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INTRODUCTION TO FLY-BY-LIGHT CONTROL IN AIRCRAFT

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ABSTRACT

Optical fiber has found the increased application in field of technology with passage of time. There are many advantages of optic fiber over other conventional technologies . The Fly-By-Wire technology brought revolution in flight control system. Optical fiber technology is seen as next generation flight control system. The optical fiber technology in aerospace industry was first practically implemented in airship. The fiber optic added a new dimension to aircraft control systems in the form of Fly-By-Light (FBL) control system. Despite of all the features as in light-weight, miniaturized size, optimum design, practical application is still constrained. To boost the application of FLY BY LIGHT system, FLASH Program was initiated by NASA in early 20th Century which gave ease to flight control system .Using FBL system it has proved cost effective than FBW . This article gives insights of architectural design and working comparison of FLY BY WIRE and FLY BY LIGHT system of control.

Keywords—component; formatting; style; styling; insert (key words)

INTRODUCTION

In optical fiber-based instrumentation system the three major components are 1. Optical source 2. Photodetector or light receiver 3. Optical energy guiding medium. The technology of optical fiber has found an increase application in aircraft industry [1]. This technology offers numerous advantages over conventional control system. Application of Fiber optic in communication and control system is more advantageous than control using wire based system Replacing the propulsion and flight control system electrical wiring with optical fiber results in substantial weight and volume saving. For example, if we say a fighter jet the weight reduction is estimated to be 57 kg and in commercial aircraft, the weight saving could reach 680kg. Since optical fibers are dielectric, problem of electromagnetic interference, electromagnetic pulse and lightning are eliminated, which in-turn eliminates the need for shielding and surge quenching circuits. This high bandwidth capabilities are advantageous for data bus lines and offer potential for all avionics data to be transmitted over a single line. Fiber optics also eliminates the threat of fires due to insulation failure or short-circuits failure which could cause inadvertent actuation of control hardware

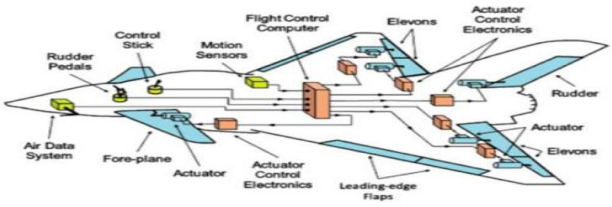

Figure-1: Fly by Light system

Figure1 above shows the fly-by-light aircraft in this the gently simplified diagram, the engine control and flight control computers are shown linked to their respective set of optical sensors and optical actuators, using fiber optic cables and electro-optic interference.

FLIGHT CONTROL

Whenever airplane changed its attitude, in flight it turns on one or more of its three axis which are imaginary line passing through center of gravity. At the point where all the three axes intersect, they are mutually perpendicular. The axes that extends lengthwise through the fuselage from the nose to tail is called as longitudinal axis which extends crosswise is called lateral axis and the third is vertical axis.

I. Development of Flight Control system

In initial aircraft, control surfaces were controlled mechanically. Here the pilot used mechanical force on control stick for controlling the aircraft. Subsequently, the aircraft control systems have evolved over the years.

Since these many years, various system of flight control have been established

1. Mechanical Control system
2. Fly-by-Wire control system

Fly-By-Light Control system

Fly-By-Light (FBL) relies on similar system followed by FBW except that all the sensors are optical rather than electronic or electrical. In this type of control system, input command signals are sent to the actuators through the medium of optical-fiber lines. The feedback from the control surfaces and other systems is routed in a similar way. The computer unit which is also called as data processor then provides data for movement of the aircraft control surfaces through these cables. Its benefits include immunity to EMI and HIRF, large data bandwidth, light weight which require less maintenance, more resistant to electromagnetic impulses than conventional FBW systems. FBL technology does not employ wires and is naturally resistant to electromagnetic interference, providing the same flight control capabilities as fly-by-wire systems without the necessity for shielding.

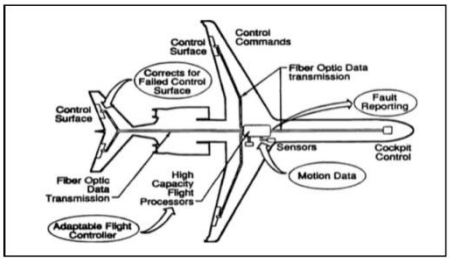

Figure 6. Fly-by-light control system [3]

Figure 2: Fly-By-Light Control

To validate a FBL system, Photonic-Controlled Actuation System (PCAS) is introduced. The PCAS consists of a modified Electro Mechanical Actuator (EMA) and an optical controller that gives actuator commands to the optical EMA. These commands are similar to the commands that a flight control computer provides. Engineers has modified the Electro Mechanical Actuator that provides motor power devices to receive as well as react to

command signals sent via light from the optical controller. In addition to that they have replaced the EMA"s conventional sensors with optical sensors that measure actuator position, motor position, and current. Fiber-optic cables transmit information to the optical controller. Data is collected by engineer by performing several test runs. Data analysis by the engineer is verified that the modified PCAS performed as designed, with no adverse effects to performance stemming from the fly-by-light components or technology. [8]

COMPARISION BETWEEN FLY-BY-LIGHT SYSTEM AND FLY-BY-WIRE SYSTEM

FBW system works on a digital data bus for the transmission of mechanical movements from pilot's joystick to the mechanical actuators located near the control surface in the form of electronic signals using suitable transducers. It eliminates considerable number of components of mechanical system like control rods, push pull system, to reduce the weight. This weight elimination is used to increase the redundancy level of FBW. It reduces the weight approximately 10% that of a copper wire. The concept of FBL uses optic fiber cables for the transmission of mechanical movements from pilot's joystick to the mechanical actuators near the control surface in the form of monochromatic light signals using suitable transducers. It eliminates the amplification units, filter circuits, modulator units etc, which have high redundancy levels in the FBW. FBL control system is not only reliable but also less degradations of signal through optic fiber cable. The loss of the optical fiber is 0.3dB/km where it is 5dB/km for copper wire. FBL is more reliable and redundancy is higher than FBW. Since the system has high reliability the maintenance cost is lesser.

FLASH PROGRAM

For almost 20 years NASA, DoD (Dept. of Defense, USA), the major aircraft engine and airframe suppliers and their lower level suppliers have been investigating the potential for improving aircraft by the introduction of optic and fiber optic technologies. Hence improvement of FBL is required. The program that is undertaken to improve the FBL system is known as FLASH (Fly-by-Light Advanced System Hardware) program.

A. Requirement of FLASH Program

To carry out different intensive activities it require high data rate of communication. That means the systems require a high bandwidth, interference-free physical medium. Fiber optics could meet that need. We now have small, powerful computers and sensors which could be distributed around an aircraft to form very powerful, reliable systems for vehicle management and data processing. The FLASH program istoo aimed at developing the low cost and reliable cables, connectors, splices, backplanes, manufacturing and installation methods, test methods, support equipment, and training systems needed to form a true optical cable plant not only for transport aircraft but also for tactical aircraft and helicopters.

Unfortunately, the present condition of the art in fiber optic technology produces hardware which isnot only too difficult but also unreliable to use. That led to a dilemma which has proven difficult to break. Fiber optics has been flown on aircraft before; but, because of the difficulty of working with it, and the unreliability of early systems, the users usually disconnected it in disgust. Similarly, the developers of advanced vehicle management systems and advanced avionics have had difficulty getting their systems on aircraft because aircraft appear to get along now without the advanced systems (despite needs for future reduced costs and improved

performance), and nobody wants to deal with the difficulties of the fiber optics interconnects that will come with such systems. That is the reason for which the Fly-by-Light Advanced System Hardware (FLASH) program required to be lunched.

CONSLUSION

With development of aircraft flight control system engineering aircraft control system reliability is increasing. Boeing 787 and A380 are operating with fully automated Fly-By-Wire control system. The Fly-By-Light control system is still in the research phase is still in the research phase due to the limitation in technological development and standardization issues. As FBL offers numerous advantages over FBW system meets the flight control system. It has potential to align with the other high speed data transmission system combined with high capacity fight processor to implement control advancement and monitoring. This system will not just improve the reliability but also effective use artificial intelligence for self-repairing and fulfilling other objective. There is need to develop FBL system to commercially viable implementation on future commercial and military aircraft

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