Simulation of Chosen Electronical Systems of Aero Turbosupercharged Engine

Doc. Ing. Ondrej Líška, CSc., Ing. Radoslav Makovník

Department of Automation and Control, Faculty of Mechanical Engineering, Technical University in Košice, Park Komenského 8, 042 00 Košice, Slovakia
Ondrej.Liska@tuke.sk, Radoslav.Makovnik@tuke.sk

Abstract: The contribution describes electronic control system of engine, his basic parts and connection system of regulation on aero-engine through the medium of electrohydraulic converter, that is intermediate between this two parts. The contribution includes simulations this chosen parts in the progam Matlab – Simulink.

Keywords: electronic regulation systems, electrohydraulic convertor

1 Introduction

The modelling and simulation of systems operative in real time and place is devoted important attention now. Designing systems are oftentimes malingers them conduct before, look like these systems established in complete operations. To the process of modelling and simulation markedly input branches of science as mathematics and cybernetics. Modelling and succesive simulation on computer makes it possible to sample real system behind permanent raising exigency on these systems.

2 Electronic System of Regulation

In this system is concerned comparison between requared value of fuel distribution, rotation speed in low-pressure compressor and temperatures behind turbine with real value this quantities. These adjustment can we allocate into two operating mode:

A: Acceleration of engine (fuel distribution),

B: Steady-state regime, where are regulated - rotation speed n_{ntk}

- temperature T_{4c}

On prescribed (required) value has effects other activity too, e.g. adjusting hexadecimal switch – regulation member, parameters in memory of constant engine, external atmospheric failure. As actuating quantity are used on control - electric current:

i_1 - on steady-state regime

i_2 - on acceleration

In light of program, run all three regulator together, that is according to immediate change of input quantity is accounting value of output currents i_1 and i_2. In a matter of fact is current i_2 used only in situation, when it relation from regulator of steady-state regime permit. And that is just at acceleration, when regulation divergence is rapid changing. Following thereof we can allocate electronic system of regulation on two subsystems: subsystem for steady-state regime and subsystem of acceleration. [4]

3 Regulation of Steady-state Regime

On regulation of steady-state regimes of engine is used linear current signal i_1, which is feeding from block of rotation speed of regulation in low-pressure compressor and from block of temperature of regulation behind turbine on EHP 150, which is element of fuel distribution regulator. Current signal i_1 then getting value i_{n1} from regulator of rotation speed n_{ntk}, or value i_{t4} from regulator of temperature T_{4C}.

On the choice of regulation current is used independent decision program, following given value of regulation divergence. Both of regulator are containing PID controller with back coupling from the system. Regulator of rotation speed n_{ntk} is containing with fast bond.

Regulation divergence Δn_{ntk} is re-format according to Q_p, because the change this parameter best represent change of outer condition. To integrator is regulation divergence Δn_{ntk} feeding when is regime stabilized, pending transmission process is integrator inhibited. The fast bough is used on speed up regulating process. At genesis regulation divergence is extracting necessary current i_1 for new equilibrium state of engine. Speed this branches is corrupt her error. The conduit of rotation speed includes limiter of maximal value n_{max}.

Required value T_{4cz} isn`t calculating on MSA. Regulation divergence T_{4C} is also correcting from fuel distribution, then is led to PID regulator. [3]

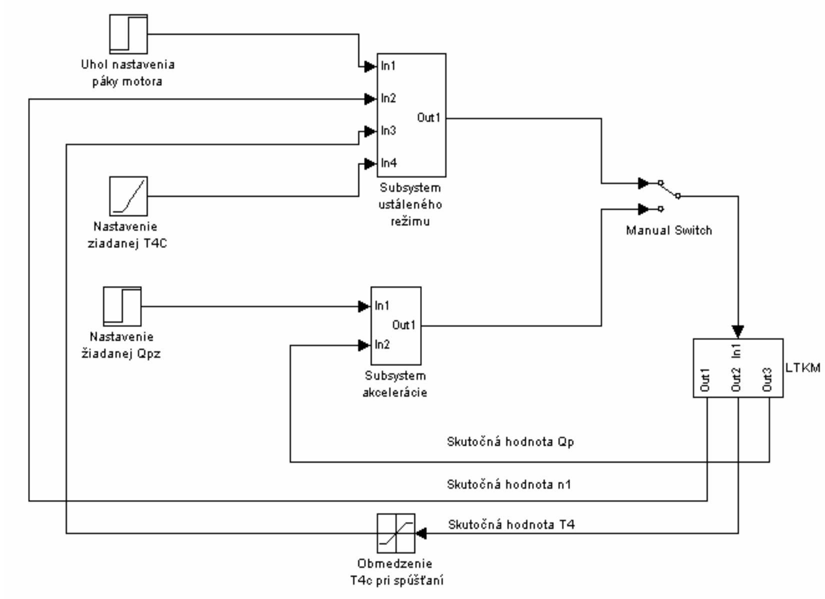

Figure 1
Principle scheme of electronic system of regulation

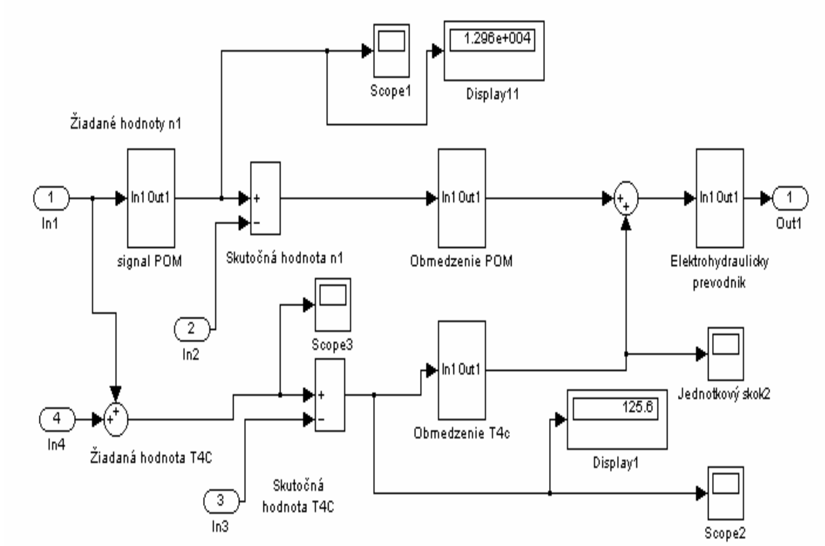

Figure 2
Principle scheme of steady-state regime

4 Regulation of Acceleration

Fuel distribution in engine is controlled during acceleration regime in relation value of rotation speed n_{ntk}, which are reduction on MSA. Simulation scheme of regulator of acceleration engine is on the Figure 3.

Regulation divergence ΔQ_p is difference between real value of fuel distribution Q_{psk} and requared value Q_{pz} for given rotation speed n_{ntk}, $\Delta Q_p = Q_{psk} - Q_{pz}$. This value is amplification and prevents through limiter EHP 137, which is element of fuel accelerator. After-running to steady-state regime is regulator of acceleration switch off with current from regulator of steady-state regime and run down is regulated (input current i_1 in limiter).

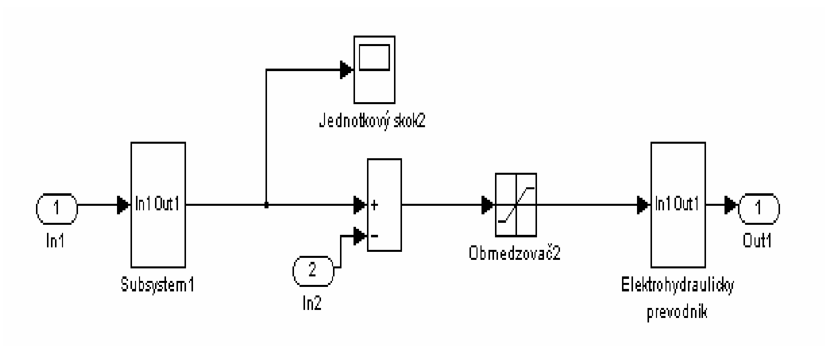

Figure 3

Principle scheme of acceleration regime

5 Simulation of Electrohydraulic Convertor

From mathematical model EHP is possible to compile his computer model with exploitation program Matlab – Simulink. Simulation makes it possible to watch course of individual parameters, to optimalize parameters his external element according to request to precision and stability of system. Input signal in simulation model EHP is operative current i_1 with concrete value and sinusoid characteristic. By option index of gain of speed is important his value. This index is elected maximum large so effect of callosity and other factors affecting on processing operative signal were minimize. [1,5]

Subsystem displayed on Figure 5 introduce simulation model of electrohydraulic servo-drive, which create first step of electrohydraulic converter and he displays his important dynamic properties.

Specific of electrohydraulic converter is comparison their low-performance positional charging on output, with frictional force. Then inertial charging introduce unimportant element. The main non-linearities, affecting on processes of control are non-sensitivity zone and limitation of speed output element. The reduced weight of ram with moving sections, by effect compressibility working liquid isn`t showing action on movement servo-drive. [2]

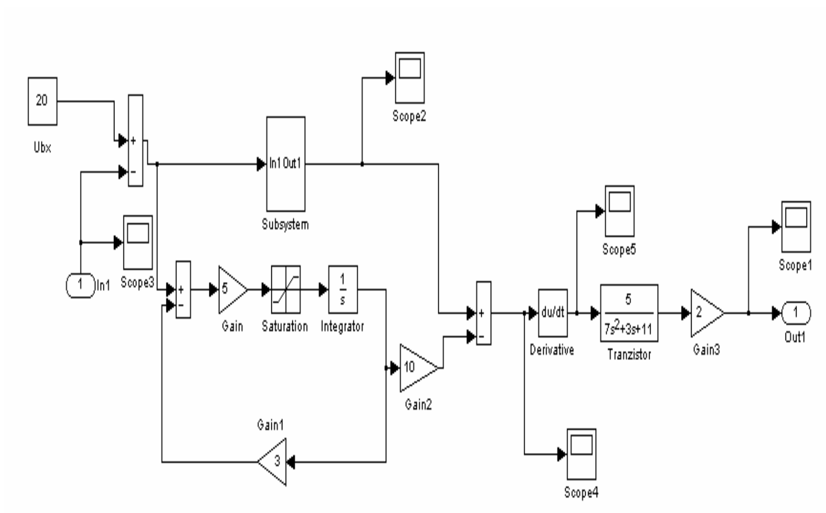

Figure 4
Scheme of electrohydraulic convertor

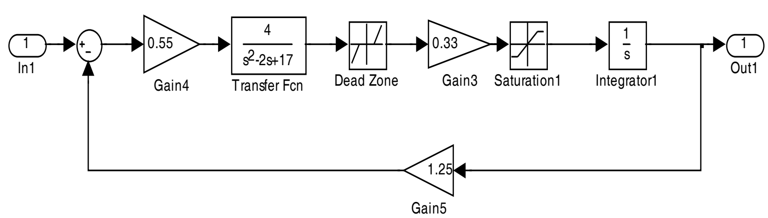

Figure 5
Subsystem of electrohydraulic servo-drive

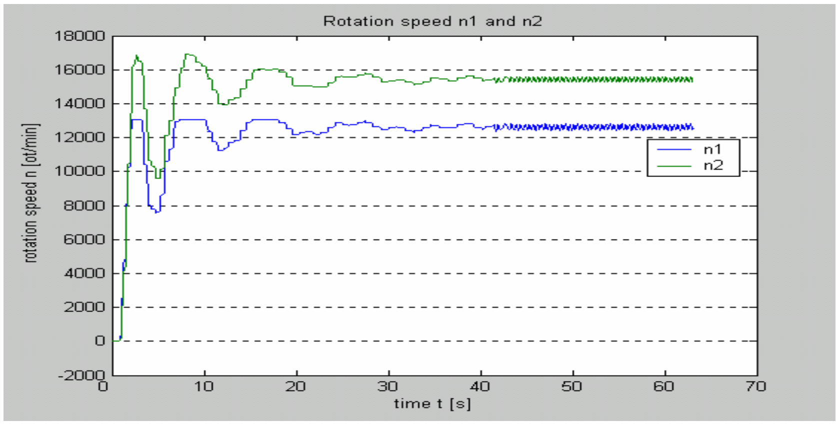

Figure 6

Rotation speed in steady-state regime

Conclusion

This contribution deals with application of simulation on electronic system of regulation aero turbosupercharged engine. In graphic expression are only rotation speed in compressor elements, but results which can extract from this simulation is more. This simulation makes it possible to sample different devices in individual sections, what would be impossible on real system in real condition. Perspective of exploitation simulation methods are great.

Note: Contribution has been paced within the solutions of grant tasks VEGA 0411/03 – Common principles planning in condition IMS.

References

[1] ADAMČÍK, F.: Základy leteckých elektrických pohonov II, VVLŠ SNP, Košice, 1990

[2] ADAMČÍK, F.: Matematické a simulačné modely vybraných palubných systémov napájania elektrickou energiou, ŠST VLA, Košice, 2004

[3] EMBEDDED: Dynamic system simulation, Aktualizované 2005-06-30 [cit.2005-06-30], Dostupné na internete: <http://www.embedded.com/showArticle.jhtml?articleID=9900113>

[4] LJUNG, L. - GLAD, T.: Modelling of Dynamic Systems. PRT Prentice Hall Englewood Cliffs, New Jersey, 1994, ISBN 0-13-597097-0

[5] NEDZBALOVÁ, M.: Modelovanie a simulácia prevodníkov regulačného obvodu pohonu lietadla, Diplomová práca, 2005

[6] VITTEK, J.: Matlab pre elektrické pohony, Žilinská univerzita, 1997