Smart Mater. Struct. **22** (2013) 000000 (9pp) UNCORRECTED PROOF

Development and wind tunnel evaluation of an SMA based trim tab actuator for a civil aircraft

(Ed: Editor19)
Ascii/Word/SMS/
sms467275/PAP
Printed 12/8/2013
Spelling US
Issue no
Total pages
First page
Last page
File name
Date req
Artnum
Cover date

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Received 17 March 2013, in final form 1 July 2013
Q.4 Published
Online at stacks.iop.org/SMS/22/000000

Abstract

This paper presents the development and wind tunnel evaluation of an SMA based smart trim tab for a typical two seater civil aircraft. The SMA actuator was housed in the port side of the elevator for the purpose of actuating the trim tab. Wind tunnel tests were conducted on a full scale horizontal tail model with elevator and trim tab at free stream speeds of 25, 35 and 45 m s^{-1}, and also for a number of deflections of the elevator (30° up, 0° neutral and 25° down) and trim tab (11° and 21° up and 15° and 31° down). To measure the hinge moment experienced by the trim tab under various test conditions, two miniaturized balances were designed and fabricated. A gain scheduled proportional integral (GSPI) controller was developed to control the SMA actuated smart trim tab. It was confirmed during the tests that the trim tab could be controlled at the desired position against the aerodynamic loads acting on it for the various test conditions.

Q.5 (Some figures may appear in colour only in the online journal)

1. Introduction

Q.6 Trim tabs are small surfaces connected to the trailing edge of a larger control surface on an aircraft, used to control the trim of the controls, i.e. to counteract aerodynamic forces and stabilize aircraft in a particular desired attitude without the need for the operator to constantly apply a control force. This is done by adjusting the angle of the tab relative to the larger surface. Changing the setting of a trim tab adjusts the neutral or resting position of a control surface (such as an elevator or rudder). As the desired position of a control surface changes (corresponding mainly to different speeds), an adjustable trim tab will allow the operator to reduce the manual force required to maintain the control surface position to zero, if used correctly.

Trim tabs are used for small lifting up or bringing down of the nose of the aircraft in cruise flight. They are also deployed in the direction opposite to the deployment of the larger control surface to which they are attached. Currently there are various types of trim tab actuation mechanisms available. They are usually hydraulically, pneumatically, or electromechanically actuated. The most important problems associated with the various types of actuation systems are as follows. In hydraulic actuators the biggest disadvantage of the system is the problem of contamination of the entire system. Besides this it has problems associated with leakage, complexity and flammability of the hydraulic fluid. It has high maintenance costs and large pressure drops in the transmission line and in valves [1]. In the case of pneumatic actuators, leakage poses a major problem. Here the system has to be large enough to develop the pressure comparable to a hydraulic actuator [2, 3]. Currently, the trend is towards electromechanical systems and the term 'all electric' aircraft is commonly heard. However, there is a serious disadvantage even with electromechanical systems. During power failure the electromechanical systems get jammed [4]. It is very difficult for the pilot to control an aircraft with a jammed control surface, since he has to apply a stick force opposing this.

