Internal Temperature Control of Automotive Vehicles

K. Viswanaath\textsuperscript{a}, A.S. Lakshmi Sangeetha\textsuperscript{a}, K. Lakshminath\textsuperscript{b}, A.S. Lokeshwaran \textsuperscript{b}

\textsuperscript{a} Department of Electronics and Instrumentation Engineering, Velammal Engineering College, Chennai, India.
\textsuperscript{b} Department of Mechanical Engineering, Velammal Engineering College, Chennai, India.

\*Corresponding Author
viswanaath.97@gmail.com
(K Viswanaath)
Tel.: +91 7904540067

1 Introduction

The quantum of solar energy density in Sultanate of Oman may be considered at par with other countries which are accounted as highest in the world. High solar energy density is available in most part of the Sultanate of Oman. According to a Study on Renewable Energy Resources in Oman carried out by Authority for Electricity Regulation, Oman \cite{1} the average solar global isolation in the country varies from 4.5 to 6.1 kWh/m\textsuperscript{2} per day. With yearly variation in average amounts to about 4 kWh/m\textsuperscript{2} per day for January to about 6.5 kWh/m\textsuperscript{2} per day for May in which the solar global isolation is highest.

The above data clearly indicate that solar resources in Oman are among the highest in the world. Unfortunately, this quantum of solar radiation energy invariably contributes towards a very dangerous phenomenon called greenhouse effect inside the vehicles cabin parked under the scorching sun. Vehicles parked under the daylight experience sharp rise in the cabin temperature due to the trapped solar radiation \cite{2}, \cite{3}. The solar radiation which enters inside the car is to some extent trapped by the wind shields of the car hence contributing to the greenhouse effect. It's often seen that, vehicles which are parked in the sun especially during hot summer day, experience drastic rise in the cabin temperature, especially steering wheel, seats, dashboards record temperature almost double that of ambient outside temperature.

So it's important to provide a positive air exchange across the vehicles cabin without using vehicles stored energy (battery) and also without causing any threat to the vehicles security. In this regard this research focuses on the design and development of a simple standalone ventilation system driven by the solar energy to provide necessary air exchange across the cars cabin. Hence an investigation with the aim to develop a simple ventilator, which inhales fresh air from outside into the car cabin and purges hot air to the outside, was carried out. It's envisaged during the sunny day, solar energy can be used to run the ventilator fans and associated systems.

In recent years the private passenger vehicles density in Oman has seen a tremendous jump, as it's the only convenient and important modes of transportation for most of the people compared to thinly available public transport. The high density of private passenger vehicles has resulted in the paucity of parking space. For instance, the need for of additional parking spaces are getting more significant especially at the government offices, universities, colleges and shopping area. Alas the available shaded parking space are no match for the existing number of vehicles, hence the alternative choice for those who are unable to park under shade is to park in an open parking space.

It's very evident that we are more concerned about our life as well as our loved ones while we are driving the vehicle, similarly it's also very important to
maintain a healthy environment inside especially when the vehicle is parked under the sun. Hence vehicle cabin occupant’s health and safety issue is of paramount importance. Few studies have been reported earlier on the issues and matters concerned with elevated temperatures in the parked car and few of the findings are well reported [4][5].

The studies carried out in Malaysia by Basar et al., [6], indicate those vehicles which are parked under the sunlight has shown temperature rise inside the cabin approaching 60°C. This higher temperature will make the driver and passenger more uncomfortable while entering the vehicle. Moreover, the vehicles cabin would face aging problem and may damage to the goods kept in the vehicle. According to the findings of Saidur et al., [7], in USA, every year many children die of (hyperthermia) heatstroke after being left unattended in vehicles. They report that from the year 1998 to 2002, the average number of children died of heat stroke was 29 persons per year. In 2003, this number increased to 42 and 35 persons in 2004. Annually, hundreds of children experience varying degrees of heat illness from being left in cars. Studies of Saidur et al., [7] suggests to use auxiliary ventilation system to increase the air flow rate and decrease the steady state temperature inside the vehicles compartment, their experimental results show an reduced temperature inside the vehicle compared to the non ventilated cabin.

Similar experimental studies carried out in the Australia show that typically 20°C hotter inside a parked car compared outside temperature on a hot summer day, in such condition children or pets left in such a parked car for periods of the order of 30 minutes suffer heat stress and a number of deaths are reported in Australia each year as a result [8].

Passengers are also being affected with the thermal condition inside the vehicle itself. More often it is observed, that the passengers and drivers are forced to wait for a period of time around 2-5 min before getting into the car to cool down the interior condition either by rolling down the windows or running the air conditioner at high speed that which will results in higher fuel consumption [9]. Jan Null [10] carried out studies on the excessive temperature in enclosed vehicles at Department of Geosciences of San Francisco State University, USA. This study was carried out with reference to the accident of children being left unattended in the closed vehicles. The aim of the study is quantify vehicle temperatures and temperature changes with time under a variety of meteorological circumstances.

The study used temperature sensors mounted on the two types of vehicles parked under the heat of the sun. The first vehicle the window was fully closed and the other with window “cracked” i.e., open approximately 1.5 inches (3.8 cm). the study revealed that there was fast buildup of temperature in short period of time in a fully closed car, while in the “cracked” window car the build-up of temperature was little slower. But the results concluded that both cars reached dangerous temperature level after long hours even if the other car windows are ‘cracked’ hence it may still can cause accident if there are children left inside unattended. From Jan Null [10], studies, it can be understood that with partial opening of windows, only minor mitigation is achieved. Russell Manning et al., [11] also studied steering.

A German study published in 2007 Also, according to a research, the car dashboard, sofa, air freshener emit Benzene, a Cancer causing toxin . In addition to causing cancer, Benzene poisons your bones, causes anemia and reduces white blood cells. A car parked indoors with windows closed will contain 400-800 mg of Benzene. If parked outdoors under the sun at a temperature above 60 degrees F, the Benzene level goes up to 2000-4000 mg, 40 times the acceptable level (50 mg per sq. ft). People who get into the car, keeping windows closed will inevitably inhale, in quick succession excessive amounts of the toxin.

2. Existing Solution

Normally, people tend to lower the car side glasses to a small amount while car is parked so that all gases get exchanged with atmosphere and also temperature is reduced. Another method is that while user arrives to take a drive they open car’s doors or lower every glass on car for small amount of time (probably 5-10mins). Disadvantage of these are if the car side glasses are lowered when its parked, the gases gets exchanged to atmosphere naturally but there is chance of highjack of car.Whereas in second case he user has to wait for some minutes which wastes his time.
3. Project Methodology

To overcome the above problem we developed a device which detects whether the user is present inside the car and if he isn’t present, we measure the vehicle cabin and benzene quantity and if either temperature or benzene quantity is above the nominal value, the device switches on the AIR CONDITIONING system of car thus exhausting the toxic gas and also reducing the temperature. This device also switches off the AIR CONDITIONING unit once the value falls below or is at required level.

4. System Architecture

5. Components Used

5.1.Msp Microcontroller
The MSP430 is a mixed signal microcontroller from Texas Instruments. Built around a 16 bit CPU, the MSP430 is designed for low cost and specifically, low power consumption embedded applications.

5.2. Dht11 Sensor:

A humidity sensor senses, measures and regularly reports the relative humidity in the air. It measures both moisture and air temperature. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold.

The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.
5.3. Pir Sensor

A PIR (Passive Infrared) sensor is a motion detector which detects the heat (infrared) emitted naturally by humans and animals. When a person in the field of vision of the sensor moves, the sensor detects a sudden change in infrared energy and the sensor is triggered (activated). They are commonly used in security lighting and alarm systems in an indoor environment. The PIR sensors have a range of approximately 6 meters, depending on conditions. The sensor adjusts to slowly changing conditions that occur normally within the environment, but shows a high-output response when a sudden change takes place.

5.4. Mq135 Gas Sensor

MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benzene steam, also sensitive to smoke and other harmful gases. It is with low cost and suitable for different application. Used for family, Surrounding environment noxious gas detection device, Apply to ammonia, aromatics, sulfur, benzene vapor, and other harmful gases/smoke, gas detection, tested concentration range: 10 to 1000ppm.

6. Software and Environment

Code Composer Studio (CC Studio or CCS) is an integrated development environment (IDE) to develop applications for Texas Instruments (TI) embedded processors.

Code Composer Studio is primarily designed as for embedded project design and low-level (bare metal) JTAG based debugging. However, the latest releases are based on unmodified versions of the Eclipse open source IDE, which can be easily extended to include support for OS level application debug (Linux, Android, and Windows Embedded) and open source compiler suites such as GCC.
7. Results and Discussion

Experiments were carried out in order to arrive at a conclusive understanding of temperature rise inside a parked car. The ambient air temperature and air quality was continuously measured during the experimental hours.

It was found that the vehicles cabin air temperatures was approximately 66°C in car with windows closed and car parked indoors with windows closed will contain 400-800 mg of Benzene and if parked outdoors under the sun at a temperature above 60 degrees F, the Benzene level goes up to 2000-4000 mg, 40 times the acceptable level (50 mg per sq. ft).

![Fig.1: Prototype of the device](image)

The above figure shows small scale model of the MQ135 sensor and a motor(used instead of AC unit for device which consist of a DHT11 sensor,PIR sensor demonstration).
From the Fig.2 it can be seen that the device first checks for thermal radiation of human (to detect human’s presence). If no human is detected it then checks for temperature (in °C) and benzene content (in ppm). If both temperature (in °C) and benzene content (in ppm) is above the required value, the device sends control signal to microcontroller to switch on the AC unit (motor for demo) thus reducing the temperature as well as exhausting the toxic benzene gas inside the cabin. If temperature (in °C) and benzene content (in ppm) falls below the required value, the microcontroller automatically switches off the AC unit. Here we made use of PIR to detect thermal radiation, DHT11 to measure temperature, MQ135 to measure ppm of benzene and MSP430 for controlling the process.

8. Conclusion and Future Scope

On a bright sunny day, the vehicle’s cabin air temperatures was approximately 22°C higher than the ambient temperature, while with this device the cabin temperature was reduced by 50% approximately, hence avoiding various problems due to cabin temperature rise.

References


