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Linearization of Y-Force Equation of Rigid Body Equation of Motion and Behavior of Fighter Aircraft under Imbalance Weight on Wings during Combat

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Abstract : Y-force equation comprises aerodynamic forces, drag and side force with side slip angle β and weight component along with the coupled roll (φ) and pitch angles (θ). This research deals with the linearization of Y-force equation using Small Disturbance theory assuming equilibrium flight conditions for different state variables of aircraft. By using assumptions of Small Disturbance theory in non-linear Y-force equation, finally reached at linearized lateral rigid body equation of motion; which says that in linearized Y-force equation, the lateral acceleration is dependent on the other different aerodynamic and propulsive forces like vertical tail, change in roll rate (Δp) from equilibrium, change in yaw rate (Δr) from equilibrium, change in lateral velocity due to side force, drag and side force components due to side slip, and the lateral equation from coupled rotating frame to decoupled rotating frame. This paper describes implementation of this lateral linearized equation for aircraft control systems. Another significant parameter considered on which y-force equation depends is 'c' which shows that any change bought in the weight of aircrafts wing will cause Δφ and cause lateral force i.e. Y_c. This simplification also leads to lateral static and dynamic stability. The linearization of equations is required because much of mathematics control system design for aircraft is based on linear equations. This technique is simple and eases the linearization of the rigid body equations of motion without using any high-speed computers.

Keywords : Y-force linearization, small disturbance theory, side slip, aerodynamic force drag, lateral rigid body equation of motion

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