Antenna

Applications of Smart Antennas to Rotorcrafts

Rotorcrafts have been increasingly playing a major role in digital battlefield. Without a reliable communication link, there could be a break down in command and control between the rotorcraft and the ground support. Reliability of the communication link is constantly degraded by Doppler effects caused by the rotation of the rotorcraft blades. In this paper, the Doppler effects on a communication link between a rotorcraft transmitter and a receiver on the ground are studied. The communication link of interest is at VHF where voice signals are transmitted at the frequency band of 30-88 MHz using multi-level FM modulation with frequency hopping (FH) schemes. Different University techniques are considered as solutions for mitigating the fading of the channel.

The communication system consists of a ground transceiver and rotorcraft transceiver. The ground transceiver consists of a signal receiver and a single antenna. The rotorcraft transceiver consists of a radio with one antenna or two spatially separated antennas.

A rigorous model that involves the near-field effects between the closely separated transmitter antennas and the rotating blades is developed. The channel model also includes the Doppler effect and the continuous position change of the rotating blades. The model reveals that various parameters in the underlying problem, specifically the rotor rotational signatures, produce a highly time-varying channel. The channel fading characteristics require the use of diversity techniques to effectively combat the channel impairment, maintain a desirable signal-to-noise ratio (SNR), and reduce outages.

The receiver diversity techniques with the use of multiple receiver antennas have well been developed. Herein, we focus on the link where the communication flow is from the single- or multi-antenna rotorcraft to the single-antenna ground systems. In particular, we consider transmitter diversity, fast frequency hopping (FFH), and multi-carrier frequency hopping (MCFH) diversity techniques to mitigate the channel fading. The improved performances of these methods are demonstrated using the receiver signal power.

The Boeing Company Web Site
http://www.boeing.com/defense-space/military/