Appendix A: Wind Model

The turbulence power spectral density function used in the analysis is given by

$$\Phi(\Omega) = \sigma_G{}^2 \frac{L}{\pi} \left[\frac{1 + \frac{8}{3}(1.339L\Omega)^2}{[1 + (1.339L\Omega)^2]^{11/6}} \right] \frac{(\text{fps})^2}{\text{rad/ft}} \quad \text{(A1)}$$

where $\Omega = \omega/V$ = reduced frequency (rad/ft), V = aircraft velocity (fps), L = characteristic length (ft), σ_G = rms gust velocity (fps), and

$$\int_0^\infty \phi(\Omega)d\Omega = \sigma_G{}^2$$

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Automatic Flight Control System for Automatic Terrain-Following

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This paper discusses the design, simulation, and flight testing of an automatic flight control system (AFCS) developed under Project 666A‡ to provide an automatic terrain-following capability in a supersonic, fighter-bomber type of aircraft. Functional operation and features of the high performance, very reliable fixed-gain AFCS are described. Excellent terrain-following performance using AFCS hardware integrated with a flight simulator was achieved in a six-degree-of-freedom simulation program. Radar system failure effects on terrain-following performance and flight safety were studied and documented for Air Force review. Comparisons of flight test and simulation study results show very close correlation. The 666A AFCS will provide the high performance and high degree of reliability required to perform the automatic terrain-following task. Further flight test development and evaluation of the automatic terrain-following system will be performed by the Air Force at Wright-Patterson Air Force Base.

I. Introduction

Background and Goals of 666A Program

McDONNELL, General Electric, and Texas Instruments were selected by the U. S. Air Force to participate in the Project 666A Automatic Terrain-Following Program. This program was conducted at McDonnell from June 1965 through December 1966. The goals of Project 666A were to develop and demonstrate an automatic terrain-following capability in the vertical plane, and to provide precise lateral control for guidance and navigational course direction in the horizontal plane of a high-performance, fighter-bomber type of aircraft, such as the McDonnell F-4.

Responsibilities of Associate Contractors

Texas Instruments Inc. was responsible for the design, development, and fabrication of the AN/APQ-101 Forward Looking Radar and the Terrain-Following Computer. General Electric was given responsibility for the design and fabrication of the AFCS hardware, performing analytical design studies, accomplishing flight-worthiness tests of the AFCS hardware, and for participating in the flight test evaluation of the AFCS.

McDonnell's primary responsibilities in the 666A program were 1) to participate in the design and development of the 666A Automatic Flight Control System (AFCS), 2) to install and integrate the AFCS and radar into the aircraft, and 3) to perform the flight test evaluation of the AFCS. This paper summarizes the results of analysis, simulation, and flight test accomplished in developing and evaluating the AFCS for use in providing the automatic terrain-following capability. Simulations and flight tests were conducted to determine that the performance of the AFCS met the specified design requirements.

II. 666A Automatic Flight Control System (AFCS)

The 666A AFCS was designed to provide the high degree of performance and reliability required for automatic terrain-following in the sensitive low-altitude, high-speed (LAHS) environment.

Features of the 666A AFCS

The 666A AFCS provides the following features in pitch, roll, and yaw channels.

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