

Application of Ordinary Differential Equations to Unsteady Aerodynamic Characteristics

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Abstract

This is my brief write up of the an article and its differential equations that was written by Vladislav Klein and Keith D, Noderer, entitled *Modeling of Aircraft Unsteady Aerodynamic Characteristics*.

1. Aerodynamic Characteristics In Terms Of Indicial Functions

Aircraft aerodynamic characteristics can be fomulated as

$$C_a(t) = C_a(0) + \int_0^t C_{a\xi}(t - \tau; \xi(\tau))^T \frac{d}{d\tau} \xi(\tau) d\tau,$$

where $C_a(t)$ is a coefficient of aerodynamic force or moment, ξ is a vector of aircraft state and input variables upon which the coefficient C_a depends, $C_{a\xi}(t)$ is a vector of indicial functions whose elements are the responses in C_a to unit steps in ξ , and $C_a(0)$ is the intial value of the coefficient at initial steady-state conditions. The indicial responses, $C_{a\xi}$, are functions of elapsed time ($t - \tau$) and are continuous single valued functions of $\xi(t)$.

2. Discussion

The study of a simple plane in mid flight and its performance has been severely limited in years past. This limitation has been present because the mathematical analysis or mathematical modeling hasn't been advanced enough to model a plane in flight. This is because in years past the moments of force (Torque's) and aerodynamic forces couldn't ever be modeled very accurately in relation to time passing. They were in most past cases approximated by linear expressions. Even the nonlinear terms such as changes in stability derivatives with a the angle of attack, extended to the range of flight conditions to a high-angle-of-attack and/or high-amplitudes maneuvers. Linear and nonlinear terms both lead to a assumption that the parameters appearing in polynomial or spline approximations are time invariant. But in this article aerodynamic characteristics in terms of indicial functions are discussed in detail, and they

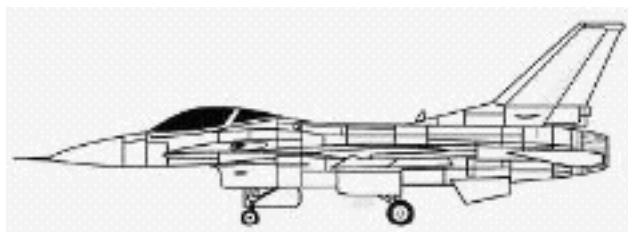


Figure 2.1: My first figure

are time variant and they do model the moments of force's and aerodynamical forces closer than before. This article also discusses the flaws of linear and nonlinear terms, and the studies that have been conducted to show the flaws of this modeling.

3. References

- *Modeling of Aircraft Unsteady Aerodynamic Characteristics (Part 1- Postulated Models)*, Vladislav Klein and Keith D, Noderer
- National Aeronautics and Space Administration Langley Research Center Hampton, Virginia 23681-0001, May 1994