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Designing Intelligent System Of Location Control In Turbojet Engine (MPM-20) With Using Fuzzy Logic

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ABSTRACT

In this research paper, the concept of modern control systems used in turbojet engines is analyzed. We will describe and evaluate the controlling system with the help of these methods and concept of artificial intelligence. So, we can consider new features for turbojet engines in terms of performance and safety .As a result, the design of an intelligent control system for a small turbojet engine MPM-20 in the position control method, with the extraction of various concepts in different situations is suggested.

KEYWORDS: Turbojet motor, Artificial intelligence, Neural-fuzzy network, PI Controller.

1. INTRODUCTION

The state of present technologies in technical and also non-technical practice implies creation of growing complexity of systems. However, as we know, a turbojet engine is a complex system with numerous variable parameters and complex multi-dimensional non-linear dynamic. Current control systems and the dynamic models are often limited to monitoring or modeling a complex system in a particular situation (most practical). Nevertheless, in practice, due to experiencing various working conditions by turbojet, working parameters and operational characteristics will be influenced. We need to design a control system which guarantees the integrity of controlling this system in all environmental situation and internal condition of system which is defined by parameters. In article [1], Andogaand his assistant have investigated situational modeling and control of a small turbojet engine MPM 20.Also,this researcher has studied some hybrid methods of situational control for compound systems in 2006 [2].Guillaume and his colleagues in paper [3], have checked the non-linear system of turbojet engines by employing neural networks. Harris and his friends have undergone different kinds of adaptive methods and estimations and have mentioned some useful points in conflated results [4]. The fundamental of planning aircraft engines is taken into consideration by Sanjay in paper [5].

2.MODERN CONTROL SYSTEMS OF TURBOJET ENGINES

The main global aim of controlling turbojet engines is similar to other systems and that isincreasing their safety and effectiveness by reduction of costs. The basic functions of control systems in turbojet engines are, manual control, setting parameters and restrictions for its turbojet engine. Manual control and therefore choice of regime of the engine is realized by a throttle lever according to a flight situation or expected maneuver.The Use of digital technologies in control systems of turbojet engines has been mentioned as the following [5],

- increasing of static precision of regulation of different parameters (for example, precision of rotations from ±0.5% to ±0.1%, precision of regulation of temperature from ±12K to ±5K)
- Increase in reliability, service life and economics of operation of the driving unit of an aircraft;
- Easier backup, technology of use and repairs, possibility of use of automatic diagnostics.

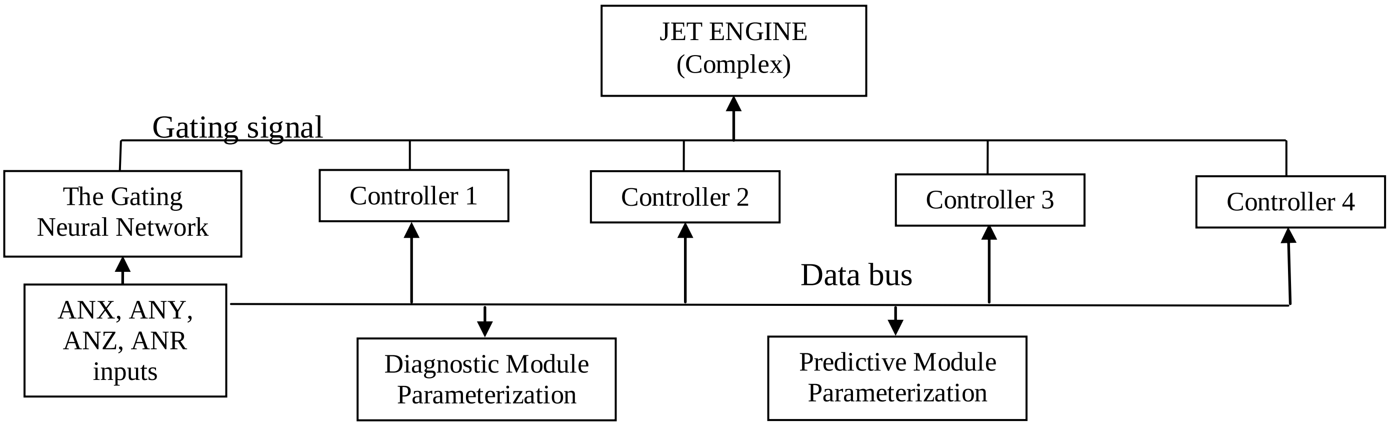

Fig. 1.Neural network applied as a decision element in FADEC turbojet engine control

The idyllic method to design of electronic systems is a modular one, from hardware or software point of view.This infers usage of qualitative processing parts which are resilient to noises of environment and also recognition of bus systems with lower delays is highly significant in this method.From the point of view of use of electrical and electronic systems in controls the turbojet control systems can be roughly divided into following sets [1,4],

- Electronic limiters,
- Partial Authority Flight Control Augmentation (PAFCA),
- 'High Integration Digital Electronic Control' (HIDEC); 'Digital Engine Control' - (DEC); 'Full Authority Digital Electronic Engine Control' – (FADEEC).

3.ARTIFICIAL INTELLIGENCE TECHNIQUES IN MODELING AND CONTROL OF TURBOJET ENGINES

The methods used in artificial intelligence offer a new quality for controlling systems . plus ,an outcome like this could only be expected from a process of system modeling with high accuracy, which is based on analysis of exerted system.This model should be based on the analysis of system in order toelevate the simplicity and performance without error-control system. Because we are mostly dealing with data and raw numbers, methods of artificial intelligence for using in designing FADEC intelligent control systems are suitable.

The resulting physical architecture including analyzers of input (X), state (Z), output (Y) and desired (R) parameters is shown in Figure 2.

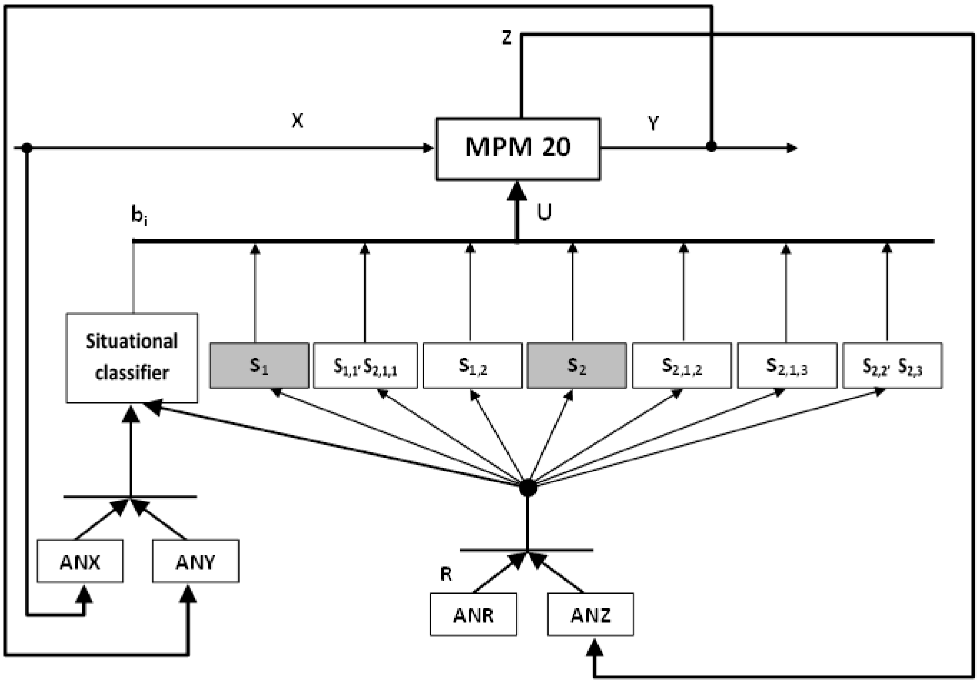

Fig 2. Situational control system architecture for MPM-20 engine [5].

4.CALCULATIONS AND RESULTS

The idea is to decompose the engine starting process to micro-status frameworks in which one rule is composed of a fuzzy-interference corresponding to the starting position within micro-location. Three inputs and one output have been chosen for the selected rules. As a result, the rules are as follows:

$$IF\ T4c\ IS\ L\{T4c\}\ AND\ dT4c\ IS\ L\{dT4c\} \\ and\ n\ IS\ L\{n\}\ THEN\ Qpal\ IS\ L\{Qpal\} \tag{1}$$

In which:
T4c: Temperature of the gases in behind of the turbine
dT4c:Derived temperature (temperature changes) of the gases in behind of the turbine
n: Engine Velocity
Qpal: Flow of fuel supply to the engine
L: membership-fuzzy function

In this method,the fuzzy controller supports 60 micro-locations with a small selected piece which has shown in Table 1.

Table 1.Location planning in Fuzzy logic

28	if	n	is PS	and	T4	is PB	and	dT4	is Z	THEN	Qpal	is PM
29	if	n	is PS	and	T4	is PB	and	dT4	is PS	THEN	Qpal	is PS
30	if	n	is PS	and	T4	is PB	and	dT4	is PM	THEN	Qpal	is PS
31	if	n	is PM	and	T4	is PS	and	dT4	is NM	THEN	Qpal	is Z
32	if	n	is PM	and	T4	is PS	and	dT4	is NS	THEN	Qpal	is Z
33	if	n	is PM	and	T4	is PS	and	dT4	is Z	THEN	Qpal	is Z
34	if	n	is PM	and	T4	is PS	and	dT4	is PS	THEN	Qpal	is PB
35	if	n	is PM	and	T4	is PS	and	dT4	is PM	THEN	Qpal	is PS
36	if	n	is PM	and	T4	is PM	and	dT4	is NM	THEN	Qpal	is PB
37	if	n	is PM	and	T4	is PM	and	dT4	is NS	THEN	Qpal	is PB
38	if	n	is PM	and	T4	is PM	and	dT4	is Z	THEN	Qpal	is PB
39	if	n	is PM	and	T4	is PM	and	dT4	is PS	THEN	Qpal	is PM

5. CONCLUSIONS

The body of a small turbojet engine MPM 20 imparts us an ideal test bed for investigation of methods in the areas of non-linear dynamic systems modeling and design of advanced control algorithms. In this area, we will be directed at use of automatic algorithms to find frontiers between situational frames within multivariate space of parameters contrary to their setting by an expert. From this research, it can be concluded that by employing an intelligent and accurate modeling method, pertinent location controlling system for controlling turbojet engines can be provided. Operation performance and accurate modeling of turbojet in military and civilian industries are some of the applications of this method.

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