International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 24 (2015) pp 44737-44742

Automated System Of Engine Tests On The Basis Of Bosch Controllers

Lenar A. Galiullin, Rustam A. Valiev

Kazan Federal University, 18, Kremliovskaya Street, 420008, Kazan, Russian Federation

Abstract: Solution of the design problem, development and future use of the automated test systems (ATS) of internal combustion engines (ICE) involves, first of all, the analysis of a number of important requirements for the development of technical, mathematical, software, information, linguistic, organization and methodological support of the automated system.
Currently, the need for a widespread adoption and operation of the automated systems in actual test conditions of stations of manufacturers and engineering research institutions imposes certain restrictions on designing computer-aided design facilities, real test technologies of various types and modifications of internal combustion engines. This situation comes from a sufficiently large number of tested engines, aggregates and units of different modifications, and also the need for phase-by-phase error elimination in the existing algorithms, including when conducting research and development test of engines.
Requirements of real engine behavior set conditions for constant improvement of engineering level of modifications and lead to the fact that the character of expenses for fulfillment of tests at designing new types of engines increases every time. These expenses become the highest in absence of interconnection of the levels of automation of production and research works. As a result of this, automation of technological processes of engine tests of internal combustion is one of the most important tasks of raising a technical level of production and quality of the produced engines.
Keywords: engine, tests, diagnostics, programming, controller, model.

1. INTRODUCTION

Growth of available power of all sectors of industry all over the world has brought about widespread development of engine-building, including the production of various types of engines, due to it the problem of improving them is of great importance [1].

Solution of the problem of improving depends more on correspondence of fuel injection to working procedure occurring in the engines. For constant operating and controlling the process of work of ICE it is needed the introduction of a controller. Electronic control module (controller) allows to provide the control with solenoids of unit-injectors. It controls and processes different downstream signals of measuring transmitters. The basic are engine shaft speed and load the driver can regulate by means of gas pedal. The controlled parameters also include temperature of air, fuel, liquid coolant and turbocompressor pressure [2]. These basic functions can be expanded by a variety of the other operations intended for improving comfort. The controller must satisfy exacting requirements of reliable performance of compensations and troubleshooting of functioning some component parts. It is also intended for facilitation of maintenance diagnostics of engine operation and its system of fuel supply.

For testing build quality and ICE, fitted with electronic controller, it is necessary the introduction of technical complex at builder providing automated controlling process conditions of the operation of ICE [3].

The system data provide fulfillment of the following functions:

– work at speed of behavior of the process technology (in real time);
– implementation of autocontrol and management of technological process-flow of ICE test;
– registration of protocols of technical control and report of production programming;
– realization of cyclogram of technical control to be carried out for each type of ICE;
– prevention of worst-case and emergency situations when testing ICE.

The functions performed by the test patterns of ICE:

– functional test of the sensors of primary parameters;
– functional test of actuating mechanisms;
– correctness checkout of control algorithms;
– verification of presence and safety of data messages;
– out-of-service record of program-technical facilities;
– recognition of failures to be not identified automatically;
– analysis of failure records of program-technical facilities;
– control of accuracy of functioning program-technical facilities.

2. STATE-OF-THE-ART OF TECHNOLOGICAL DEVELOPMENT OF ICE

Prompt progress of software engineering and its onrush penetration into almost all spheres of activity of a man are specially evident by way of example of automobile industry. Currently, the evolutionary development of vetronics comes to the various problems, which gives grounds for assumptions about the birth of revolutionary engineering development in the near future.

Integrated circuits on semiconductor elements have carried out a revolution in the automobile production, especially in aggregate and automotive control on the whole [4]. Nowadays no automobile is produced without electronic devices in the world. The main of which are voltage regulators, transmission control devices, fuel injection control devices, braking system control unit, steering control apparatus, suspension control device.

The first microcomputers were used to control the ignition timing (in1976, in the systems «Misar» of «General Motors»). Due to the high precision of control it has become possible to significantly improve engine performance.

In 1980, there appeared electronic dashboards, suspension control system, automatic air conditioners, radio-sets with electronic adjustment, multifunctional information systems with the displays based on cathode ray tubes, and others. Nowadays, on-board control systems based on electronic control units (ECU) have become widespread. These ECU carry out self-diagnostics.

All the electronic units on functionality can be classified into three basic control systems of: engine; transmission and chassis; interior equipment.

Currently, it has been developed and mass-produced a wide variety of engine control systems in the world. These systems according to operating principle have much in common, but differ significantly. According to their function, they are multi-functional and integrated. In complex systems, one electronic unit controls several subsystems: fuel injection, ignition, valve timing, self-diagnostics and other. In multifunctional systems, ECU signals only in ejection system. On fuel distribution one distinguishes multipoint and central injections. By multipoint injection it is set one injector per a cylinder, and by central there is one injector per all cylinders.

Besides, the difference is in the method of injection. Injection can be carried out continuously and by impulses. At a constant fuel supply the amount of it is varied by changing the pressure in the fuel tube, at impulsive – by impulse duration and its frequency. Thus, in one injection it may be fed with the full portion of the fuel or its part (usually half). If for every revolution of the crankshaft a fuel injection is performed in each cylinder, so called synchronous injection.

Integrated engine control system ensures its optimum performance by the fuel injection control, ignition timing, frequency of rotation of the crankshaft of the engine at idle and diagnosis.

Upgrading the equipment of modern cars can be displayed in the form of many small, fast consecutive steps, and often it does not threaten additional financial electronics costs to the auto-producers [5]. At present, electronics is widely used, including to control the burning of fuel in internal combustion engines, in trackers of the condition of individual systems and devices, for controlling the actuators and the like.

At present, absolutely non-standard automation systems began additionally installing in newly developed models of automobiles, they are referred to automated system of assistance with software, including: satellite navigation system; audio and radar systems to protect vehicle theft and collision; a system of improving the comfort and safety of people in the saloon; cruise control system and so on.

At the same time it is carried out the search for the optimal technology of automatic processing messages in onboard automated systems. It has been developed and have been used sometimes called "linguistic function generators" working with the fuzzy sets of linguistic variables expressed in single words or whole sentences in a natural (English) or artificial (computer) language [6].When complicating logic and arithmetic operations in the microcomputer it enhances the soundness and adequacy of the (speed) messaging system. Therefore, interface has become much more complex and it has become necessary to introduce CAN- protocol into multiplex system.

Application of electronic engine control system has the following advantages:

– engine is optimally supplied with fuel at all running regimes which is resulted in decreasing fuel consumption with retention of dynamic characteristics of automobile;

– in connection with a complete combustion of the fuel and the use of the catalyst, emissions of harmful substances with the exhaust gases decrease;

– since electronic engine control system determines and stores faults, the search and detection of faults significantly accelerate;

– engine management system on all operational modes sets the optimum ignition timing angle, the time and the amount of fuel supplied to the engine. Also, the engine management system communicates with other vehicle systems, in particular, with a control system of automatic gearbox or with antitheft system.

The components of the engine management system is very reliable and virtually maintenance-free [7]. During maintenance, it is only needed to replace the air filter and spark plugs. As for testing, adjusting and repair of the engine management system it is necessary to use a complicated expensive equipment, then the work should be performed at a specialized workshop.

Today, there are many standards for communication protocols between the ECU and test system. The list of ISO and SAE on diagnostics:

- ISO 9141: The requirements for the exchange of digital information

- ISO 9141-2: The requirements for the exchange of digital information
- ISO 9141-3: Connection setting between the vehicle and OBD II
- ISO 14230-1: Protocol 2000 - Physical layer
- ISO 14230-2: Protocol 2000 – Communication link
- ISO 14230-3: Protocol 2000 – Applied layer
- ISO 14230-4: Protocol 2000 – Requirements for the emission systems
- SAE J1850: Class B. Interface data network
- SAE J2012: Recommended Practice for diagnostics of trouble code definitionsSAE J1930: Electrical / electronic diagnostics: Speed of definitions, abbreviations and acronyms
- SAE J2178: Class B. Communications data network.
- SAE J1978: OBD II Scanning tools
- SAE J1979: E/E Diagnostic test methods
- SAE J2201: Universal interface for OBD II of browsing tools.
-

3. STRUCTURE OF INTELLECTUAL DEVELOPMENT MODEL OF TEST

Creation of automated system is based on object-oriented approach. The advantage of this approach lies in the interface to download the project of testing and maintenance of communications protocol OBD-II between the electronic control unit MS-6.1 of the company «Bosch». The source code is developed on the basis of the programming language Visual C ++ [8].

To create the model structure of the project it is necessary to determine the original structure of the testing process that reflects the scheme of automated testing systems (Figure1), and also to establish functional features of set modes.

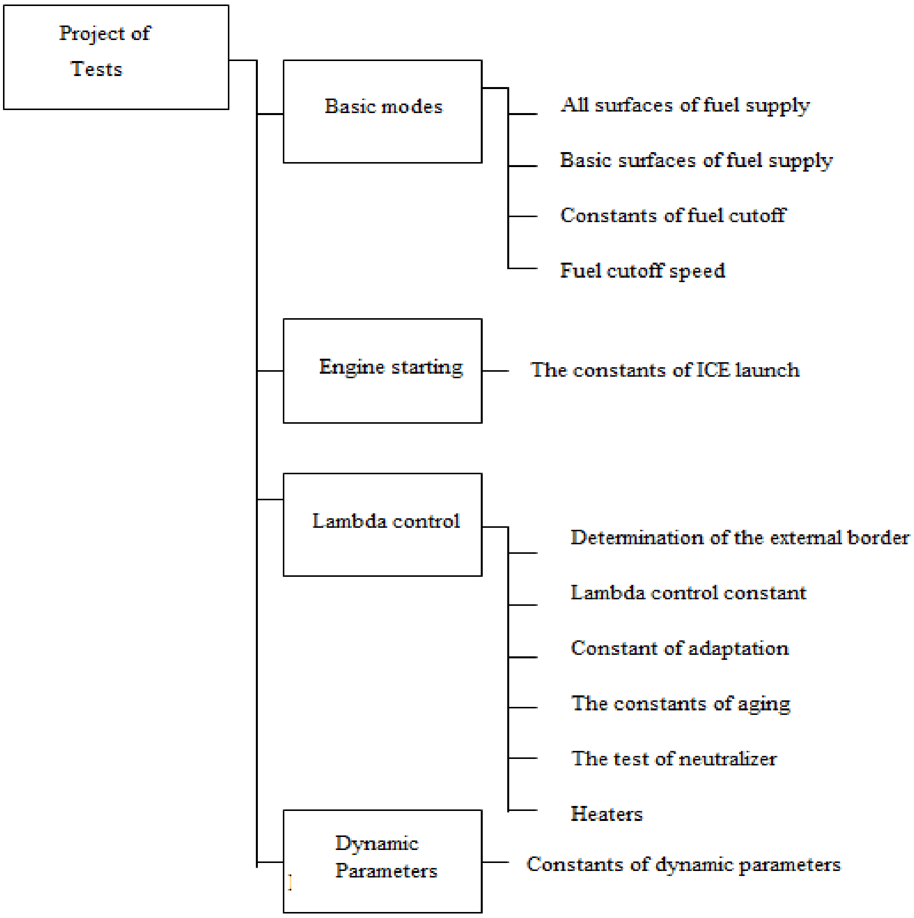

Figure 1 – Project structure

During testing, all information stored in computer memory in tabular form, the structure of which is shown in Table 1.

Table 1 – Summary table of parameters

№ p/p	Parameter 1	Parameter 2	Parameter 3	…	Parameter m

1	A11	A21	A31	…	Am1
2	A12	A22	A32	…	Am2
3	A13	A23	A33	…	Am3
	…	…	…	…	…
S	A1S	A2S	A3S	…	AmS

where:
Aij – settings value of ICE;
M – measuring parameters;
S – number of test measurement points;

In order to more accurately select a test mode, it must be taken into account the main characteristics of the ICE that require special controls (Table 2). When testing the ICE, it is necessary to check the following parameters:

- current parameters of fuel supply;
- adjustment of idle running;
- functionality of the supercharging air sensor;
- transition fuel mixture from the mode of lean mixture to rich.

Table2 – Functional peculiar issues associated with test conditions of ICE

Name of group	Modes of test	Functional particulars
Basic modes	All surfaces of fuel-handling	representation of model parameters associated with the fuel supply
	Base surfaces of fuel-handling	reflection of dynamic output of fuel feed
	fuel cutoff constants	It reflects the difference of turns on the top and bottom boundary depending on the current state of the internal combustion engine
	Rate fuel cutoff	rate restriction of fuel supply speed
Engine start	ICE start constant	It shows the transition fuel time from the initial starting position to normal
Lambda particle regulator	Determination of outer boundary	It reflects the characteristics of the controller of mixture
	Lambda control constant	It displays a range of control of fuel, the threshold of the transition fuel mixture from the lean to the rich.
	Adaptation constant	It reflects adaptation of ICE idling from the data obtained from the supercharging air sensor.
	Aging constant	The test of aging of charging air sensor.
	Test of neutralizer	The aging test of sensor neutralizer of exhaust gases.
	Heaters	controlling the temperature of the coolant.
Dynamic parameters	Constants of dynamic parameters	It shows the acceleration of the pumping operation depending on the position of the accelerator pedal

Initially, the settings file of ICE and vehicle is loaded into the electronic control unit [9]. After loading the engine is launched, followed by exposure to an apparatus for performing the tests of ICE [10]. During the test, information is collected from the sensors. The resulting information is displayed on the monitor(Figure 2).

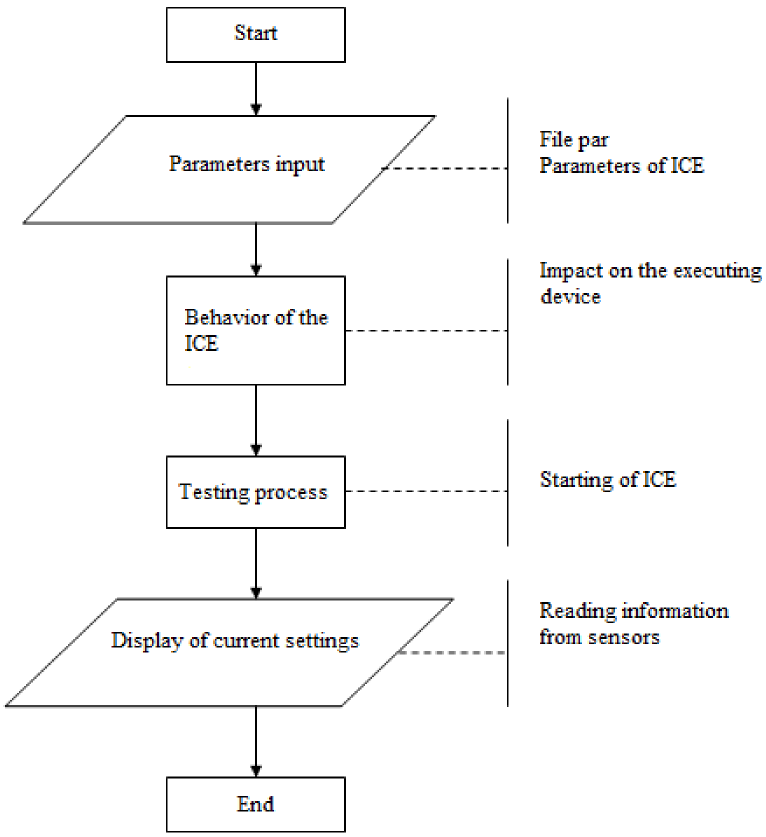

Figure 2 –The algorithm of the ATS of the ICE

4. SUMMARY

Based on the above it can be concluded that the developed testing system allows you to effectively perform the test vehicle controller-based company Bosch MS-6.1. Of particular interest is possible to compare the current settings of test results with the parameters specified in the design of the ICE and the vehicle as a whole.

5. CONCLUSION

As a result of this work, it has been developed an automated automobile test system based on controller of the company-firm Bosch MS-6.1 [11].

In the course of the project it was conducted the analysis of existing ICE tests, which showed the need for an automated test system in consideration of the small competition. To create a top-level software it has been given the structure of tests, based on the design and technological parameters of the internal combustion engine. When developing the structure of test systems the main mode groups were identified. To implement the test modes it has been determined the constants of variables assigned to groups according to their functionality, eliminating the preset project tree of tests. On the basis of the structure of tests it has been realized the top-level software.

Automated Test System is made on the basis of object-oriented approach. The advantage of this program consists in easy interface for loading tests project, as well as support of communication protocol OBD-II with an electronic control unit MS-6.1 of the company-firm «Bosch».

THE CONFLICT OF INTERESTS

The author confirms that the presented data do not contain the conflict of interests.

ACKNOWLEDGEMENT

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

REFERENCES

[1] Galiullin, L.A., Zubkov E.V. Hybrid Neural Network for the Adjustment of Fuzzy System when Simulating Tests of Internal Combustion Engines //Russian Engineering Research. - 2011. - Vol. 31, № 5. - pp. 439-443.

[2] Biktimirov, R.L., Valiev R.A., Galiullin L.A., Zubkov E.V., Iljuhin A.N. Automated test system of diesel engines based on fuzzy neural network. 2014. Research Journal of Applied Sciences, V.9, P.1059-1063.
[3] Galiullin, L.A. Automated test system of internal combustion engines (2015) IOP Conference Series: Materials Science and Engineering, 86 (1), art. no. 012018.
[4] Valiyev, R.A., Galiullin, L.A., Dmitriyeva, I.S., Ilyukhin, A.N. Method for complex web applications design (2015) International Journal of Applied Engineering Research, 10 (6), pp. 15123-15130.
[5] Yao, Z.T., Pan, H.X. Engine fault diagnosis based on improved BP neural network with conjugate gradient (2014) Applied Mechanics and Materials, 536-537, pp. 296-299.
[6] Galiullin, L.A. An Adaptive Neural Network for Diesel Engines Testing «Computer Systems Aided Science, Industry and Transport», Transcomp — XIV International Conference (Zakopane, 6.XII-9.XII 2010, Poland) – 2010. – PP. 3861-3867.
[7] Shatnawi, Y., Al-Khassaweneh, M., 2014. Fault diagnosis in internal combustion engines using extension neural network. IEEE Transactions on Industrial Electronics, 61 (3), art. no. 6511979: 1434-1443.
[8] Zhou, M.L., Wang, J.C., Li, Y.P., 2014. Automobile engine fault diagnosis and prediction system. Advanced Materials Research, 1008-1009: 641-644.
[9] Osovsky, S. Neural networks for information processing. – M.: Finances and Statistics, 2002 – P. 235-238..
[10] Fuzzy neural network control model when tested diesel. Tractors and agricultural machines. – 2011. – №12. – P. 21-23.
[11] Galiullin, L.A., Zubkov, Ye. V., 2011. Certificate of state registration of the computer №20111614373 «Automated information system "tests of diesel internal combustion engine based on fuzzy neural network. '"M .: Rospatent.