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ON-BOARD DIAGNOSTIC SYSTEM FOR VEHICLES

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ABSTRACT

On-board diagnostic systems play an important role in the current generation of cars and will play an increasingly important role in the next future. This paper proposes the development of ON-BOARD DIAGNOSTIC SYSTEM for vehicles using wireless sensor network. This OBD system consists of Arduino Board which has an ATMEGA microcontroller that acts as a processing unit where the program is written using ARDUINO software, sensors, LCD and keypad as user interface. The vehicle parameters such as fuel level, temperature, voltage are sensed and those results are viewed from LCD display. Initially, the sensors are installed at different parts of the vehicle to sense various vehicle parameters. For wireless data transmission, zigbee is used.

KEY WORDS: Arduino,OBD, Sensor, Zigbee.

INTRODUCTION

On-board diagnostic systems play a very important role in the performance of vehicles. Usually it takes more time to diagnose a problem in vehicle than to rectify it. So these systems not only diagnose the faults but also save us a lot of time. Parameters observed and diagnosed by OBD system are used by the Electronic Control Unit (ECU) of vehicle which in turn controls the engine's main operation (like spark timing control, air fuel mixture, fuel injectors spraying period etc.).Combination of these two systems ensures safety and efficient vehicle operation.

LITERATURE SURVEY

[1] From "**Parking vehicle positioning system based on ZigBee",** Jia Huiqin1 Xi'an Shiyou University, China, it is observed that ZigBee is a new kind of short distance, low power consumption, low cost, low rate and low complexity wireless network technology. It takes all advantages of IEEE802.15.4. In this paper ,we use ZigBee technology to construct a wireless communication network, setting a full function ZigBee module as a coordinator in the proper place of the parking lot, it communicate directly with the host computer. Install several ZigBee routers according to the distance need, and record their position information. Because this system is directed to card users, so each vehicle is required to install a ZigBee module.

[2] From **"Generating on-board diagnostics of dynamic automotive systems based on qualitative models"** Centro Ricerche Fiat, Strada Torino 50; Dip. Informatica, University di Torino, it is understood that offboard diagnosis can take full advantage of the model-based approach, on-board diagnosis requires some further considerations and taking into account some important practical constraints. First of all, in the on-board case the diagnostic system must react promptly to anomalies and must run fast in order to interpret the anomalies and, which is most important, in order to take an appropriate recovery action . This means also that the on-board diagnostics should be focused only on performing recovery actions, rather than on the actual isolation of the fault(s) . However, keeping track of more detailed information about the fault(s) that occurred can be extremely important, as it is a valuable information to

be passed to the diagnostic system that will be used in the workshop to actually locate and identify the fault . Moreover, only a few measurements can be available onboard and the possibility of performing tests/probes is very limited .

[3] From "**ZigBee-based Vehicle Access Control System"** by Rong Zhou, Chunyue Zhao, Lili Fu, Ao Chen and Meiqian Ye College of Information & Electronic Engineering Zhejiang Gongshang University Hangzhou, China following is understood. when a vehicle assess to the entrance, the transmitter installed in the car sends related information, through the radio transmitter module in CC2430 chip, to the receiver which is set in the access control office. After successfully received the vehicle's information, the receiver passes the data to microcontroller to decode them. The control system will receive this information and store it in the database. The manager can query all the information in database, including license plate number, driver number and so on.

[4] From "**Vehicle On-Board Diagnostics Added Values**" Technical Paper by J.-F. Hétu, S. Plante we understood that Today's vehicles have more and more electronics, and this leads to a greater wealth of information available on a vehicle's communication network. This paper will address the added value of having access to this information. Whether you are the development engineer, the dealership mechanic or the end-user, the information available to the different individuals has become indispensable. Rapid diagnostics of events and faults, automatic correctional interaction of vehicle equipment to compensate failures, as well as preventive maintenance alerts of specific vehicle components are all actions that are helping the various individuals throughout the vehicle's existence. These actions are helping to save time, increase diagnostics accuracy and make the vehicles generally safer. This paper will provide details about a number of events and probable scenarios to demonstrate the added value of having access to the vehicle's communication network.

[5] From **"A Study on Remote On-Line Diagnostic System for Vehicles"** by Integrating the Technology of OBD, GPS, and 3G" by Jyong Lin, Shih-Chang Chen, Yu-Tsen Shih, and Shi-Huang Chen it is cleared When the OBD system detects a malfunction, OBD regulations require the Electronic Control Unit (ECU) of the vehicle to save a standardized Diagnostic Trouble Code (DTC) about the information of malfunction in the memory. An OBD Scan Tool for the servicemen can access the DTC from the ECU quickly and accurately to confirm the malfunctioning characteristics and location in accordance with the prompts of DTC that shortens the service time largely. Moreover, currently the number of item for the real-time driving status that OBD can monitor is as high as up to 80 items

EXISTING SYSTEM

In 1996, OBD-II system was developed by SAE (U.S.society of automotive engineers), EPA (Environment protection agency U.S.) and CARB (California air resources board). Majority of automobiles that were introduced in U.S.A. after 1996 had this system. This system has become a standard for all vehicles. These systems monitor different parameters of vehicle and store information in memory but don't have any interface for user. Whenever a fault arises in the vehicle, the system senses it and notifies the user of warnings using a malfunction indication light (MIL). Flashing of MIL in different sequences tells user nature of problem ; This, however, is not an effective way of warning indication as user cannot tell which part has fault, what the fault is and when it occurred.

(1) Occasional flashing: momentary malfunction.

(2) Constantly on: serious problem affecting the safety of vehicle or emission output.

(3) Constant flashing: major problem and serious damage if engine not stopped immediately.

This, however, is not an effective way of warning indication as user cannot tell which part has fault, what the fault is and when it occurred.

These systems have a DLC (data link connecter) usually at the bottom of dash board to which a hand-held scan tool can be connected. The scan tool communicates with the OBD system using trouble codes and then displays the information on its LCD. The limitation of these hand-held tools is that whenever they communicate with the OBD system, they send the trouble codes and in return get information which was previously stored by the system. It does not give real-time values and does not mention the time when the information, being displayed, had occurred in the vehicle. It does not provide any repair guidance. Every time MIL indicates a warning, the handheld OBD scanner has to be used to diagnose the problem. The OBD scanner is a costly device and is mainly owned by workshops. The proposed design integrates this scanner in the system, allowing real-time indication of faults, without having to visit a workshop every time the MIL indication turns ON.

PROPOSED SYSTEM

Proposed technique provides an alternate method for diagnosis. For this diagnostic system no scan tool is required. It is a microcontroller based system and has a comprehensive user interface with an LCD and keypad. The system gets data from different sensors fitted onto the vehicle and observes those parameters.The system will not only examine the parameters of vehicle continuously but also display real-time values, warnings etc. to the user. So while driving, the user can easily see what's happening in selected parts of vehicle. The interactive interface allows the user to choose and view real-time values of parameters. Whenever a parameter of the vehicle goes into abnormal condition, warning alarm is generated. Abnormal condition is detected by the controller whenever Maximum or minimum level defined for the normal operation of a parameter is crossed. These maximum and minimum levels are stored in the system by default but the user can also change these values later on. This is done to make the system user structured.

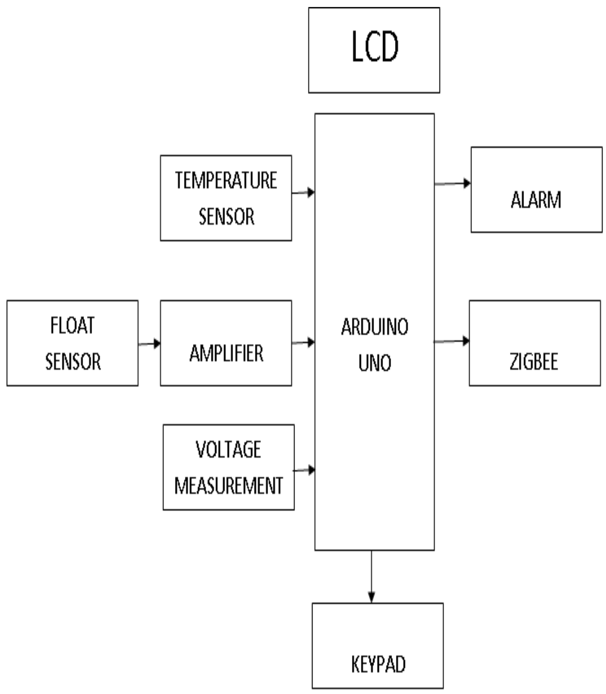

Fig. 1: Basic Block Diagram

The system uses predefined equations for calculating the real-time values. These calculations are done according to the boundary values of any parameter.

The system has a unique user interface. It consists of a keypad and LCD. It will initially display list of all parameters being observed and user can view status of parameters by pressing appropriate keys. This will show real-time value of that parameter.

SYSTEM SECTIONS

System consists of three major portions;

(1) Sensor part
(2) Processing unit
(3) User interface

Sensors have been fitted into different parts of the engine to observe different parameters. These include alternator/battery status, coolant temperature, fuel level, RPM, time since engine start and total engine run time in hours. Some of these parameters require fitted sensors on vehicle while some parameters can be read directly from the vehicle and calculated by the processing unit. Main task of the processing unit is to continuously monitor the sensors and other parameters and store the conditions in its memory. Processing unit controls the user interface. Let us look into details of each parameter.

IMPLIMENTED PARAMETERS

For comprehensive implementation of system in limited time, three parameters were selected. However number of parameters can and must be increased for complete diagnosis of vehicle.

A.BATTERY STATUS

A 12volt rechargeable battery and its recharging system (alternator and voltage regulator) are present in every vehicle. Status and condition of both battery and charging system can be determined from the voltage appearing on battery terminals. In vehicle off condition, battery terminal must have 12 to 12.5 volts and lesser voltage shows weak battery. In running condition the terminal voltage must be 13 to 15 volts and lesser values shows fault in charging system. This voltage is firstly brought down to a range executable by the built-in analog to digital conversion unit of microcontroller which is present in arduino board. For this purpose, a simple voltage divider followed by a voltage buffer is used and output of buffer goes to the input ADC pin of controller. Controller produces an 8-bit result and sends this information to another controller (main controller) serially in a specific packet format discussed later. The above mentioned voltage values are stored by the main controller and used to check for errors by comparison. Warning is generated whenever voltage is less than given values or there is an abrupt decrease of voltage i.e. large difference (0.25volts) between two readings. If the terminal voltage goes down to 11 volts, then the system recommends the user to turn the vehicle off.

B. COOLANT TEMPERATURE

Temperature sensor(47K) is fitted into the hose pipe of vehicle to sense the temperature of liquid coolant. Operating temperature of vehicle is usually around 80 to 100°C at which fuel burning is efficient. Warning is generated whenever the temperature goes above 130°C. Flow of coolant is also detected by a flow sensor fitted into the radiator pipe. Operation of radiator fan, used to cool down the coolant, is also checked using opto-couplers. So whenever temperature rises above 130°C, a warning screen is generated and system will also tell if the coolant is flowing and if the radiator fan is working or not. Also abrupt increase in temperature (5°C) between two consecutive readings also is a fault.

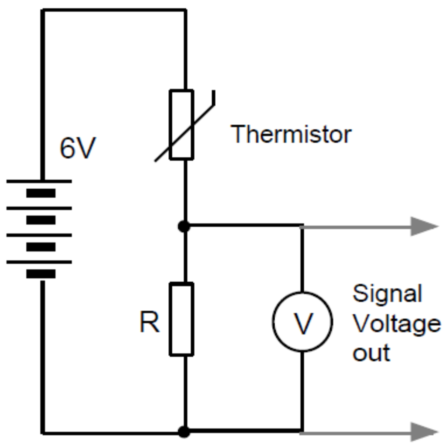

Fig.2:Temperature Measurement

It has two terminals and acts as a resistance according to temperature in its surroundings. Resistance of temperature sensor changes in the range from -47 to +150°C . Coolant temperature is a very sensitive parameter for any vehicle. High temperatures may lead to engine cease.

C.FUEL LEVEL

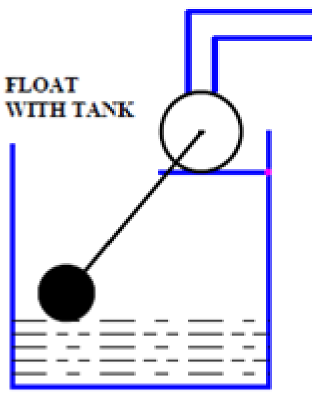

Fig. 3: Float Sensor

Fuel tank of a vehicle is usually fitted with a float sensor that consists of a wiper and fuel card. As the fuel level increases or decreases the wiper moves up and down changing its position on the wiper card and hence changing resistance. A similar signal conditioning unit as that used for coolant temperature is used to convert change in resistance of float sensor to a voltage value.

signal conditioning unit containing a difference opamp amplifier is used to utilize this change of resistance and convert it into corresponding voltages executable by the ADC unit of controller. The prototype sensor had resistance of 10Ω when tank was empty (zero liters) and 120Ω when full (30 liters). Warning will be generated whenever the fuel level goes down below 1 liter or if there is fast decrease in fuel level showing leakage of fuel. Similar technique can be used to measure level of engine oil and coolant in reservoir.

PROCESSING UNIT

In this section we discuss the microcontroller part. Here the Arduino has an in built AT-mega8 is used. There are two controllers in the system.One is a local controller and another one is a main controller. The main purpose of local controllers is to collect data from sensors and transmit corresponding data to the main controller.Neither calculations are done nor warning generated in local controllers. All this happens in main controller. Output of signal conditioning units of alternator/battery status, temperature and fuel level are used by local controllers. The local controllers send data to main controller serially (UART) at 9600bits/second baud rate whenever requested by the main controller.

CONCLUSION

The discussed design is mainly proposed for non-OBD vehicles. Very few modifications in such a vehicle can make it suitable for the system. In this design great emphasis has been given to make the system user friendly and vehicle friendly. As compared to the OBD systems in the market this design has its own advantages. However the design can be improved by increasing the number of parameter to be observed. This can be easily done as the used local controllers have capability to handle more parameters. Also more local controllers can be added easily as all local controllers transmit their data in same format to a single main controller. The system can also be integrated with an electronic fuel injection (EFI) system of vehicle as EFI takes feedback of different parameters like coolant temperature, RPM, oxygen sensor, throttle position sensor etc. for controlling the timing of fuel injectors.

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