AUTOMATED SYSTEM FOR AIR POLLUTION DETECTION AND CONTROL OF SPEED IN VEHICLES

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ABSTRACT

Every vehicle has a standard of emission of gases, but the difficulty occurs when the emission is beyond the standardized values. The prime reason for this violation of emission level being the incomplete combustion of fuel supplied to the engine which is due to the improper maintenance of vehicles. This emission from vehicles cannot be completely avoided, but it can be definitely controlled. The aim of this paper is to monitor and control the pollutants in the vehicle by using the pollution control circuit. This pollution control circuit consists of various sensors like gas sensors, temperature sensor, GSM, Pulse width modulator (PWM) and all of them are integrated and connected to a Controller. When a vehicle reaches beyond certain threshold pollution level then the speed of the system gets automatically slow down and if the temperature reaches beyond some threshold value fan is automatically turned on. The DC motor speed control of the system is done using PWM. It is also demonstrated using MATLAB simulink simulation using PID and PWM.

KEYWORD: *Gas sensors, GSM, PWM and controller.*

I. INTRODUCTION

Day by day the number of vehicles is increasing very fast. In major cities like Delhi, Mumbai and Pune number of vehicles is far more. Due to imperfect combustion in the vehicle engine the pollution through vehicle increases. Increasing number of vehicles tend to increase in co2 concentration in the atmosphere. According to Mumbai pollution control board, pollution levels particularly NOX, and SPM perched particulate matter increased rapidly. SPM above 100 µgram/cubic meter and NOX 88µgram/cubic meter is very harmful for health. The main sources of pollution in metro cities like Mumbai, Delhi, Pune and Bangalore are vehicles.

The imperfect (incomplete) combustion in the engine of a vehicle leads to emission of different harmful gases leading to increase in the pollution and unfavorably affecting the environment. Detection and control of these gases emission source in the environment is an important area of work. Emission of these gases from vehicles cannot be completely avoided but, it definitely can be controlled. As a solution to the above problems we aim to build an automated control system for emission level control of vehicle. The system is provided with the sensors, data from the sensors is used to make check the pollution level and accordingly the control action is carried out to control the speed of the system. MATLAB is the tool used here. The system is organized with Hardware design and methodology, project overview, simulation of motor using PID and PWM; Results are tabulated and discussed followed by conclusion.

Recently, different pollution control systems discussed in literatures. Chi-Man Vong[1] uses a pollution control system consists of RFID which is connected to the lambda sensors. The lambda sensor mounted on exhaust pipe to measure air ratio when air ratio is less than one carbon monoxide and hydrocarbon emission will increased and when air ratio greater than one more nitrogen oxide will be produced. ChunxiaoLI[2] author presents a vehicle's CO2 emission reduction scheme by an ETC-Electronic Toll Collection (ETC) devices is used at each traffic junction and traffic at each junction can be find out. ETC devices communicate with signals at each junction. With the help of this

communication traffic at each junction is obtained. Nishigandha Athare, Prof. P.R.Badadapure[3] Human safety and air pollution detection in vehicles. KwangSooYo[4] demonstrates gas Sensors sensing properties for Monitoring Air Pollution and different gases causing air pollution.

Objective of the system

- The project has three parts: the traffic signal, the vehicle module and the client. Every vehicle has a GSM module installed in it.
- The traffic signal has the RF transmitter to activate the vehicle module.
- Once activated the vehicle module will check for the pollution level and displayed in the LCD.
- Also an alert message is sent to the vehicle owner.
- Speed of the system using PWM is reduced until corrective action is taken.
- PID and PWM technique is used in MAT Lab to control the speed of a system.

BLOCK DIAGRAM AND DESCRIPTION

2.1 Hardware design

The components used in this system are simple, cost efficient and the system is most indeed system, which is added as a part to the vehicle.Fig.1 shows the schematic diagram of the pollution monitoring and control of the system. The components used are explained below[4].

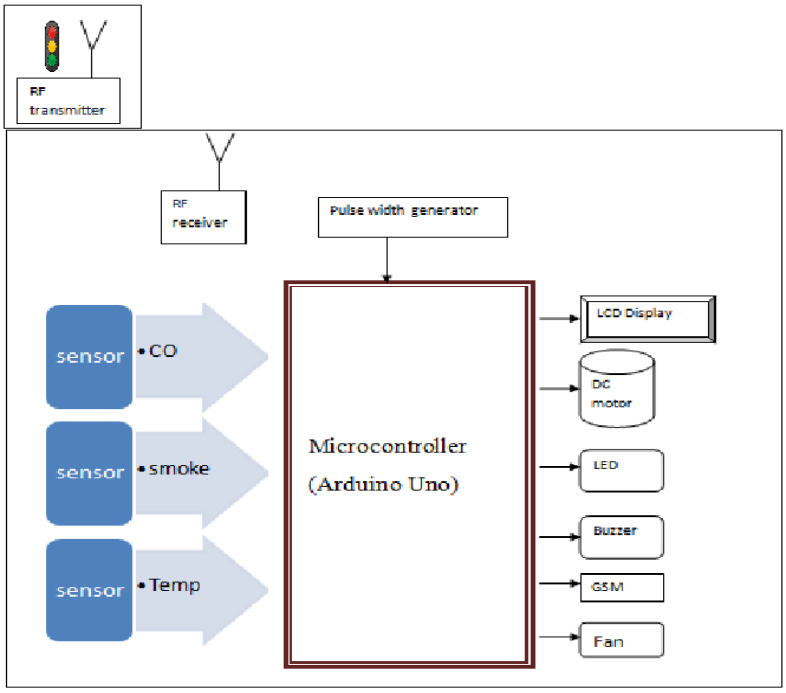

Fig.1 Schematic diagram of pollution monitoring system

- **Arduino Uno board-** An Arduino Uno board consists of Atmega328 a *bit microcontroller with components to facilitate programming and incorporation into other circuits. An important aspect of the Arduino is the standard way that connectors are exposed, allowing the board to be connected to a variety of interchangeable modules known as shields.
- **Sensors- MQ-7** carbon monoxide sensor, **MQ-135** smoke sensor, **LM 35** temperature sensor.
- **RF Transmitter and Receiver-**RF module has a Radio Frequency transmitter at the traffic signal and Radio Frequency receiver in the vehicle. The four inputs are for the frequency range of 17 KHz, 19 KHz, 22 KHz and 25 KHz and four switches are provided for each range. Different frequency can be assigned for different vehicles so that at each signal one type of vehicle can be operated. FM modulation is used in this process. If the carrier frequency is 17 KHz then the modulated signal of 27 KHz is generated and transmitted from the transmitter. Accordingly receiver is designed to get back the original data signal at the receiver end.
- **Timer:** 555 timer is used here to generate the PWM signal.

- **DC motor-** The speed control of any vehicle can be demonstrated using simple DC motor. The speed of the motor depends on the voltage supplied to it. PWM technique is used to control the seed of a motor. PWM generates a pulse proportional to the voltage that has to be provided for the motor. In simulation PID and PWM is used to control the speed of the system. The basic electrical and mathematical model is rigged up using mat lab simulink.
- **LCD display-** LCD (16*2) is used to display the pollution level detected from the gas sensor and continuously display the temperature.
- **GSM-** GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS. The baud rate of the device is configurable from 9600-115200 using AT command. It is suitable for SMS, Voice as well as data transfer application. The onboard Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem, you can make audio calls, SMS, Read SMS, attend the incoming calls and internet etc through simple AT commands.

2.2. Methodology

Each traffic signal has a RF transmitter with one of the four frequency range assigned to it. Each vehicle type is assigned with one of the four frequency range. For example if cars are assigned as 17 KHz, buses as 19 KHz and the rest accordingly. This reduces the clumsiness that occurs when all the vehicles are assigned with the same frequency.

Once the vehicle enters the range of traffic signal the sensors get activated and checks for the pollution level using the gas sensors and temperature sensor in the vehicle. If the gas sensors range is higher than the predefined value then it is displayed in the LCD display, LED is turned on, Buzzer to alert the rider is used. In case if owner is not same as the rider an alert message (SMS) is generated using GSM device. If temperature is higher than the predefined value then fan is switched on.

DC motor is used in our project for demonstration of speed in our project. If the pollution is high then the speed of the vehicle is limited. We are not completely stopping the vehicle because they have to move to the service station and take the actions like servicing the engine. As the engine gets heated up even that leads to incomplete combustion so to reduce this fan is automatically switched on.

The control algorithm used here is PWM and ON-OFF control.

1. PWM for motor speed control[5]: PWM is a method for supplying the electrical power to a load having slow response. The supply produced is a continuous pulse. The voltage level to the load is controlled by the pulse applied.. The PWM output on the Arduino can be varied by varying the duty cycle from “0” to “255”. Thus the speed can be varied. Also timer can be used to generate pwm signal in the system.

$$V_{\text{eff}} = V_s \frac{\tau_0}{\tau_c}$$

2. ON-OFF control: An on-off controller is one of the ways for temperature control of a device. The output from the device is either on or off, with no intermediate state. An on-off controller will switch the output only when the temperature crosses the set point. Continuously monitoring the temperature using aurdino uno and once it reaches above the set point the fan is automatically turned on to cool down the system.

II. PROJECT REVIEW

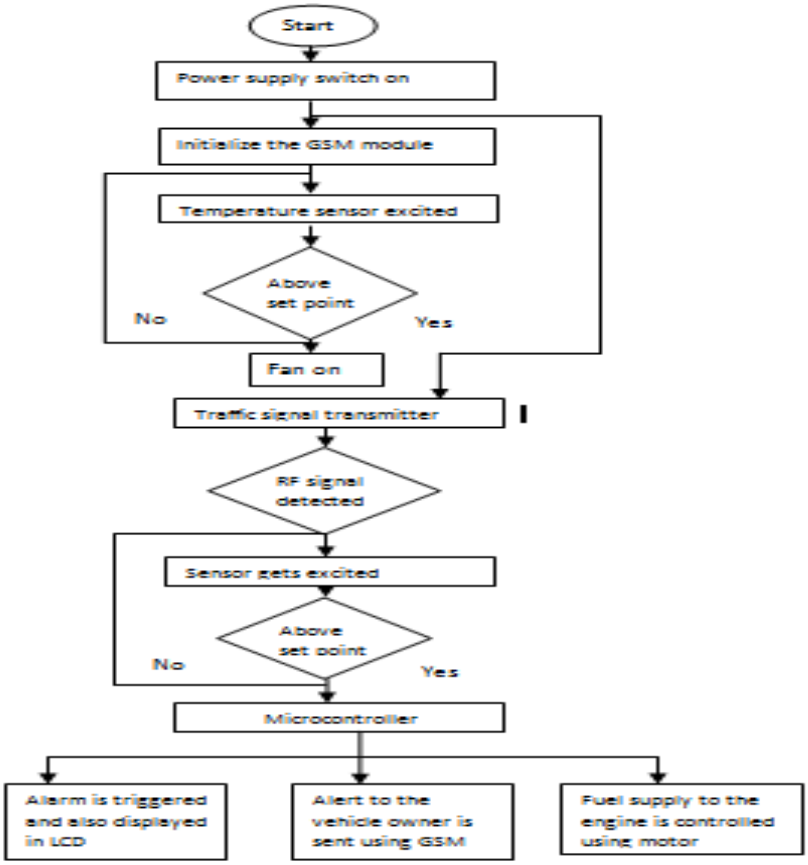

Fig.2 Flow chart of the system

The system gets started once it receives the power from the power supply. Components like GSM, LCD display, Temperature sensor gets initialized to the preset (default) values. On initializing the temperature sensor keeps monitoring the temperature which is kept at the engine and checks for the set point, if it is above the set point value automatically fan gets switched on to cool down the system else it keeps monitoring the temperature. At the same time on getting supply RF transmitter at the traffic signal starts sending the signal. Vehicles entering this region detect the signal through RF receiver and on receiving signal the gas sensors kept at exhaust pipe gets activated and starts checking for the pollution level. If the pollution level is above the set point value the signal is sent to the microcontroller. Microcontroller triggers the buzzer to alert the driver and it is also displayed on the vehicle's LCD display. Sometimes driver and owner of the vehicle are different so an alert message to the previously specified number is sent to the owner using GSM[7]. Speed of the motor also gets reduced.

III. SIMULATION OF DC MOTOR FOR SPEED CONTROL

Matlab simulink is the tool use here to control the speed of a dc motor. PID controller and PWM technique is used to control the speed of a DC motor. The control algorithm carried out to control the speed, current flow of the system is used is PID. DC motor is modeled using its electrical and mechanical equation.

PID (Proportional Integral Derivative):The most efficient controller type provides proportional with integral and derivative control i.e PID. This controller combines proportional control with two additional adjustments, which helps the unit automatically compensate for changes in the system. These adjustments, integral and derivative, are expressed in time-based units.

The proportional, integral and derivative terms must be individually adjusted or "tuned" to a particular system using trial and error. It provides the most accurate and stable control of the three controller

types, and is best used in systems which have a relatively small mass, those which react quickly to changes in the energy added to the process. It is recommended in systems where the load changes often and the controller is expected to compensate automatically due to frequent changes in set point, the amount of energy available, or the mass to be controlled.

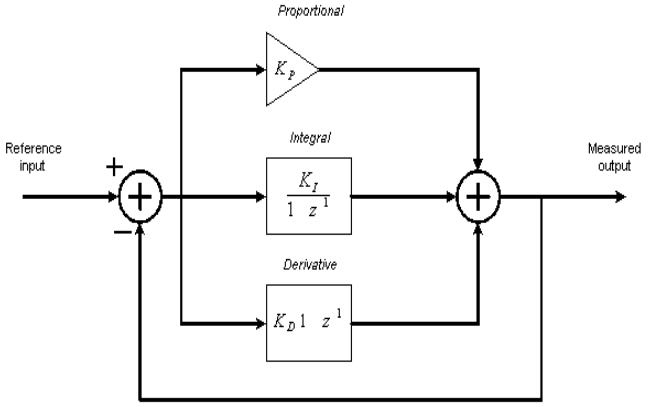

Fig.3 General Block diagram of PID controller

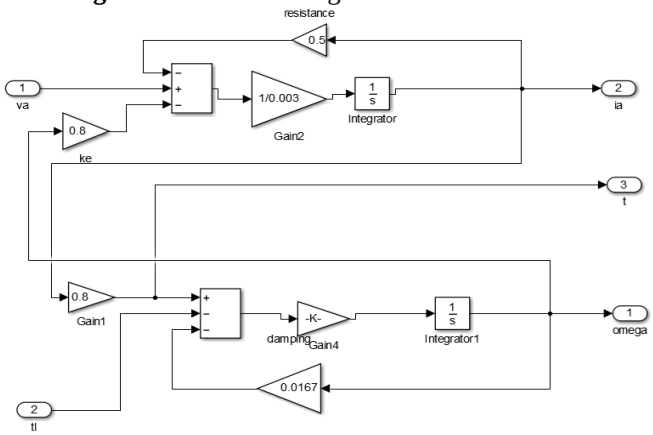

Fig.4 DC motor model

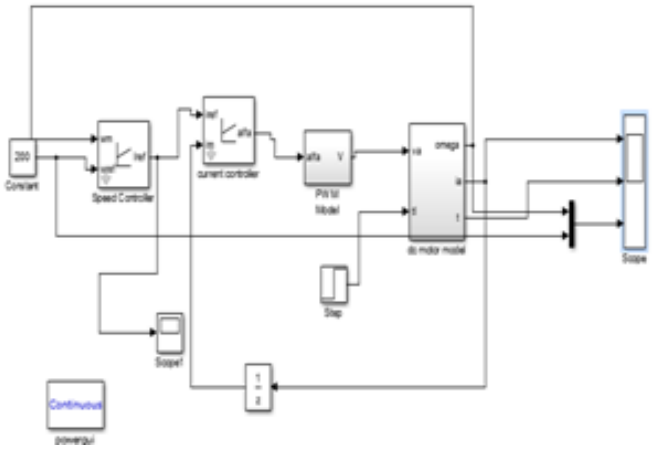

Fig.5 Simulation of DC motor using PID and PWM

IV. RESULTS AND DISCUSSION

The signals acquired from the gas sensors and temperature sensors are compared with the user defined set point, crossing the threshold limit the pollution level gets displayed in the LCD and when it crosses the set point it gives a buzzer indication, led on and fuel injection to the motor is limited there by limiting the speed of the vehicle. This is carried out using PWM control of the speed motor. Also an alert message to the client is sent using GSM module. The graph of variation of current, motor torque and angle of rotation (theta) is shown in Fig 4.

PID controller and PWM technique[6] is used to maintain the constant speed of the motor. The electrical and mechanical model preceded by the speed controller, current controller and pwm generator is tuned manually and output of the current, motor torque and motor speed is tabulated. The variation of current, motor torque is inversely proportional to the speed of the motor; it is as shown in the fig.6. The PID tuned output of the system is shown in the fig.7. Here we are manually using P=1, I=0.01 and D=0.

The gas sensor sensitivity is carried out using two point methods; for Carbon monoxide range is 0V-3.2V and for smoke sensor it is 0V-4.2V. The range of this sensors voltage corresponds to the 20ppm-2000ppm of the volumetric content of the gas. The temperature sensor output corresponding to voltage at every 10 degree is tabulated and it is shown in table1.

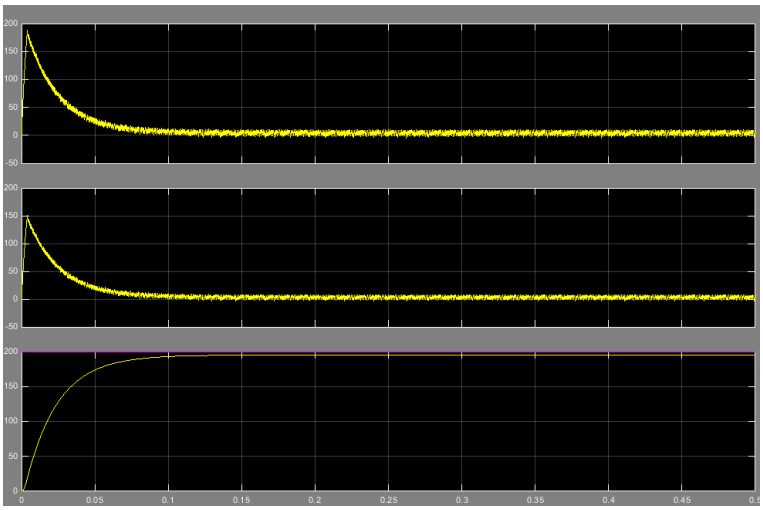

Fig.6 Variation of current, motor torque and SpeedVs time

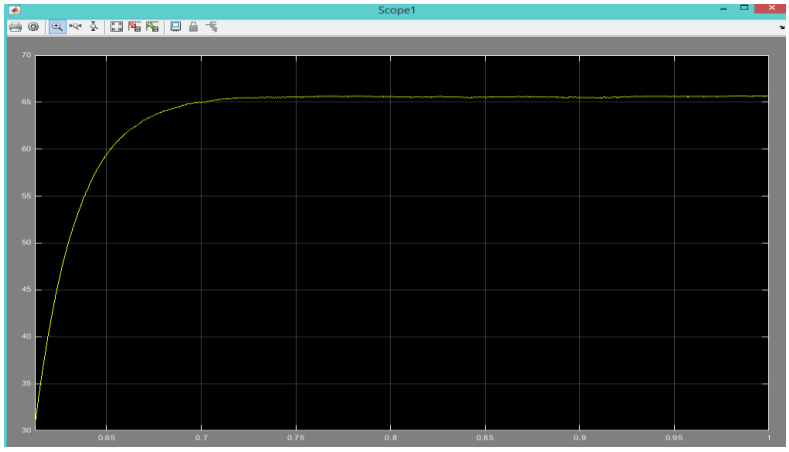

Fig.7 PID output

Table.1 Temperature sensor output and fan condition

Temperature (degree)	Output Voltage (v)	Fan condition
30	0.29	OFF
35	0.32	OFF
40	0.423	OFF
50	0.47	OFF
60	0.56	OFF
70	0.72	ON
80	0.84	ON
85	0.89	ON

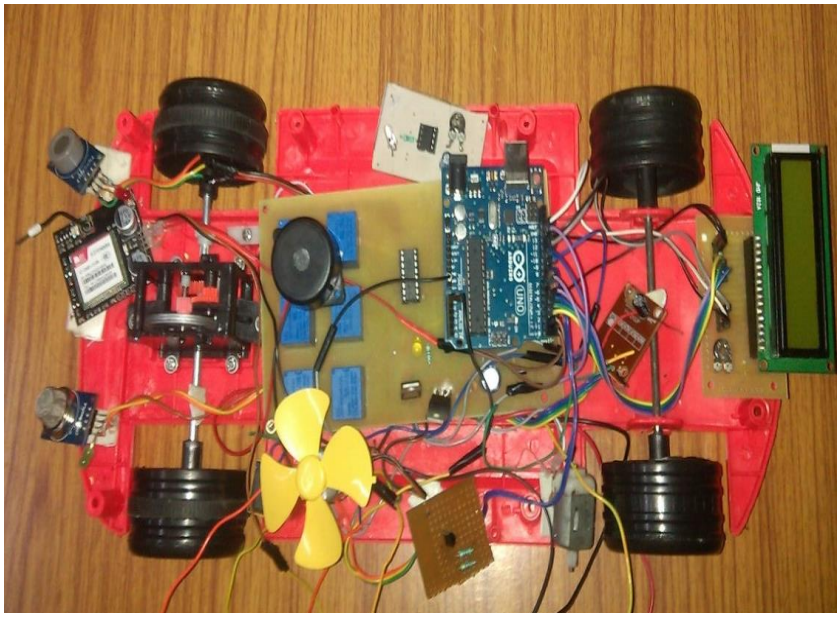

Fig.8 Hardware setup

The complete hardware setup with buffer, driver, relay circuitry and all other components mounted on the car model is shown in fig.8.

V. CONCLUSION

The concept of detecting the level of Pollution and indicating it to the driver (vehicle owner through message) is implemented. There is an increase in the level of Pollution over the last couple of decades, leading to several severe Environmental problems and health issues. Due to busy life an automated system is needed to take the action against pollution control. This paper can be extended by adding GPS device and maintaining the data base and sending a message to the user about the details of the nearest service station.

VI. FUTURE SCOPE

This paper is extended by adding GPS with the GSM module and sending a message to the user about the details of the nearest service station. A server and database can be maintained to keep track of the pollution level of the system and control action on the owner can be taken if the pollution level alert is ignored.

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