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Abstract

Aircraft Digitization: The Innovative FADEC (Full Authority Digital Engine Computer) for Turbo-Propeller Aeroengines and AI Challenges to Optimized Engine Performance †

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1. Objectives

The digitization of turbo-propeller aeroengines fitted on aircraft is of paramount significance. This study documents the interrelationship between an engine's digitized FADEC computerized functions and the engine/propeller's optimized performance, plus FADEC's contribution to flight safety [1,2].

Also, we analyze the role of Artificial Intelligence (AI) as a challenge to the industry which has already begun, focusing on embedding AI into engine/propeller digital functions free of human errors [3].

2. Methodology

We carried out a Literature Review Synthesis (LRS) with bibliographic secondary data analysis. The review involved related bibliography including aviation regulations, engine/propeller manufacturing data, technical publications and manuals, plus training books.

3. Results

By converting analogue information into a digital format/PC-readable data, FADEC handles massive information regarding all engine/propeller functional parameters, i.e., altitude, pressure, velocity, ambient air temperature, engine temperatures, rpm, torque, etc., during all phases of a flight from start–taxiing–ascend–cruise to descend–landing–taxiing–shut down [3].

As a result, the engine/propeller achieves optimized thrusting performance, which is a regulatory manufacturing requirement [1].

Since the propeller attached to the engine generates the thrust, FADEC also optimizes the propeller's propulsive efficiency; plus, it maintains its structural integrity by preventing structural damage to the propeller blades from aerodynamic overloading [4].

FADEC's digitized functions also eliminate any improper human errors or inputs into the engine's fuel thrust and propeller's blade-pitching systems, resulting in the elimination of hazards and, thus, ensuring flight safety [5].

AI is defined as the simulation of human intelligence in machines, in terms of learning, reasoning, and perception, in a human-error-free manner [6]. AI being embedded in FADEC's functions ultimately results in safe engine/propeller performance and aircraft flight safety [4].

4. Implications

In turbo-propeller engines, FADEC benefits both the engine and propeller [3,4] by (a) replacing complicated, old-type, multi-item, hydromechanical engine fuel control systems with fully digitized control components; (b) optimizing the engine's airflow/fuel control by increasing thrust with less fuel whilst reducing the chance of engine surges or flameout; (c) optimizing the propeller/blade pitching angle at all flight ground phases, hence providing digital engine/propeller speed control and ensuring the avoidance of overspeed; and (d) setting the propeller/blades to feathering mode during engine failure, thus preventing them from aerodynamic loads.

In terms of human interaction, FADEC (a) reduces the pilot workload when incorporated and (b) reduces the maintenance workload due to its digitized reliability, as well as the ease with which it can troubleshoot maintenance defects resulting from its Built-In Test (BITE) defect coding and fault isolation ability.

5. Originality Value

This study's originality value lies in the documentation of the positive impact of digitized functions on a turbo-propeller aeroengine, not only from a technological perspective but also from an optimized-performance perspective, for a combined jet engine–propeller propulsion system and, ultimately, the functions' direct impact on flight safety.

Also, the originality value lies in the digitization's positive impact on methods of preventing and capturing human error during engine/propeller operation, plus the exceptional performance of human-error-free maintenance during troubleshooting.

6. Contribution

This paper's contribution lies in the documented conclusion that, for a completely safely operating turbo-propeller engine, fully digitized authorized engine/propeller control systems with AI functions have to be embedded as a standard for the ultimate goal of flight safety and human error minimization, either during air operations or maintenance, but must still be under human governance.

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