International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 30 No. 3 May 2017, pp. 357-363

http://www.ijisr.issr-journals.org/

Automatic Engine Ignition Based on Traffic Signal Using Micro-Controller

M. Anbarasan[1], A. Ajeeth Kumar[2], P. Ranjith Kumar[2], and A. Subashini[2]

[1]Assistant Professor, Electronics and Instrumentation Engineering, Adhiyamaan College of Engineering, Tamil Nadu, India

[2]Student, Electronics and Instrumentation Engineering, Adhiyamaan College of Engineering, Tamil Nadu, India

ABSTRACT: Pollution and fuel consumption in automobiles is becoming a matter of grave concern. It is essential to build an efficient and much more reliable system that would control this issue in traffic signals. The objective of this project is to introduce a system, which would detect the status of the traffic signal and control the engine ignition automatically thereby reducing the fuel consumption and reducing pollution. Radio frequency modules, interfaced with micro controller are used to transmit the signals from traffic light and detect them by the automobiles.

KEYWORDS: microcontroller; traffic signal; radio frequency modules.

1 INTRODUCTION

Contemporary growths in fuel expenses have a great impact on global economic changes. The drivers are worried about their monthly budget because of the fuel consumption. Excessive usage of petroleum increases the budget and also emits more pollutants [1]. In 2011, the Transportation Institute of Texas found that due to congestion, urban Americans travel an extra 5.5 billion hours and they purchase an additional 2.9 billion gallons of fuel for a congestion, costing $121 billion. During these congestions 56 billion pounds of additional Carbon Monoxide (CO) and greenhouse gas are released into the atmosphere during urban congestions in that year alone. The world suffers heavily from environmental pollution nowadays [2, 3].

According to a study conducted by the Transport Corporation of India and IIM Calcutta, India loses almost Rs.60,000 crore a year due to traffic delays, including fuel wastage on high volume highways. Urbanization and rising incomes have been driving rapid motorization across almost all countries of the world. If no action is taken, these cars threaten literally to choke tomorrow's cities. The pollution level has reached alarming rates and the cities are like smog chambers. Pollution levels are found to be up to 40% higher while in traffic jams or at a red traffic light compared to free flowing conditions. When these cars keep accelerating or inching by slowly, they emit a great deal of emissions. These emissions take more time to disperse as well. The pollution ends up accumulating in the air at traffic lights. Long traffic jams may cause exposure to traffic fumes, and potentially increase various health risks, including cancer, say researchers.

According to a report by the World Health Organization (WHO), exposure to outdoor air pollution is among the top ten health risks faced by humans, especially in urban concentrations. Thus WHO has classified outdoor air pollution as being carcinogenic to humans. Previous studies have shown that drivers stuck at traffic lights were exposed up to 29 times more harmful pollution particles than those driving in free flowing traffic. A research on 'How much does traffic congestion increases fuel consumption' has obtained the remarkable result that traffic congestions have increased the fuel consumption by a factor of less than two. According to findings by Central Road Research Institute (CRRI), Delhi's eight most congested traffic signals are consuming at least 40,000 kiloliters of fuel daily while vehicles wait in peak rush hours. And even worse, it is adding to cities pollution with nearly 115 tonnes of carbon dioxide (CO2) being released daily. The amount of fuel burnt by idling of vehicles at traffic intersections amounts to 39,860 kg (petrol, diesel and CNG vehicles combined) and the quantity of carbon dioxide produced equals 1,15,609 kg that is 115 tonnes of the unhealthy black soot. And these figures are just from eight traffic junctions of the city [4,5]. As a result, switching off the engine at traffic signal helps save money and also keeps the environment clean and safe. It may not be the complete solution to traffic congestions, but aims at reducing fuel consumption and air pollution. Many government and private agencies are now advertising about turning off the vehicle's ignitions to save fuel, which is the right thing to do. It is a general misconception that switching off the ignition and restarting it consumes more fuel than keeping the engine on idle while stuck in traffic or when waiting for the signal to turn green.

According to studies, "on an average we waste 0.098 liters of fuel every 10 minutes of idling. That may not sound much but it all adds up over time"[6]. Anything more than 10 to 15 seconds would save fuel, because car that is already warm does not need that much effort to restart, as it is at the proper operating temperature, and oil is distributed around the engine at a high lubricity. The efficient range of temperatures is maintained by the motor for more than few minutes, and takes a few hours to completely cool down, so there is definitely no need to keep the car running during short stops. So switching off the engine if we are idling over 10 seconds is the best idea [6]. And this system is devised for the automatic control of engine ignition.

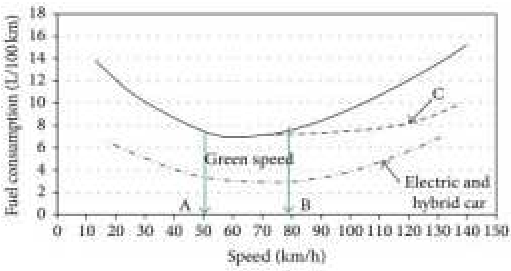

Fig 1. Relation between fuel consumption and average speed

There are several factors that affect the fuel consumption on streets. From the mechanical properties of the vehicle, it has been proved that a vehicle running at 50– 70km/h for gasoline engines and at 50–80 km/h for petrol engines consumed fuel at lesser rates. Figure 1 illustrates the relationship between the vehicle speeds and the fuel consumption from which exhaust pollutant by the driving pattern can be assumed [8, 9]. By eliminating congestion and suggesting a path that is uninterrupted with the help of ITS technique the vehicle can maintain this green speed and then obtain the best fuel efficiency and pollution at minimum level [10]. If the vehicle drives above green speed or runs bellow the green speed it will consume more fuel [11]. The curve C in figure 1 shows that fuel consumption will be reduced if the aerodynamic drag is reduced at high speed [12]. The speed versus fuel consumption for the hybrid and electric vehicle is shown by doted dash line.

Figure 2 shows the relation between fuel consumption and gear change of a manual driving car. The best way to maintain the engine in low speed and high torque mode is to select the highest speed ratio. Engine consumes more fuel in 1st gear than in 3rd gear and more fuel in 4th gear than in 5th gear. Lower the speed ratios higher is fuel guzzling, because they are associated with an engine that is not loaded sufficiently. The transmission vehicle operated manually goes to the highest speed ratio as soon as possible. When going up a slope, shifting to a lower gear should be avoided as much as possible to keep engine loaded. As the vehicle is about to stop, it can be shifted to a lower gear without braking, so as to recover energy over longer distances. For an automatic transmission, it is difficult to control speed ratios but can be done, by momentarily taking foot o the gas pedal when going up a slope to reach the upper speed ratio.

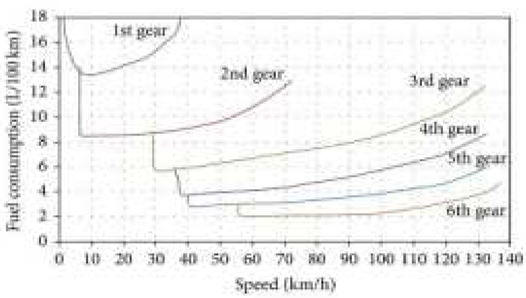

Fig 2. Relation between fuel consumption and gear change of a manual driving car

2 PROPOSED SYSTEM

The traffic signal circuit consists of ATMEGA 328, counter display and RF transmitter, which is powered by a 9V battery. The 9V battery supply is regulated to 5V by a voltage regulator (IC7805) and is distributed to the ATMEGA 328, counter display and RF transmitter. The ATMEGA 328 is programmed using Arduino software and the program is downloaded in the ATMEGA 328, which controls the signal status and the counter display value. The RF transmitter transmits the counter value continuously to the RF receiver in the automobile circuit.

The automobile circuit holds the ATMEGA 328, RF receiver, relay and a DC gear motor. The DC gear motor runs with the 9V power supply, hence the relay is used to provide a separate 9V supply, whereas other components does not require 9V power supply. Hence the 9V power supply from the battery is regulated using the voltage regulator (IC7805) and then sent to the components based on their requirements. The ATMEGA 328 is programmed to receive the traffic signal counter value and the conditions are also programmed in the ATMEGA 328. It is programmed by using Arduino software and loaded into the ATMEGA 328. The ATMEGA 328 holds the program code, which contains the RF, commands, necessary to control the DC gear motor. When the automobile is turned ON and is in idle state, it switches the receiver circuit to active state. In active state, the RF receiver interfaced with the ATMEGA 328 receives the counter value and checks the condition that is programmed in the ATMEGA 328. When the condition is satisfied, it provides a 5V input signal to the relay, which switches the DC gear motor ON. And when the condition is not satisfied it does not provide any input signal to the relay and the DC gear motor is in OFF state.

In case of an emergency, to turn ON the DC motor, a bypass switch is used. It triggers the relay, which would power the DC gear motor. In the real time application of this project the ATMEGA 328 at the receiver end should be interfaced with the Engine Control Unit (ECU) of the automobile, which will control the ignition of the automobile. The interfacing programming has to be done in the ECU board, in addition to the programming done in the ATMEGA 328.

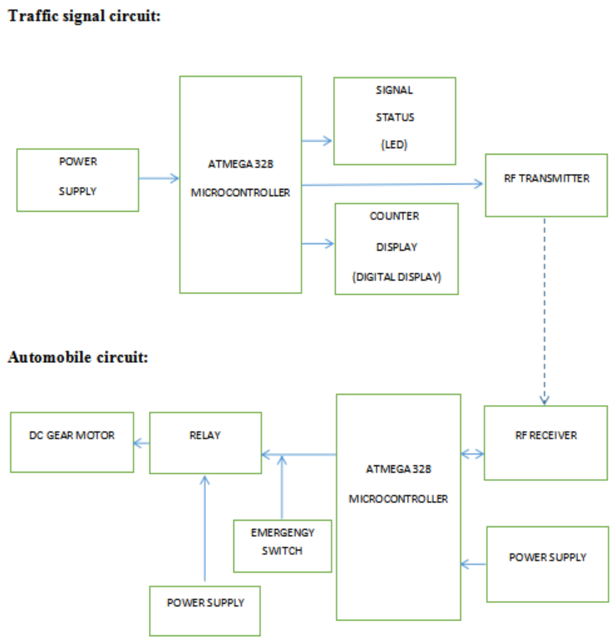

Fig 3. Block diagram of the system

3 SYSTEM ARCHITECTURE

3.1 MICROCONTROLLER (ATMEGA 328)

Fig 4. Arduino UNO

An Arduino UNO R3 board is used in this project. Arduino board is a micro-controller kit for building digital devices and interactive objects that can sense and control objects in the physical world. They are distributed as open-source hardware and software. It designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins. These pins may be used to interface to various expansion boards and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB), which are also used for loading programs from personal computers.

It consists of an Atmel 32bit AVR micro-controller (ATmega328). It has 14 digital I/O pins at the top (of which 6 can be used as PWM outputs), 6 analog input pins at the lower right, and the power connector at the lower left, a 16 MHz quartz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. The board can operate on an external supply of 6-20 V. If supplied with less than 7V, however, the 5V pin may supply less than 5V and the board may become unstable. If used in more than 12V, the voltage regulator may overheat and damage the board. The recommended input voltage is 7-12 V. The DC current per I/O pin is 20mA. The DC current for 3.3V pin is 50mA. The flash memory is of 32kB, of which 0.5kB is used by boot loader. The SRAM is 2kB and EEPROM is 1kB. Generally the UNO board is powered via the USB connection or with an external power supply. The power source is selected automatically.

3.2 RF TRANSMITTER AND RECEIVER

An RF module (radio frequency module) is a (usually) small electronic device used to transmit and or receive radio signals between two devices. The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF module, variations in the amplitude of carrier wave represents the digital data. This kind of modulation is known as Amplitude Shift Keying (ASK). Transmission through radio frequency is better than infrared (IR) because basically, signals through RF can travel through larger distances making it suitable for long range applications. This RF module comprises of a transmitter and a receiver. The transmitter and receiver pair (Tx/Rx) operates at a frequency of 434 MHz. An RF transmitter receives serial data and wirelessly transmits it through RF by an antenna connected in its 4^{th} pin. The transmission happens at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the frequency similar to that of the transmitter. The RF module is always used together with an encoder/decoder pair. The encoder is used for encoding parallel data for transmission feed while a decoder decodes reception. HT12E-HT12D, HT640-HT648, etc. are some commonly used modules.

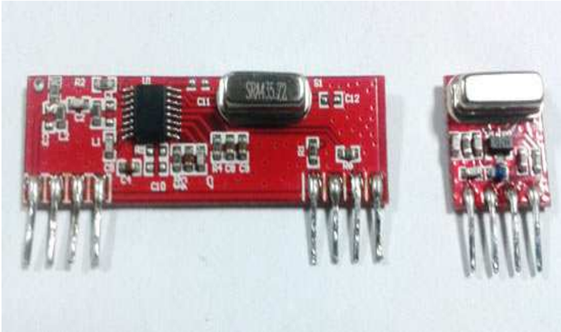

Fig 5. RF Transmitter and Receiver

3.3 Relay

Relay is an electromagnetic device, that isolates two circuits electrically and connect them magnetically. Relay allows one circuit to switch another one while they are completely separate. It can interface an electronic circuit, at a low voltage, to an electrical circuit, which works at very high voltage. For example, a relay can switch a 230V AC mains circuit in a 5V DC battery circuit. Thus, a small electrical circuit is able to drive a fan or an electric bulb. In this project, a basic 5V relay is used. It is a high quality single pole- double throw (SPDT) switch, which is fully sealed. It can be used to switch high voltage and/or high current devices. The coil of this relay is rated up to 12V, with a minimum voltage of 5V at 250V AC or 30V DC. The rated current is up to 5A. When the relay is not activated, the common pin is in contact with the NC pin. Similarly, when it is activated, the common pin will break away from contact with the NC pin and make contact with the NO pin. Also, when the relay is deactivated from activated state, the common pin will conversely break away from contact with the NO pin and return back in contact with the NC pin.

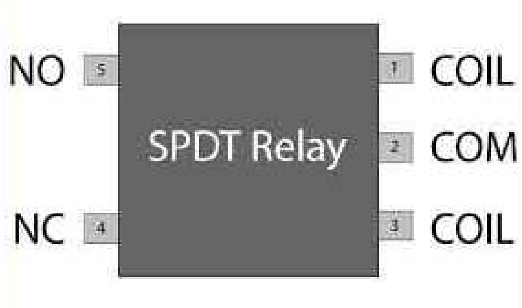

Fig 6. Pin diagram of relay

4 Result And Discussions

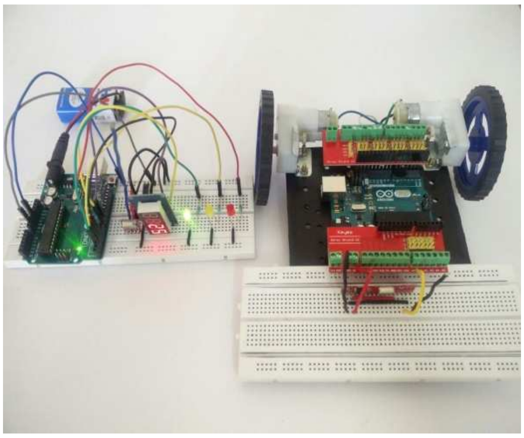

Fig 7. Hardware kit

Protecting car engines by idling less and frequent restarts are no longer hard on car's engine and battery. The added wear which amounts to no more than $10 for an annual, is much less than the cost wasted for fuel, which is nearly $70-650 for an annual, depending upon fuel prices, idling types, vehicle types, etc. Idling actually increases overall engine wear by causing the car to operate for longer than necessary [7]. From this, we can conclude that, in addition to saving fuel, money is also saved. The important thing is that air pollution by automobiles can be reduced considerably. This is possible by the centralized automatic traffic control signal. The same system can also be developed for manual traffic control in future. From this proposed system, we can control the fuel consumption by vehicles waiting in traffic signals. This is possible with the help of ECU, interfaced with microcontroller, which turn on or turn off the engine unit.

5 CONCLUSION

Thus this system will help reduce fuel consumption and emission of air pollutants like carbon dioxide, hydrocarbons, carbon-mono oxide, nitrous oxides and other pollutants from automobiles. It saves lot of money spent on fuel that is wasted in traffic signals. In addition, it will also help in regulated traffic. Turning on and off the engine every time a vehicle waits in traffic signal can be arduous for the driver. This project is the minor part of a major project. The main future work is to design it in an efficient manner. After the complete review of the scientific literature, it can be concluded that the design of this system is viable. This may give a marginal gain in fuel economy without any strain on the starter system.

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