Kinematic synthesis of flight control systems for light aircrafts

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Abstract

In this paper, kinematic synthesis of a planar flight control system mechanism has been conducted for a light aircraft designed and built by TAI. To achieve a simple construction, the four-bar linkages are used in the synthesis. Freudenstein's Method and Bloch's Method are utilized for analytical three and four bar position syntheses respectively. A case study of an elevator flight control system is presented.

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θ_2 Rocker angle (°)
θ_3 Coupler angle (°)
θ_4 Rocker angle (°)
θ_6 Rocker angle (°)
θ_8 Rocker angle (°)
l_1 Fixed link length (mm)
l_2 Rocker link length (mm)
l_3 Coupler link length (mm)
l_4 Rocker link length (mm)
l_5 Fixed link length (mm)
l_6 Rocker link length (mm)
l_7 Coupler link length (mm)
l_8 Rocker link length (mm)

Dummy variables confined to certain sections are clearly defined wherever applicable.

Introduction

Aircraft flight controls are divided into two categories: primary and secondary flight control systems (FCSs). Figure 1 gives the FCSs for a conventional light aircraft.

The conventional primary flight control systems consist of ailerons, elevator, and rudder. They are used for moving the aircraft about its three axes. The ailerons are operated by lateral movement of the control stick. The elevator is operated by fore and aft movement of the control stick and the rudder is actuated by movement of rudder pedals (Mallik *et al.*, 1994).

The conventional secondary flight control systems on the other hand are elevator trim tab, rudder trim tab, and wing flaps. The elevator and the rudder trim tab are controlled by means of a control wheel connected to the tab. The wing flaps are controlled by a control lever (Mallik *et al.*, 1994).

The ailerons, elevator, elevator trim tab and rudder are statically balanced. If the system itself is not balanced, the control surface may be forced to move when the airplane is perturbed by vertical accelerations. This could lead to undesirable oscillations and in some cases could also lead to flutter (Mallik *et al.*, 1994).

In light aircrafts, the pilot has direct mechanical links to the surfaces. Output from the cockpit controls is transmitted to the flight control surfaces through the cables and mechanical linkages.

One of the challenges that an engineer faces is to design (or synthesize) and develop mechanisms used in control systems. The

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