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Automatic Emission Control System For Heavy Vehicles

Ganeshmoorthy T[1], Vaitheesh SS[2]&Vijayakumar B[3]

Department of Electronics and Instrumentation Engineering,
K.S.Rangasamy College of Technology,Affiliated to Anna University

Supervised by,E-mail Id:
Dr. T.Baranidharan M.E., Ph.D.,
1ganeshmoorthy2495@gmail.com
*Associate Professor,*2ssvaitheesh@gmail.com
Department of Electronics and Instrumentation
3bvkvejay@gmail.com
Engineering,4baraniinst@gmail.com
K.S.Rangasamy College of Technology.

Abstract: **With the increasing number of vehicles, the main source of air pollution caused by heavy weight vehicles has become increasingly serious. In some cities, automobile exhaust pollution account for 80% of the air pollution. The dangerous waste gas from heavy weight vehicles in one year is 3 times larger than its own weight. To reduce the effect of pollutant gases the vehicle must be serviced regularly.The effect of carbon monoxide released by the vehicles is moderately high nowadays. Our project is to reduce the emission of CO. A gas sensor is placed in the path of exhaust gas in the vehicle. Then the amount of CO will be measured and sensed by the sensor. If the gas sensor exceeds the set point limit, then the control valve in the inlet fuel valve will be adjusted accordingly. Whenever the inlet fuel valve is adjusted by the amount of CO sensor, a message will be intimated to the vehicle owner, which means vehicle must be taken to the service station. If this occurrence continues, a message will send to the pollution control room along with the vehicle registration number to take further action for spoiling the environment. Whenever the effluent value exceeds the set point limit value, it will controlled by air fuel ratio controller and a message will be intimated to the owner by IoT.**

I. Introduction

1.1 Air Pollution: Air pollution is an important environmental issue that has a direct effect on human health and ecological balance. The primary airborne pollutants covered by European legislations are SO, NO, NO2, Benzene, Ozone, CO, CO2 and particulate matter. Air pollution has diverse causes and sources. "Stationary sources" such as factories, power plants and smelters; "mobile sources" such as automobiles; and "natural sources" such as windblown dust and wildfires are primary contributors to air pollution. Due to the trans-boundary nature of airborne pollutants, it is difficult for any single organization to take responsibility for overall emission levels.

1.2 Automobile Air Pollution: In transportation contributed more than half of the carbon monoxide and nitrogen oxides, and almost a quarter of the hydrocarbons emitted into our air. This air pollution carries significant risks for human health and the environment. Through clean vehicle and fuel technologies, we can significantly reduce air pollution from our cars and trucks, while cutting projected oil use in half within the next 20 years.

Passenger vehicles and heavy-duty trucks are the main sources of this pollution, which includes ozone, particulate matter, and other smog-forming emissions. The health risks of air pollution are extremely serious. Poor air quality increases respiratory ailments like asthma and bronchitis, heightens the risk of life-threatening conditions like cancer, and burdens our health care system with substantial medical costs. Particulate matter is singlehandedly responsible for up to 30,000 premature deaths each year. Passenger vehicles are a major pollution contributor, producing significant amounts of nitrogen oxides, carbon monoxide, and other pollution.

When the effluent value of emission exceeds the maximum value the sensor senses the CO2 gas emitted and it is amplified to the microcontroller. Then the controller will reverse the set point ratio back to its original state at the ratio of 1:14 for a period of 7 days. A message will be intimated to the owner whenever the change is made in set point value and if the problem continues even after the completion of 7 days message will be sent to the pollution control room along with the

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vehicle registration number.

1.3 Sources of Automobile Pollutants:

1.3.1 Hydrocarbons: A class of burned or partially burned fuel, hydrocarbons are toxins and are a major contributor to smog, which can be a major problem in urban areas.

1.3.2 Carbon monoxide (CO): A product of incomplete combustion, carbon monoxide reduces the blood's ability to carry oxygen

1.4 Effect of Automobile Pollutants:

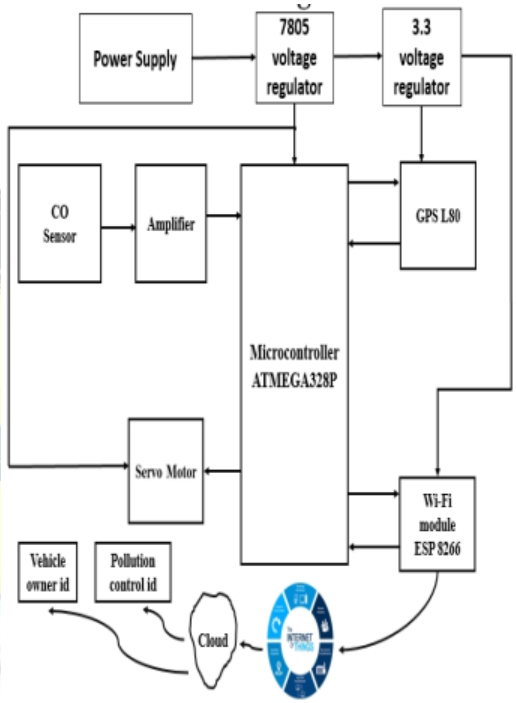
Prolonged exposure to hydrocarbons contributes to asthma, liver disease, and cancer, overexposure of carbon monoxide poisoning may be fatal. NOx is a precursor to smog and acid rain. NO is a mixture of NO and NO2. NO2 destroys resistance to respiratory infection. Particulate matter causes negative health effects, including but not limited to respiratory disease. Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people. One quart of oil will contaminate thousands of gallons of water because it does not dissolve. These toxins as well as trace metals and degreasing agents used on automobiles contaminate drinking water and can cause major illness. Some of these toxins and metals are absorbed in various sea life and cause medical problems to people when eaten.

1.5 Control of Automobile Pollution:

Engine efficiency has been steadily improved with improved engine design. One of the first-developed exhaust emission control systems is secondary air injection. Originally, this system was used to inject air into the engine's exhaust ports to provide oxygen so unburned and partially burned hydrocarbons in the exhaust would finish burning. After a cold start, an engine needs a fuel-air mixture richer than what it needs at operating temperature, and the catalytic converter does not function efficiently until it has reached its own operating temperature. The air injected upstream of the converter supports combustion in the exhaust head pipe, which speeds catalyst warm up and reduces the amount of unburned hydrocarbon emitted from the tailpipe.

II. Block Diagram Description

Initially the gas sensor analyses the gases exhausted from the vehicle. The sensor output signal is low so it is then amplified and fed back to the microcontroller. Then the microcontroller compares the signals with predefined set point. If the signal exceeds the set point value, ratio controller makes the air/fuel mixture at proper rate to the carburetor. The process is repeated continuously. It is also informed to the vehicle owner. If same pollutant content is exhausted by the vehicle for last 1 week then it is informed to the pollution control through IOT. If also the vehicle owner does not take any action on the vehicle, they was tracked by GPS system and surrendered to the police.



2.1 Power Supply:

Figure 2.1

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A regulated power supply is an embedded circuit; it converts unregulated AC into a constant DC. With the help of a rectifier, it converts AC supply into DC. Its function is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC (Direct Current). The type of stabilization used may be restricted to ensuring that the output remains within certain limits under various load conditions, or it may also include compensation for variations in its own supply source.

2.2 Amplifier (LM 741):

The LM741 series are general-purpose operational amplifiers. It is intended for a wide range of analog applications. The high gain and wide range of operating voltage provide superior performance in integrator, summing amplifier, and general feedback applications.

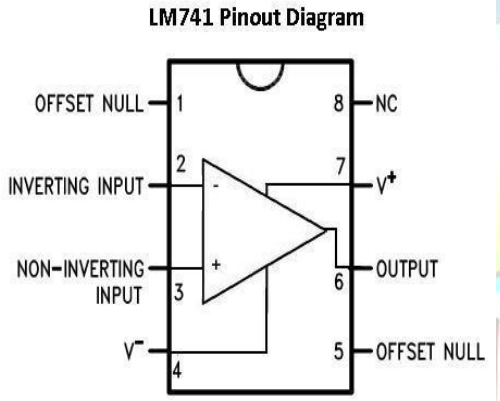

Figure 2.2

Characteristics of a circuit using an op-amp are set by external components with little dependence on temperature changes or manufacturing variations in the op-amp itself, which makes op-amps popular building blocks for circuit design.

2.3 Signal Conditioning Unit:

The signal-conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter. This unit also accepts the digital sensor inputs and gives outputs in 10-bit binary with a positive logic level of+5V. The calibration voltages (0, 2.5 and 5V) and the health bits are also generated in this unit. The DCSTS unit controls the entire operation of a DCP fieldstation. It consists of power supply regulator, timing generator, control logic circuit, multiplexer-cum-A/D converter, health monitor circuit, memory, pseudo-random burst sequence generator and a UHF transmitter. It operates on +12V uninterrupted power.

2.4 Microcontroller (ATMEGA 328P):

Figure 2.4

The Atmel 8-bitAVRRISC-based microcontroller combines 32 kBISPflash memory with read-while-write capabilities, 1 kBEEPROM, 2 kBSRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter ,programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching one MIPS per MHz. [6] discussed about Intelligent Sensor Network for Vehicle Maintenance System. Modern automobiles are no longer mere mechanical devices; they are pervasively monitored through various sensor networks & using integrated circuits and microprocessor based design and control techniques while this transformation has driven major advancements in efficiency and safety.

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2.4.1 Peripheral Features:

- Two 8-bit Timer/Counters with Separate preclear and Compare Mode.
- One 16-bit Timer/Counter with Separate preclear, Compare Mode, and
- Capture Mode.
- Real Time Counter with Separate Oscillator.
- Six PWM Channels.
- 8-channel 10-bit ADC in TQFP and QFN/MLF package.
- 6-channel 10-bit ADC in PDIP Package.
- Programmable Serial USART.
- Master/Slave SPI Serial Interface.
- Byte-oriented 2-wire Serial Interface (Philips I2C compatible).
- Programmable Watchdog Timer with Separate On-chip Oscillator.
- On-chip Analog Comparator.

2.4.2 Special Microcontroller Features:

- Power-on Reset and Programmable Brownout Detection.
- Internal Calibrated Oscillator.
- External and Internal Interrupt Sources Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby.
- 64 kb of instruction RAM, 96 kb of data RAM.
- 16 GPIO pins.

2.5 Wi-Fi Module ESP8266:

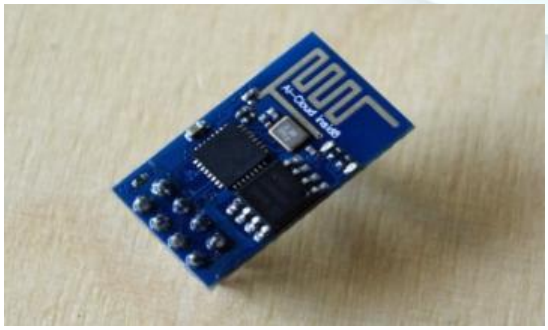

Figure 2.5

The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (Micro Controller Unit) capability produced by Shanghai-based Chinese manufacturer, Express if Systems. The chip first came to the attention of western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer, AI-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

However, at the time there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module which suggests that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation. The **ESP8285** is an ESP8266 with 1 MB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.

2.5.1 Features of ESP8266:

- 802.11 b/g/n.
- Wi-Fi Direct (P2P), soft-AP.
- Integrated TCP/IP protocol stack.
- Integrated TR switch, balun, LNA, power amplifier and matching network.
- 1MB Flash Memory
- Integrated PLLs, regulators, DCXO and power management units.
- Power down leakage current of <10uA.
- Integrated low power 32-bit CPU could be used as application processor.
- SDIO 1.1 / 2.0, SPI, UART.
- STBC, 1×1 MIMO, 2×1 MIMO.
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval.
- Wake up and transmit packets in <2ms.

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2.6 GPS Module L80:

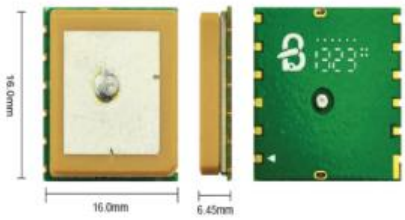

Figure 2.6

L80 is an ultra slim module with embedded 15.0 × 15.0 × 4.0mm patch antenna. It is a SMD type module, brings the high performance of MTK positioning engine to the industrial applications with compact profile, ultra-low power consumption and fast positioning capability.

Combining advanced AGPS called EASY™ (Embedded Assist System) and proven Always Locate™ technology, L80 achieves the highest performance and fully meets the industrial standard. EASY™ technology ensures L80 can calculate and predict orbits automatically using the ephemeris data (up to 3 days) stored in internal flash memory, so L80 can fix position quickly even at indoor signal levels with low power consumption. With Always Locate™ technology, L80 can adaptively adjust the on/off time to achieve balance between positioning accuracy and power consumption according to the environmental and motion conditions.

2.7 CO Sensor:

Figure 2.7

Carbon monoxide (CO) is a colorless, odorless, poisonous gas. A product of incomplete burning of hydrocarbon-based fuels, carbon monoxide consists of a carbon atom and an oxygen atom linked together. This is a simple-to-use Carbon Monoxide (CO) sensor, suitable for sensing CO concentrations in the air. The MQ-7 can detect CO-gas concentrations anywhere from 20 to 2000ppm. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

2.8 Servo Motor:

Figure 2.8

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate

A **servo motor** can usually only turn 90° in either direction for a total of 180° movement.The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position.

The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it in the counter clockwise direction toward the 0° position, and any longer than 1.5ms will turn

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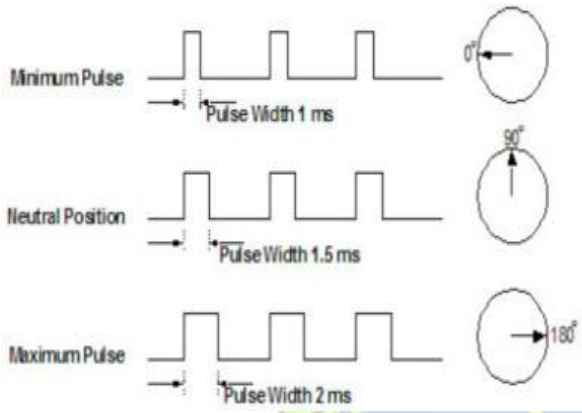
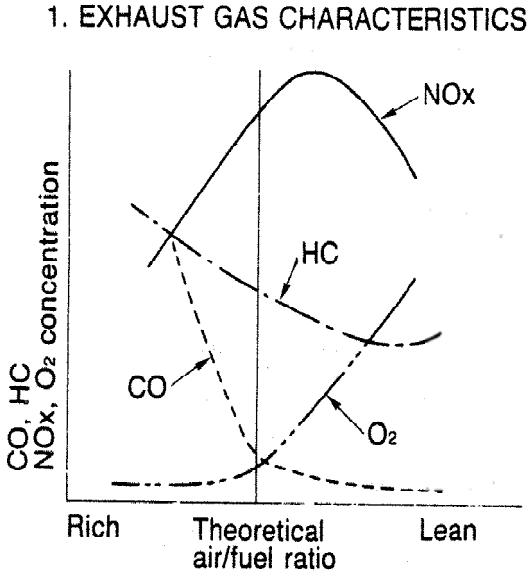
the servo in a clockwise direction toward the 180° position.



When these servos are commanded to move, they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is called the **torque rating** of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.



2.9 Internet of Things:

Figure 2.9

The internet of things is the internetworking of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013, the Global Standards Initiative on Internet of Things defined the IoT as "the infrastructure of the information society."

The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

III. Conclusion and Future Scope

This project has been designed to meet the objectives of controlling harmful gas like CO from the automobile exhaust, in order to make the environment less polluted.

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Henceforth, the human health and the ecological balance can also be maintained through this project.

The proposal project helps us in minimizing the effect of air pollution and to implement the technology of Internet of Things (IoT), which is need for the future growth by controlling various sources in different applications.

IV. Acknowledgements

We are highly indebted to provide our heart full thanks to our project guide **Dr. T.BARANIDHARAN M.E., Ph.D.,** Associate Professor**,** for his valuable ideas, encouragement and supportive guidancethroughout the project.

Wewishtoextendoursincerethankstoallfaculty membersofourElectronicsand InstrumentationEngineeringDepartmentfor their valuable suggestions,kindco-operation and constant encouragement for successful completion ofthis project.

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