Design and Construction of a board simulation for an engine with electronic fuel injection system.

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Abstract.

The Engineering Automotive Maintenance career has identified the need to have a scheme a test for an engine with electronic injection system in the auto-repair shop practices of the career, which has the characteristics numerical indicators and wave operation of each sensor with respective datasupply, ground and signal [4]. The aim of the project is to build an electronic board for performance analysis, fault detection and diagnosis in an engine; facilitating the variation of sensor signals in a required regimen. The research is technology-literature character and study methods used in the research are analytic-synthetic and trial-error. The methodology was based on measuring, monitoring and vary sensors of electronic fuel injection system of the engine [5], and obtain results were compared with literature data obtained in the auto-repair shop manual [14], to identify possible causes and variations. In designing this board used analysis software and computer design [13] assisted; hardware in building a DAQ board and relay modules are used. With the development of the Project obtained board pin and an interface between the computer and the engine.

Keywords

Test bench, fuel injection, numerical indicators, waves of operation, monitoring sensors.

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1. Introduction

The design and construction of a board simulation system injection engine Chevrolet Aveo is an issue of vital importance for Automotive Mechanical Engineers and related people, allowing simple form, using a programmable system created on a computer [13], which interface with the engine using a data card generatefaults, variationscommon and notable changes in sensors and actuators [7], considering operating data of each one to perform a comparative table values between the data obtained and granted the auto-repair shop manual of the vehicle [14], and thus have characteristics of each failure.

The overall aim is focused on design and build a data table to simulate injection system of an engine [8], the development of the project was achieved through the specific aim as design a board diagram [11] to the location of the various sensors, actuators and the ECU, with their respective power distribution and installation of the elements and tools needed for the operation of the board [10]. In addition, realize a series of tests aimed at verifying the proper operation of the board by curves and comparison of data, being a study on the data sent by the sensors to the ECU, and this to the actuators, both when the system is in good operation as when one of the faults raised in the system [4] is generated.

Project completed to obtained series of conclusionswhich help identify important features as: get real data signals from sensors and actuators, both contact and high idle speed [1]. Also could be found the most glaring failure of each sensor, allowing you to identify symptoms such as destabilization of the engine, fuel consumption, engine power check, lack of acceleration, drowning, among others, that are unique to each failure [6] and which are detailed in the Project. In addition, the project is considered as a system of high accuracy, because it can measure a variation decimal digit to sixth [13].

2. Materials and methods

In the development project obtained atechnological research because implemented something innovative, which is to create a system programmablewhere so controlled by a computer can be measured , vary and open circuit signal from each sensor [13] which are received by the ECU , which processes and generates a response work actuators ; this innovative system allows a data acquisition numerically and graphically , to improve engine performance and identify the location of the fault in it more effectively .

1.1 Methodology

Within this project use an analytical-synthetic method that aims to explore all the information related to the topic of degree, achieving reassert acquire new knowledge and information is used. This information is taken from books dealing with electronic injection, ECU, injectors, actuators and fault codes, that is to say all related to electronic management of a vehicle [2], this documentation will be on the web, in books university library and research books about the subject; also it seeks help of specialists in the areas mentioned above. Any information found is synthesized to identify a reality and a current problem and thus find a solution by implementing an innovative project in a matter of social, technological, educational interest.

It is also essential to use the trial-error method where performance tests aimed at detecting and correcting errors that may occur in the design, assembly and operation of the data acquisition board, to correct faults and obtain proper operation of the board is done.

1.2 Materiales

In the aforementioned project with 1.6L engine 16v DOHC (Double Overhead Cam) 2006 was used; considering it has great accessibility to spare parts and accessories at an affordable price below.The technical specifications of motor [14] indicated in the table below is detailed.

TABLA I. ENGINE DETAILS USED IN THE PROJECT

Motor	
Motor	1.6L 16v (103hp)
Power (HP / Rpm)	103 / 6000
Engine Volume	1598 cm^3
Torque kg-m (Nm) / RPM	14.7/3600
Fuel System	Multipoint injection
Distribution	DOHC
Position of cylinders	Lineal
Number of cylinders	4
Diameter cylinder	79 mm.
Cylinder stroke	81,5 mm.
Compression ratio	9.5
Valves per cylinder	4
Block /cylinder head	Cast iron / aluminum
Fuel	Gasoline
Petrol Pump	Electronics
Ignition system	Electronic

Continuing the project a technical drawing of the structure where the engine with their accessories will be mounted is performed. The structure is designed in the SolidWorks program thickness specifications and respective measurements. Isometric view of the design of the structure where its elements and respective dimensions shown in the illustration below.

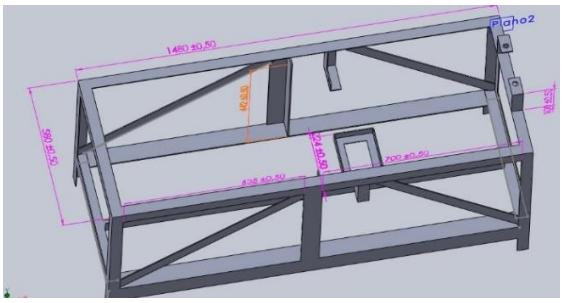

Figure 1: Design Solidwork structure that will support the engine.

An important element in the process of construction of the project is the ECU (Electronic Control Unit) that conform to 2 modules A and B of 32 pins each. Module A is the main housing and all the sensors, however the module B has the same number of pins, which actuators and electrical accessories [14] is focused.

Other fundamental devices are relay modules that amplify the amperage (mA) [12], since card data acquisition (DAQ) caters not only to activate a relay. This module can amplify 200 mA, which provides the DAQ to

20mA needed by the relay. Among the most notable features we are: independent channels protected by optocouplers. Relay 1 pole 2 shots, the voltage of the relay coil is 5 V, LED indicator for each channel (on when the coil is energized) can be controlled directly by logic circuits [11].

Figure 2: Relay module board.

The 6008 is a DAQ acquisition card data not very common in our environment, used by electronic and electromechanical and very little in the automotive field; it allows simple and easy programming; facilitating the acquisition and data monitoring.

This card facilitates synchronization and interface with a PC running LabVIEW software to monitor, assess and record data obtained from a system, either a motor, a business or industry [13].

It is characterized by 12 digital ports, generating an amperage of 200mA, which can be used as inputs and outputs; also it has 10 analog ports, which generate an amperage of 10mA, 8 of which are used as input ports and 2 ports as outputs. The most important qualities of this card are its accuracy and resolution with which data can be obtained with minimal variations and a very small iteration (in thousandths of voltage) [10].

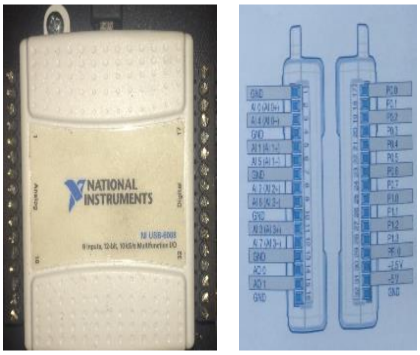

Figure 3: Data Acquisition Board with their pinout

2. Results

At the end structure design strength calculations it is performed using the option forces SolidWorks simulator to verify if this supports the weight generated by the motor. The following figures show the calculations made in the structure dynamically based on the principles of Von-Mises observed.

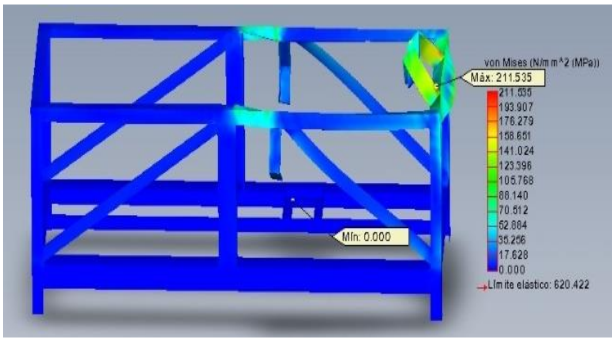

Figure 4: Static Displacement (von Mises)

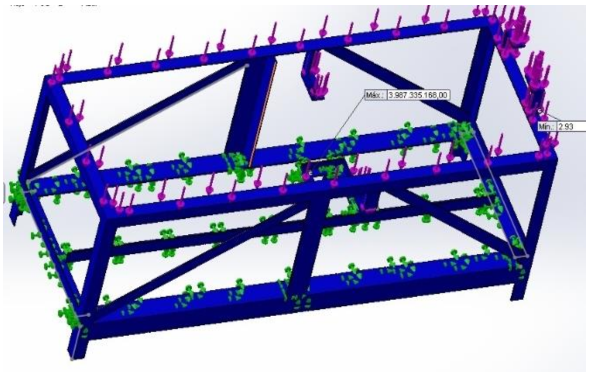

Figure 5: Stress Analysis Static Nodal stress (von Mises).

One of the results is the ability to generate fault codes, among the most notable is the process to cut the circuit voltage of a sensor or actuator being mass supply and signal [12]. Operation begins when connecting to a relay interface module with the DAQ card and Labview this program with active or off the relay, and thus open circuit or change the sensor or actuator.

To generate the most notable failure in the sensor, taking into consideration conditions such as signal type, power source, waveform and body type, which are specific to the various sensors and actuators, which are found in the engine characteristics [1].

Upon completion of the Project, it has a number of components that work together and allow the proper functioning of the designed system. Among the tests to be performed, it is necessary to review the excellent work of all the elements involved, to thereby ensure that the data are real. The elements used in the project are listed in the following table, verifying that operation is correct.

TABLE II: VERIFICATION OF OPERATION OF EACH ONE OF THE ELEMENTS IN THE BOARD

Verificación de funcionamiento de los elementos

Elementos	Funcionamiento
I relay module.	Right
DAQ card.	Right
LabVIEW program.	Right
Connecting cables between DAQ and relay module.	Right
Court voltage sensors and actuators.	Right
Relay interface module, DAQ and programming.	Right

At project completion, the same signals (voltages) are obtained at different points of the board simulation, which are : pin board, sensors and DAQ card (in the LabVIEW program), which differ in their ability to grasp the variations in the voltages of each sensor. In sensors and measurement pin board is performed with a multimeter, which presents a variation with two decimal one second delay; however, in the LabVIEW program by DAQ board, a variation occurs to six decimal places in real time.

One of the most important features of the project is the ability of the board to generate faults in the engine sensors and actuators, dependently of the show you want to do. The open circuit voltage to cut power, ground and signal of a sensor or actuator, different voltage values generated by the electronic elements listed in good condition are obtained.

Figure 6: Project in their final state and running.

Another result is the programming done within the Labview developer; you have as workspaces two windows: the first corresponds to the front panel where all the aesthetic form of the Project is observed, meaning that size, color, type of instruments such as buttons, graphs and indicators; however, in the second, the block diagram where all the graphical programming that has the overall project is broken down and where each of the parties is observed.

3. Conclusions

The voltage values obtained through the Labview 6008 DAQ interface card and have an average range variation of 3% compared to the readings taken with the meter directly to the engine sensors; for this reason, they meet the needs required by this project.

The main limitations of card operation data acquisition DAQ focus on its analog and digital ports. The first, not receive larger signals 10v; and second, they generate a maximum voltage of 5V to an amperage of 8.5 mA current value is not sufficient to activate a relay; therefore, it is necessary to use an optocoupler module to amplify the value of said amperage.

The parallel connection of different power circuits, mass, signal sensors and actuators of the injection system of the engine, to simulate faults and voltage readings performed without affecting the normal operation of the motor.

Generating Board failure simulation is performed by interrupting one of the supply lines of the sensor or actuator; then, using relays modules located in series with said lines is achieved produce failures normal engine operation.

Knowing the specifications of the DAQ calculation and verification of data, with which it can be concluded that the accuracy and resolution of the data acquired are very efficient is done; therefore, to identify variations of 0.14 volts at each of the sensors 4000 iterations per second, having real and accurate data.

Gratefulness

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