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Research Communication

DEVELOPMENT OF DECISION SUPPORT SYSTEM FOR MANAGING THE MAINTENANCE OF FUEL INJECTION PUMP AND DIESEL ENGINE IN AUTOMOTIVE TECHNOLOGY

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Abstract: *The automotive industry in India is one of the largest in the world and one of the fastest growing globally. This paper venture to propose a diagnostic tool that introduce a software which presents the expert solutions on the troubles associated with Automobile's Fuel Injection Pump of Diesel Engines by means of different diagnosis levels through predictive maintenance process for the end-users . This research combines a uniquely developed Simulating Function Module i.e. Automobile Workshop Manager and the intensive individual method studies on the problem solving methodologies for the malfunctioned cases in Automobile Fuel Injection Pump of Diesel Engines.*

Keywords: *Expert System, Software modelling in predictive maintenance, Fault Detection of Fuel Injection Pump of Diesel Engine.*

Introduction

In order to observe the chronological survey it is learned that there is no record on the development of any Expert Software Modelling in Fault Detection of Fuel Injection Pump of Diesel Engine in Microsoft windows VB.Net Framework. That leads this research to collect the Data Set from the practical experience of several Indian Automobile Workshops which concludes the best resolving techniques of the unexpected behaviour of the Diesel Engine and Fuel Injection Pump. This Analytical resource is implemented in the Function Modules of Microsoft windows VB.Net Framework. As this platform is "Event-Driven" this research contains the End-user diagnosis levels through predictive maintenance process methods and object oriented events to simulate the Analytical experiences generated by the raw data collected by the authors. This software model is capable of generating the Expert Compilation by several Clustering Techniques and it provides the Intelligent Views of the marked and concerned queries to the end-users. This research allows diagnosing the troubles by a Soft Computational Interface Model developed in Microsoft windows VB.Net Framework i.e. "Automobile Workshop Manager" which has a scope to be examined in the real time environment although it is tested with the experimental boundary conditions and the accumulated data set. To validate the proposed expert system this paper is enriched by Diagnosis algorithm, Views of intensive computer simulations, and Recommended Computational Environment.

In the field of fault detection there are lots of domain where the research already has been done in fault detection the research has done in Fault diagnosis for magnetic bearing systems Nan-ChyuanTsai, Yueh-HsunKing, Rong-MaoLee Department of mechanical Engineering, National Cheng Kung University,TainanCity70101, Taiwan Accepted 21 August 2008 [1] Here faults are detected in the actuator & sensor in a rotor system at a single time & this is done in MATLAB / Simulink simulation environment which enhance the diagnosis accuracy.

Similarly engine fault diagnosis system using intake manifold pressure signal and Wigner–Ville distribution technique by Jian-Da Wu, Cheng-Kai Huang [2] has been done with the help of neural network and pressure signal with Wigner-Ville distribution technology. Here two types of neural network is used and compared as radial boxes function Neural Network and generalized regression Neural Network.

In diesel engine vibration noise are very important its carry the quality of a car which is demanded by the customer for that Procedure for determining manufacturing defects in a diesel engine in a workshop by J.A. Calvo, V. Díaz, J.L. San Román, A. Gauchía [3] paper where these faults are detected by three sensors at strategic points and established the faults with certain level of frequencies.

As technologies improved day by day so many diesel cars come associated with electronically application like ECU sensors, CRDI etc. In this field also work has been done in the paper an intelligent diagnostic tool for electronically controlled diesel engine by Junxi Wang, Xiaojian Mao, Keqing Zhu, Junhua Song, Bin Zhuo [4] based on KWP 2000. The software used GSS function module and fundamental function module in six tests and four functions. It structured the diagnosis and maintenance period.

There are fault diagnosis in scooter in the paper Development of an expert system for fault diagnosis in scooter engine platform using fuzzy-logic inference by Jian-Da Wu a,*, Yu-Hsuan Wang a, Mingsian R. Bai [5] developed by using Fuzzy logic at different rpm with different area like belt, pulley, clutch etc.

Fault diagnosis of diesel engine are done in neural network with WPT analysis of I.C.E. in various working condition " An expert system for fault diagnosis in internal combustion engines using wavelet packet transform and neural network" by Jian-Da Wu*, Chiu-Hong Liu [6]. It is achieved near about 95% accuracy.

Similarly fault diagnosis of I.C.E. is done using probability neural network An expert system for fault diagnosis in internal combustion engines using probability neural network by Jian-Da Wu a,*, Peng-Hsin Chiang a, Yo-Wei Chang b, Yao-jung Shiao [7]. Here the faults are done PNN and compared BPN & RBIN and PNN is best among of them.

In this field faults are detected for modern diesel engine using sign and process model based method "Fault detection for modern Diesel engines using signal- and process model-based methods" by Frank Kimmich, Anselm Schwarte, Rolf Isermann [8]. Here the faults are namely done with intake system, injection system and exhaust system.

Similarly in diesel engine lots of work has been done on pressure of the cylinder as well as speed is the parameter on which real time supervision is done by S. Leonhardt, C. Ludwig and R. Schwarz of Technical University of Darmstadt, Institute of Automatic Control, Laboratory of Control Engineering, Landgraf – Georg - Str. In the paper named "REAL-TIME SUPERVISION FOR DIESEL ENGINE INJECTION" [9]. It has been done to generate faults by Neural Network and the experiment is done in four cylinder diesel engine.

In diesel engine work, research has been done also in air-leakage, EGR valve, and air-mass flow sensor faults etc by Mattias Nyberg and Thomas Stutte in the paper named "Model based diagnosis of the air path of an automotive diesel engine [12]. Here a new method adaptive threshold is proposed.

NOx emission of a diesel engine is very important factor. Research has been done on LNT after treatment system on "Model based fault detection and isolation for a diesel lean NOx trap after treatment system" by Marcello Canova, Shawn Midlan-Mohler, Pierluigi Pisu, and Ahmed Soliman [13] based on detection and isolation of sensor faults.

Problem Definition

This section of the paper contains the constraints in real time environment in automobile industries as well as the goals and criterion of the research which is focused on the absolute necessity of this research.

A. Constraints in the real time environment for Automobile Industry

Automobile industries especially in automobile SSEs (Small Scale Enterprise) are largely affected by the lack of Product Knowledge as because the new generation of automobiles is well equipped with the cutting edge technologies such as Electronic Sensors, ECUs (Electronic Control Unit), CRDI (Common Rail Direct Injection) that has generated a need to make a completely compact Integrated Simulating Device which can be executed to get the concerned product information to debug the malfunctions of the diesel engines associated with fuel injection pumps. Automobile SSEs are unable to sort the troubleshooting methodologies by the intelligent probing method. There are no recorded researches in the case studies on any of the Diagnosis System attempted to explore the integrated software modelling.

B. Goals and Challenges

This research is aimed to develop a user friendly software interface where the end-users could diagnose the troubles of diesel engines associated with fuel injection pump by step by step intelligent and directional probing where this research do the Native Synchronization with the experimental data set which was gathered from the real time environment in a minimal time.

C. Criterion

The procedure to determine faults that possibly occur in the Diesel Engine associated with fuel injection pump can be organized according to three different stages

(1) Fault detection,
(2) Fault isolation,
(3) Fault analysis/identification,
(4) Multiple Probing Levels,
(5) Multiple combinations of faults,
(6) Expert Solution.
(7) Database Modeling
(8) Predictive maintenance

Therefore as this research is mainly focused on the soft computing, this expert software model is considering the criterion of Multiple Probing Levels, Multiple combinations of faults, and Expert Solution with the help of predictive maintenance.

Computational Result and Discussion

A. Diagnosis algorithm

Step1	Isolated stand by yourself installation of Visual Studio 2008 .Net Framework and MSDN (Microsoft development network) Library with Windows Application Environment.
Step2	Create <Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> Partial Class Form1
Step3	In Private components As System.ComponentModel.IContainer declare the InitializeComponent() in Form1

Step4	Create multiple Check Box controls in the VB Designer to select the level 1 type of troubles.
Step5	The Logic applied in the source to select the multiple options.
Step6	Create multiple ComboBox controls in the VB Designer to select the level 2 & 3 type of troubles.
Step7	The Logic applied in the source to get the Multiplexity.
Step8	Label Controls are used for the symantic informations regarding the Software Utilities.
Step9	An analytical Button is added to trigger the Expert view in Form2 containing the intelligent solution for the multiple queries generated by the end-users.
Step10	Textures of the form designer is modified in accordance to requirements. The prepaed experimental Data and the required logics feeded in the created controls and souce in Form1 accordingly as well.
Step11	Create <Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> Partial Class Form2
Step12	In Private components As System.ComponentModel.IContainer declare the InitializeComponent() and attach with Form1
Step13	Partial Class Form2 Inherits System.Windows.Forms.Form
Step14	In Private components As System.ComponentModel.IContainer declare the InitializeComponent()in Form2
Step15	Create the master ListBox1 to show the expert solution. To do that Global Variables are also created in the ClassBuilder and Function Modules are taken as Parametres.
Step16	Button added to go back to the previous Form1
Step17	Label Controls are used for the symantic informations regarding the Software Utilities.
Step18	Create <Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> Partial Class Form3
Step19	In Private components As System.ComponentModel.IContainer declare the InitializeComponent() and attach with Form1
Step20	Label Controls are used for the symantic informations regarding the Software Utilities and the End-User.
Step21	TectBox Control is used to encrypte the user idetification key.
Step22	Button added to proceed to the previous Form1 with the logic of encryption.
Step23	Create <Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> Partial Class Form4

Step24 In Private components As System.ComponentModel.IContainer declare the InitializeComponent() and attach with Form1

Step25 Label Controls are used for the symantic informations regarding the Software Utilities.

Step26 Added RadioButton Controls on the desingner are logically desined in souce for unique field selection.

B. Views of intensive computer simulations

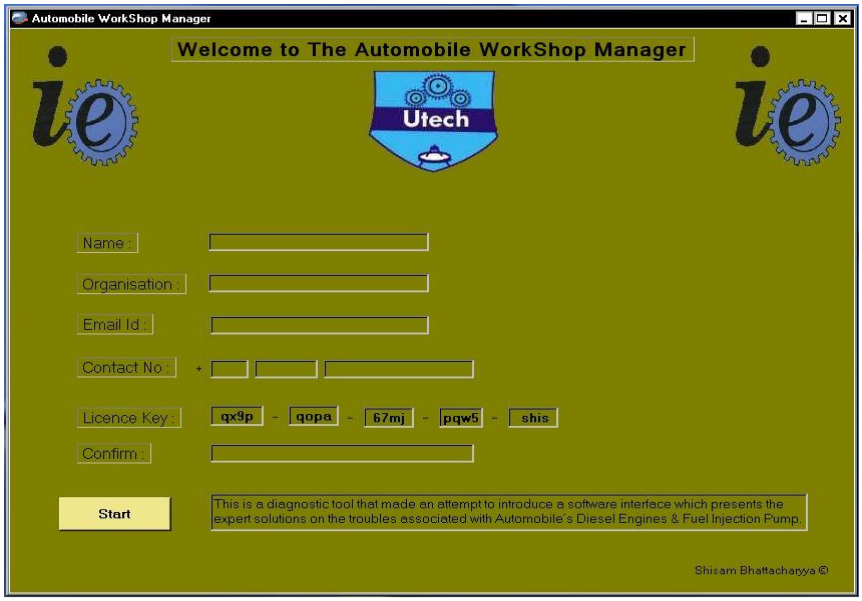

Fig. 1: Initial Screen

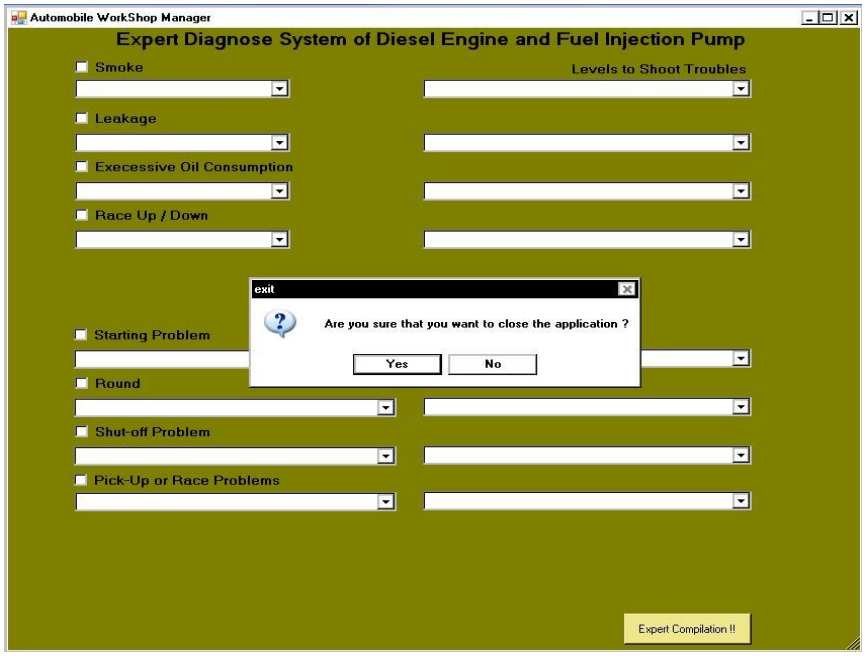

Fig. 2: Termination

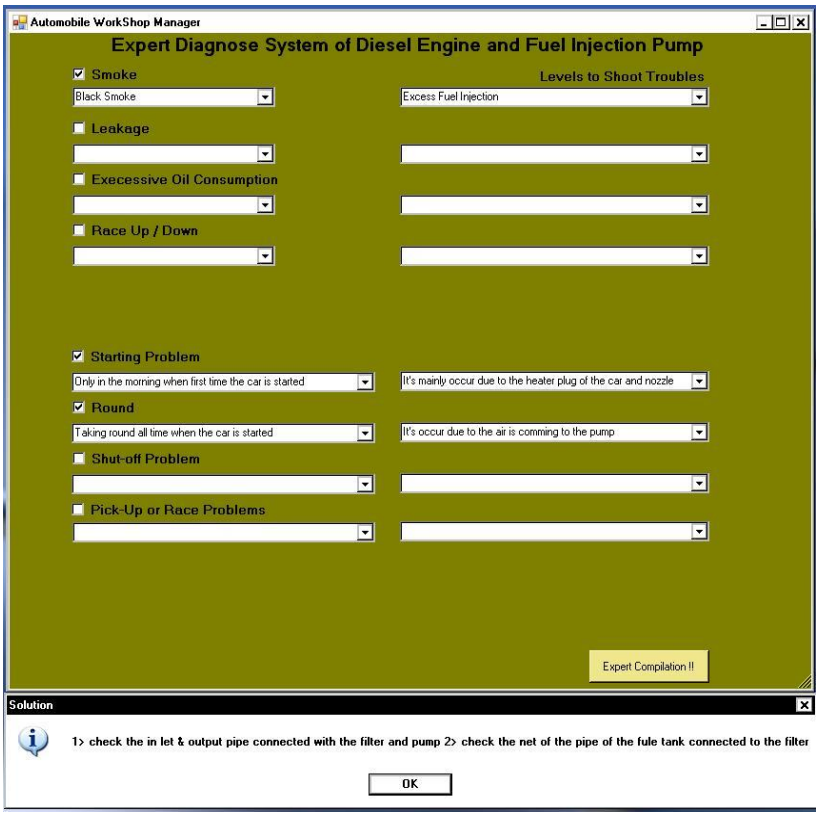

Fig. 3: Forming Query

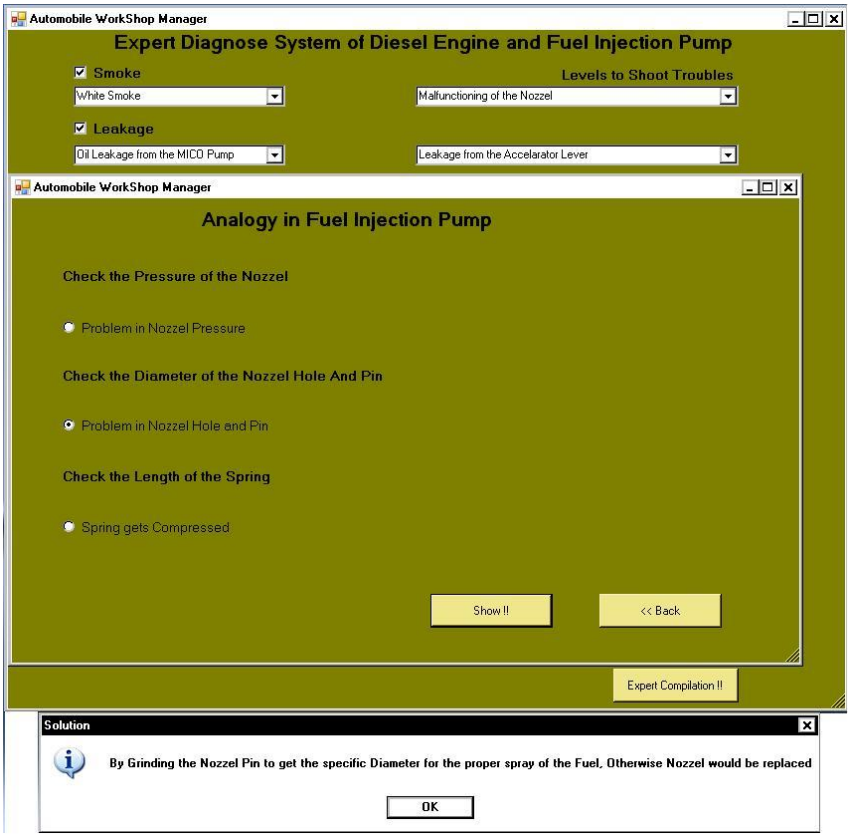

Fig. 4: Multiple selection & Solution Window

Fig. 5: Simulation Technique through Automobile Work Shop Manager (Expert view)

C. Recommended Computational Environment

This section of the paper contains the system requirements for the developed Software model i.e. Automobile Work Shop Manager. As this object development is based on Microsoft Visual Studio 2008 that requires Microsoft Windows Operating System, Physical Memory of 1GB and the file size of 49.5 KB (50,688 bytes). End-users need to install Microsoft windows VB.Net Framework beforehand to the simulation and use.

To develop this entire Windows Application i.e. the Expert Software Model in Fault detection of Diesel Engine associated with Fuel Injection Pump (Automobile Work Shop Manager) it is experienced that Data Mining without the SQL Server is a tough challenge. This research achieved the success in many difficulties such as in String Conversion, Declaration of global Variables, Module Creation, and Defining Class.

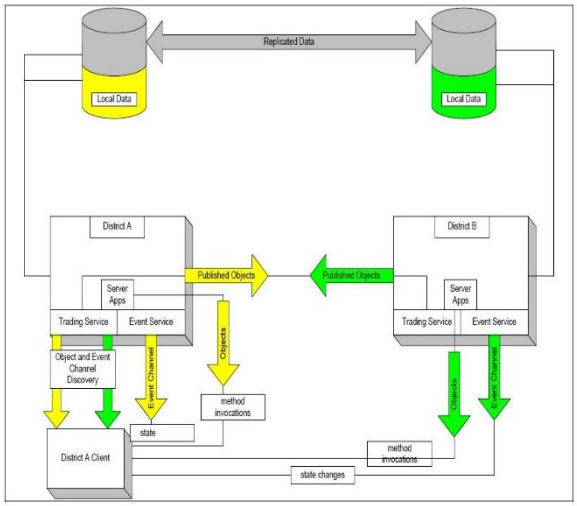

Fig. 6: Data Flow Diagram

Conclusion

A novel full expert system fault diagnosis algorithm is proposed in this paper to analyse. This nonlinear system dynamic model, state observers and required fault symptoms are established for real-time diagnosis.

This research developed software interface is expected to be appreciated for the significant growth in productivity of the SSE automobile workshops in fault diagnosing of diesel engine associated with fuel injection pump. By computer simulations and intensive experiments, the presented diagnosis has been verified to exhibit its superior efficacy in practice. This research consist an ample of Future Scope to increase the Efficiency and the Intelligence of the proposed Expert System in Fault Detection of Diesel Engine associated with Fuel Injection Pump by using Microsoft SQL Server. That will generate a completely separate Database Server dedicated to fetch the concerned date in response of the relevant queries selected from the Front End (Presentation Layer) or GUI (Graphical User Interface) by the end-users.

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