ECM Software Testing using Automatic FMET

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ABSTRACT

The engine is the main part for various 'on' highway and 'off' highway applications. Safety and performance of engine is very important to avoid the hazards in automotive system. So, manufacturers developed the embedded electronic control system which is called as Electronic Control module, to make automotive system safer. For monitoring the function of engine, Electronic Control module is used. Electronic control module is the main part of engine which controls the series of actuators mounted on internal combustion engine to ensure the optimal engine performance. To test the software logic of ECM in different fault condition of signals from sensors and actuators, manual FMET testing was developed. But the drawback of manual FMET testing is time consuming and required more manual efforts. So, to overcome the drawbacks of manual FMET testing, this system is developed to test ECM in different fault condition automatically with the help of automation tool.

Keyword: - *Electronic Control Module (ECM), Fault Mode Effect Test (FMET), Automation Tool*

1. INTRODUCTION

Now, a day's most of automotive engine industries trying to manufacturing the good quality of automotive product [1]. For that, automotive industries is developed the electronic Control unit. The Electronic control module which controls more that 100 factors of vehicles. Hence, to avoid hazards in vehicles, the engine should work properly and safely. So, to make engine working properly and safely, various sensors and actuators are mounted in various part of the engine which used to continuously measure the performance of the engine. Fig.1 show the basic concept of automotive engine with ECM.

These sensors and actuators signals are given to the controller i.e Electronic Control module, which control various parameters of the engine like air and fuel ratio, temperature of air, temperature of the engine, etc. So, ECM software or control algorithm plays an important role in operation of the engine [2]. Hence, it is necessary to test ECM software in different fault condition of ECM pins like open pin, short to ground pin and short to battery pin. For assure the good quality of the Electronic control module (ECM), their is increasing in number tests of ECM software. For that, manual FMET system was developed to test ECM software in different fault conditions of ECM pins. For this type of testing, more time and more manual efforts are required. So, to overcome this drawbacks, automated testing is developed with the help of automation tool NI-TestStand to test ECM software [3,4].
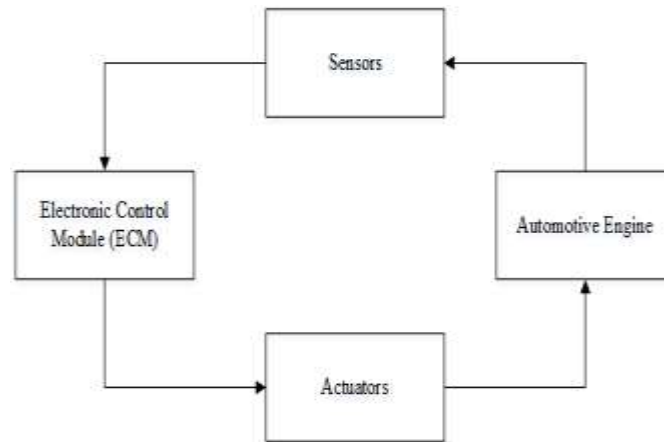
Fig-1: Concept of automotive engine with ECM [2].

This paper is organized as follows: The section 1 describe the idea behind the given system. The section 2 explain the test sequence logic with the help of flowchart. And section 3 explain the result of given system followed by conclusion.

2. METHODOLOGY

The given system is developed to test performance of ECM software automatically in different fault conditions like open pin, short pin to supply pin and short pin to Ground pin. For this, system requires Digital FMET box, engine simulator like Load box user interface (LUIS), NI-testStand and ECM. Fig.2. Show the block diagram of the proposed system. As shown in Fig.2, the Test PC is required to install, all necessary software of the automation testing such as Load box interfacing system (LUIS) software to control the all the parameters of LUIS engine software [5]. Engineering tool is required to flash software logic in Electronic Control Module (ECM) and automation tool NI TestStand to write the test sequence [6]. Then PCAN adapter is required to communicate between the NI TestStand, Digital FMET Box and LUIS engine simulator.

The Load Box Interfacing System (LUIS) is engine simulator which generate all signal of sensor and actuator same as that of real engine [5]. Electronic Control Module (ECM) is controller which continuously monitor the performance of the engine parameters with the help of different sensors and actuators is used to control the parameter of engine if there is any need.

Digital FMET box is a gateway between the ECM pins. It is used to making and braking the connection between the ECM pins to test the ECM software in different fault condition such as open pin, short to supply pin and short to ground pin. To make connection between the hardware harness is used. The harness is bunch of wire which is used to transferring and receiving the signal among the hardware [7]. So, this is all about the block diagram of given system which is required to make the complete setup of automation of FMET testing.
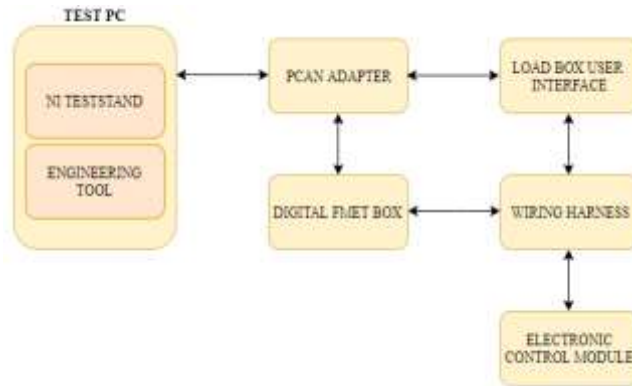
Fig -2 : Block Diagram of Proposed System.

3. FLOWCHART

This section deals with test sequence logic of given system with the help of flowchart. Flowchart divided into main sequence logic and their sub-sequence logic before writing the actual test code using NI TestStand.

3.1 Main Sequence

In main sequence first step is establish connection between LUIS engine simulator, ECM and digital FMET box. Then go to next sub sequence as shown in Fig.3, to get parameter name and their corresponding pin number, error name from database.
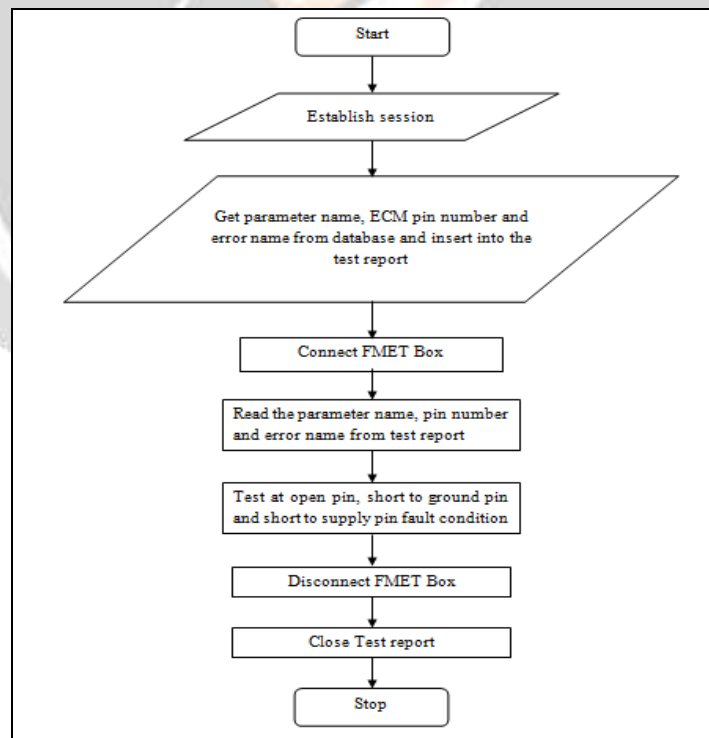

Fig – 3: Main sequence of automation of FMET testing

3.2 Get parameter name from database

Parameters name are same for all engine application except pin number and fault code. Hence, parameters name are taken from the database to use same code for multiple ECM module. After establish connection, next step is started i.e get parameter name from the database as shown in Fig.4. To get the total number of parameter and name of the parameter from the database, SQL queries are used. After getting the parameter name inserted into the test report. This sequence is continuing till parameter name in database is equal to empty.
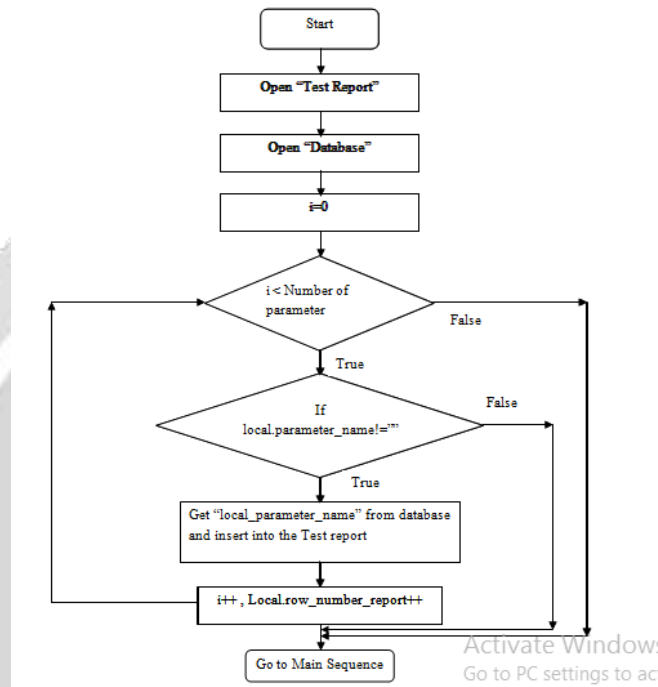

Fig - 4: Get parameter name

3.3 Get Pin number and Error name of corresponding parameter name from database

After getting the parameter name from database, next step is get the corresponding pin number and error name from database as shown in Fig.5, then insert that data into the test report for further use. This procedure is continued till parameter name is equal to empty.

3.4 Short to supply pin fault condition

Now connect the FMET box, to insert the different fault fig. 3. First fault condition is short to supply pin condition as shown in Fig.6. For that, parameter name and their corresponding pin which is to be shorted with supply pin of ECM. After inserting the fault, read the voltage value of that parameter which should be equal to the supply voltage and then check fault code is active or not. In test report, '1' indicates fault code is 'ACTIVE'. This procedure is carried out still total number of parameter is equal to empty.

3.5 Short to Ground pin fault condition

Second fault condition is short to ground pin condition as show in Fig.7. For that, parameter name and their corresponding pin which is to be shorted with ground pin of ECM. After inserting the fault, read the voltage value of

that parameter which should be equal to the ground voltage and then check fault code is equal to '1' or Not. This procedure is carried out still total number of parameter is equal to empty.

3.6. Open pin fault condition

Last fault condition is open pin condition means connection of parameter signal get disconnected. For that, parameter name and their corresponding pin which is to be open pin of ECM as show in Fig.8. After inserting the fault, read the voltage value of that parameter which may be equal to the supply voltage or ground voltage and then check fault code is equal to '1' or Not. Here, '1' indicates fault code is 'ACTIVE'. If fault code is active then generate the test report for that. This procedure is carried out still total number of parameter is equal to empty.
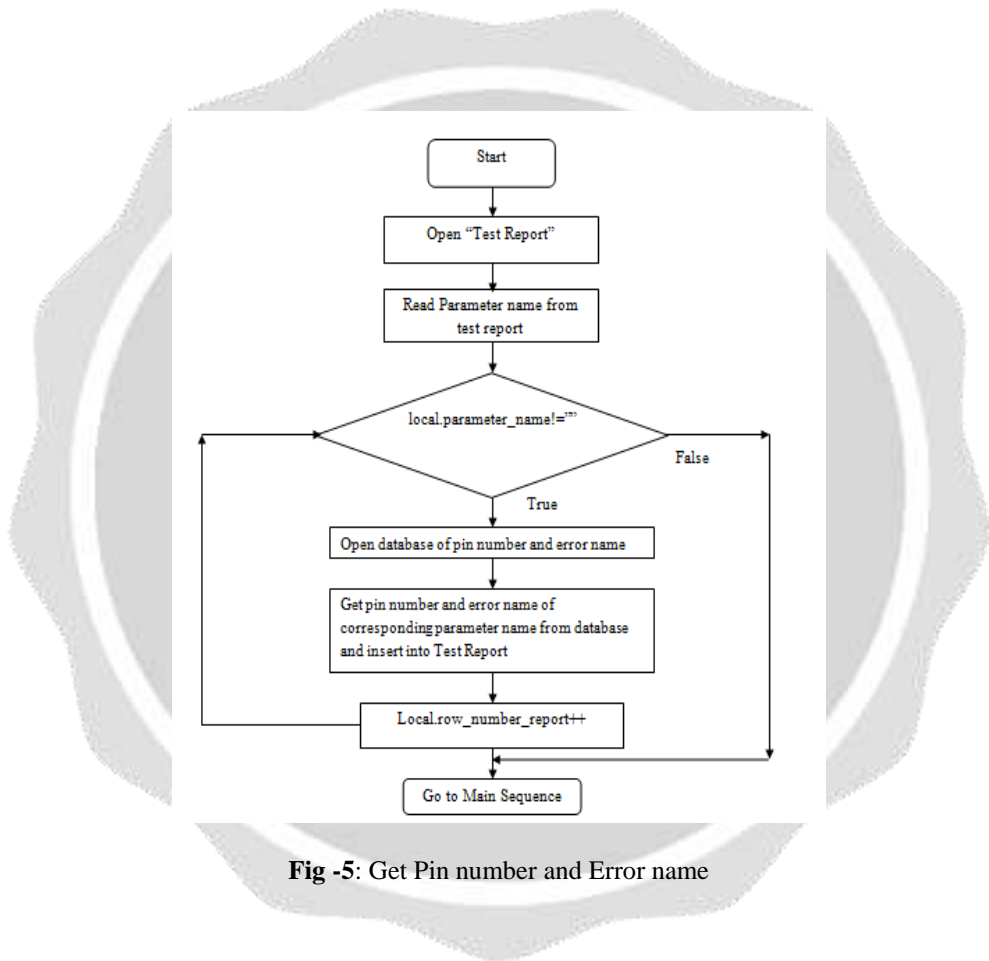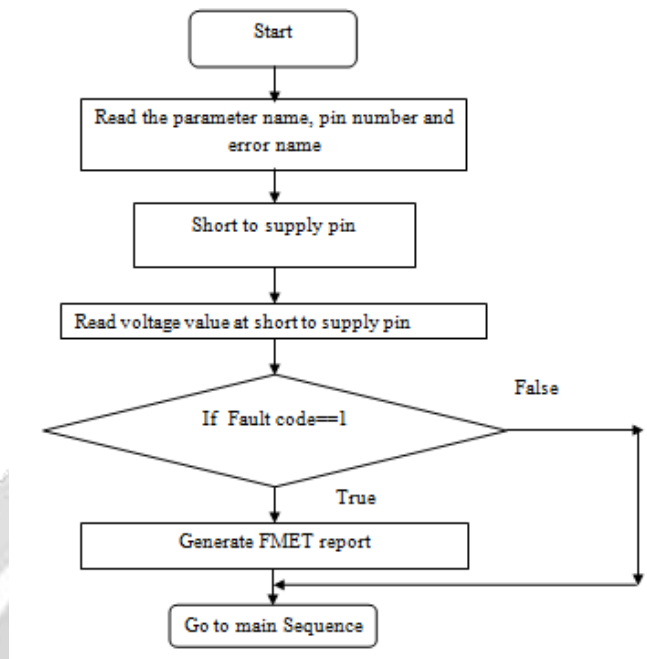

Fig -5: Get Pin number and Error name

Fig -6: Short to supply pin fault condition
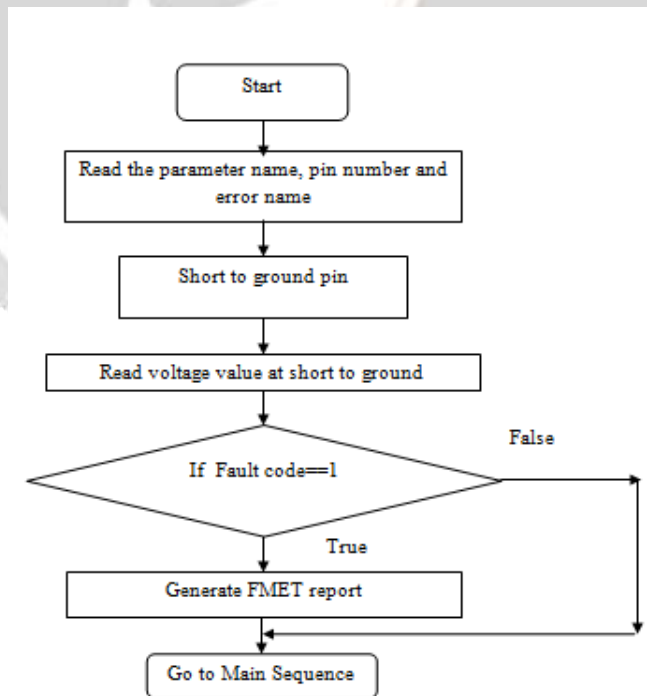

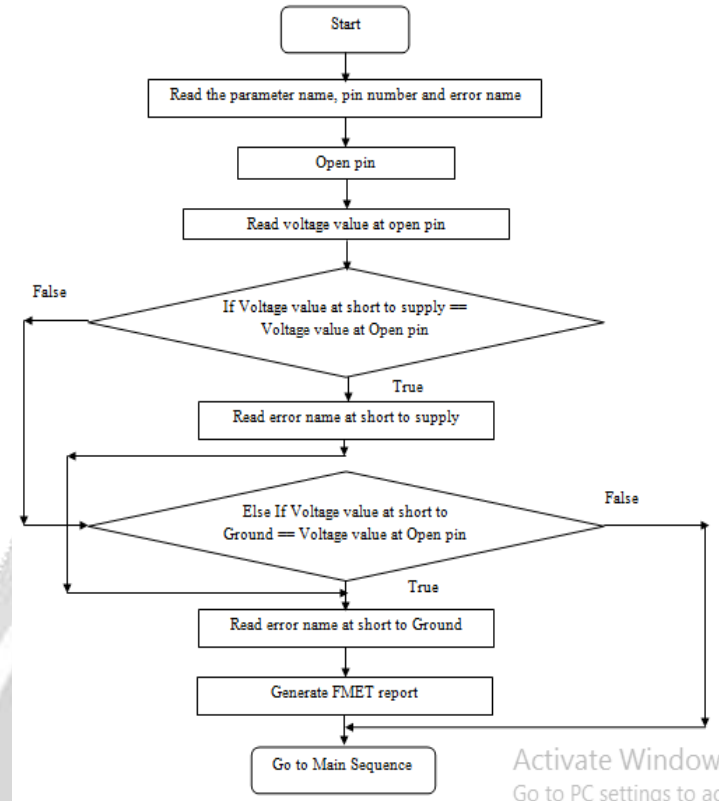
Fig -7: Short to ground pin fault condition

Fig -8: Open pin fault condition

4. RESULT

The steps of automation should be followed to make testing successfully. The Fig.9 show the steps of Automation of FMET Testing. If there is any step missed, it does not shows correct result. In LUIS configuration file contain GUI of different parameter of engine. Different application of engine has different LUIS configuration file. Then open the engineering tool to flash the configuration file and calibration file into ECM. The calibration file contain information about different parameters and their respective values. The configuration file contains software logic of ECM. Then open the automation tool i.e NI TestStand, then insert the step 'TotalBench- Configuration' which is required to make the connection between ECM and NI-TestStand. For automation testing, this step important to make communication between Digital FMET, LUIS engine simulator and NI TestStand tool. Now open test sequence file which written for the automation testing of ECM. And at the end, run the test sequence to get the test report automatically. Fig.10 shows test report, which contains all information about the parameter signal pins and their different fault condition, after insertion of fault with the help of digital FMET box. Fig.10 show the execution time of manual testing and automation testing of FMET for different parameters of engines.
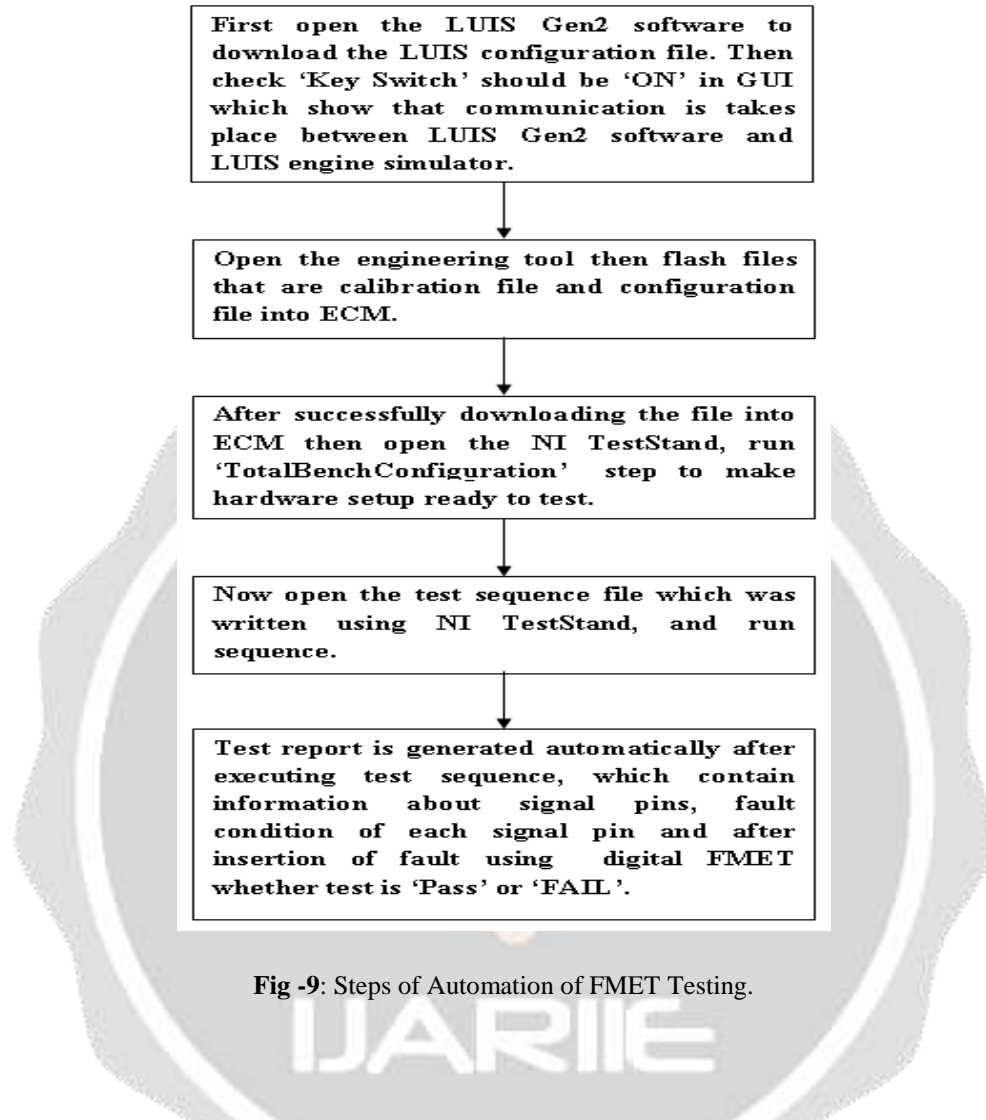
First open the LUIS Gen2 software to download the LUIS configuration file. Then check 'Key Switch' should be 'ON' in GUI which show that communication is takes place between LUIS Gen2 software and LUIS engine simulator.

Open the engineering tool then flash files that are calibration file and configuration file into ECM.

After successfully downloading the file into ECM then open the NI TestStand, run 'TotalBenchConfiguration' step to make hardware setup ready to test.

Now open the test sequence file which was written using NI TestStand, and run sequence.

Test report is generated automatically after executing test sequence, which contain information about signal pins, fault condition of each signal pin and after insertion of fault using digital FMET whether test is 'Pass' or 'FAIL'.

Fig -9: Steps of Automation of FMET Testing.

Test Type	Pin#	Data And Test Results			
		Normal Condition Data	Fault Condition Data	Pass/Fail	Error Code
Open Pin	J1-45	INACTIVE	ACTIVE	PASS	0, 0, 0
Short To Sensor Supply	J1-45 TO J1-10	INACTIVE	ACTIVE	PASS	0, 0, 0
Short To Ground	J1-45 TO J1-9	INACTIVE	ACTIVE	PASS	0, 0, 0

Fig -10: Test report of Intake manifold pressure at different fault condition and their ECM pin number.
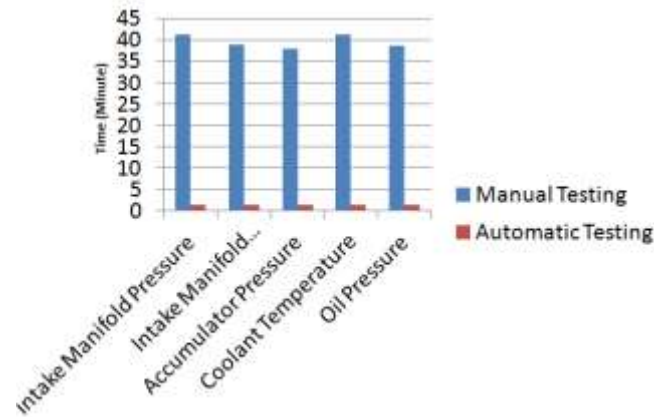
Fig. -11: Time required for different parameter in manual testing and automation testing.

5. CONCLUSIONS

In manual FMET testing, the making and braking the connection of ECM pin more time and manual efforts are required. So, overcome this drawback proposed system is developed to test the ECM software automatically before testing on the actual engine. Hence to make automatic testing NI-testStand software and digital FMET box, LUIS and ECM hardware is used.

6. REFERENCES

[1]. Eckard Bringmann, Andreas Krmer, "Model-based Testing of Automotive Systems", International Conference on Software Testing, Verification, and Validation, IEEE, 2008, pp.485-493.

[2]. Yin Jinguan, Su Tiexiong, Guan Zhuowei, Chu Quanhong, Meng Changjiang, Jia Li, Wang Jun, Zhang Yangang, "Modeling and Validation of a Diesel Engine with Turbocharger for Hardware-in-the-Loop Applications", Energies, vol.10, issue.5, 2017, pp.685-702.

[3]. Renuka M. Kulkarni, Rohita P. Patl, Chidambar R. Bhukya, "Hardware In Loop Test Bench Development And Automation For Failure Mode Effects Test Of After Treatment System", International Journal of Industrial Electronics and Electrical Engineering, vol.4, issue.10, 2016, pp.27-30.

[4]. R. M. Bhide and V. S. Kulkarni, "Automated testing tool for engine software testing," International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT), Pune, 2016, pp. 940- 942.

[5]. Ajay Pradhan, "Current Trends in Automotive Wire Harness Design, International Conference on Mechanical, Production and Automobile Engineering, 2011, pp.277-279.

[6]. Rajashree M Bhide, Pratiksha Raut, Rohini S Jadhav, Vaishali S Kulkarni, Sunil L Tade, "Test Automation Tool for Electronic Control Units Software Testing," International Journal of Scientific Engineering Research, vol.7, issue.4, 2016, pp.1208-1210.

[7]. www.ni.com/teststand/

[8]. www.gartechenterprises.com