
AN ALGORITHM OF ADAPTIVE TORQUE CONTROL IN INJECTOR INTERNAL COMBUSTION ENGINE

D. N. Gerasimov, M. V. Lyzlova, F. L. Mogilevtsev, V. O. Nikiforov

Subject of Research. Internal combustion engine as a plant is a highly nonlinear complex system that works mostly in dynamic regimes in the presence of noise and disturbances. A number of engine characteristics and parameters is not known or known approximately due to the complex structure and multimode operating of the engine. In this regard the problem of torque control is not trivial and motivates the use of modern techniques of control theory that give the possibility to overcome the mentioned problems. As a consequence, a relatively simple algorithm of adaptive torque control of injector engine is proposed in the paper.

Method. Proposed method is based on nonlinear dynamic model with parametric and functional uncertainties (static characteristics) which are suppressed by means of adaptive control algorithm with single adjustable parameter. The algorithm is presented by proportional control law with adjustable feedback gain and provides the exponential convergence of the control error to the neighborhood of zero equilibrium. It is shown that the radius of the neighborhood can be arbitrary reduced by the change of controller design parameters.

Main Results. A dynamical nonlinear model of the engine has been designed for the purpose of control synthesis and simulation of the closed-loop system. The parameters and static functions of the model are identified with the use of data acquired during Federal Test Procedure (USA) of Chevrolet Tahoe vehicle with eight cylinders 5,7L engine. The algorithm of adaptive torque control is designed, and the properties of the closed-loop system are analyzed with the use of Lyapunov functions approach. The closed-loop system operating is verified by means of simulation in the MatLab/Simulink environment. Simulation results show that the controller provides the boundedness of all signals and convergence of the control error to the neighborhood of zero equilibrium despite significant variations of engine speed. The radius of the neighborhood is far less than required level of 20 N×m that affords ground for practical implementation of the algorithm.

Practical Relevance. The proposed algorithm is recommended for application in the practical problem of torque control in injector and other types of ICE.

Keywords: adaptive control, nonlinear system, injector engine, engine torque.

Acknowledgement. This work was partially financially supported by the Government of the Russian Federation (grant 074-U01), the Russian Ministry of Education and Science (project 14.Z50.31.0031).

References


