A Self-Regulated Module for Vehicle Interior Ventilation System

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Abstract

Background/Objectives: The sunlight heats up closed area which is free of air and in close contact with sun much faster and significantly. This project is used to reduce the very high temperatures present inside the vehicles to feel very comfortable. Methods/Statistical Analysis: This paper proposes a CAN based module for self-regulated inside ventilation of vehicles to reduce the high temperatures presented inside the vehicles in summer. Two microcontrollers and a group of sensors which facilitate efficient, reliable, safe ventilation and sufficient data to ensure functional are used by this project. The communication using CAN bus is established between two ARM controllers. By changing the windows of the vehicle to open position, the ventilation process is performed. The position of the windows is controlled by the controller itself and without presence of driver using an algorithm that gives the details of sensors. Findings: The movements observed near the vehicle, precipitation and others have importance besides temperature for the ventilation. The results of the tests give usefulness and the modules utilization, the windows of the vehicle is closed when the temperature inside the vehicle achieves more than comfortable temperature and if any fire accidents, thefting of vehicle occurs then the location of the vehicle is sent to the user. Application/Improvements: The system provides comfortability to the users with a low cost. It saves the fuel by reducing the usage of AC. This system can be used in home and own vehicles, cabs, and transport business.

Keywords: ARM, CAN, Sensors, Temperature, Vehicles

1. Introduction

The module has to collect sufficient data from the vehicles immediate surroundings in order to satisfy all the criteria of quality ventilation. The necessity of lowering the vehicle windows and begin the ventilation process is decided based on the data collected by the module. There are three logical Units in which the module can be divided. They are: peripheral unit—for collecting details, control unit for controlling operations of device, switching unit for signal adjustment as shown in Figure 1.

The power supply of 5v, 750MA is used in this project. For voltage regulation 7805 is used, full wave rectifier and stepdown transformer is included. The sunlight heats up closed area which is without air circulation and directly exposed to sunlight much faster and high temperatures are achieved and causes greenhouse effect. This type of situations are happened in the vehicles parked in the hot summer sun. The main aim of this project is to reduce the very high temperatures present inside the vehicle and provide comfortable environment1.

Figure 1. Block diagram.

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When opening the windows of the vehicle marginally, the ventilation process will be performed. It is not reliable and not safe if the process of ventilation is occur in a vehicle which is parked because it is not manish inside the vehicle. So the self-regulated method of ventilation is required. The microcontroller default algorithm is used for automatic ventilation process.

The vehicle interior temperature is measured using a temperature sensor. If the temperature exceeds normal level and if it is very high temperature then controller reduces the height of the windows of the vehicle for the air to enter. The reliability and safety are important in the automatic ventilation process.

2. Components

Controller Area Network (CAN): In 1980, Bosch developed the CAN which is a serial bus communication protocol. ISO-11898, ISO-11519 standards are used for CAN and the standard is used as standard for networking of vehicles. From Figure 2 whenever CAN was implemented, firstly it was used in vehicles only but now a days it is used in other areas also like automation of buildings, medical fields etc. Bus topology is used by the CAN protocol. CAN bus requires only two wires for data transmit and receive. The devices which are connected to the bus can transfer or receive data and the structure is multimaster structure. When one node is sending the data then all other nodes should wait until the data transfer is finished.

Only the highest priority device is allowed to data transfer when more than one device or node is try to send data at a time. More CAN buses with different speeds are used in applications of vehicles. The slow speed bus and high speed bus are available in CAN bus. Slow speed bus connects the devices which require slow response such as climate control, controlling of doors and driver details modules. High speed bus connects the devices which require fast response like transmission control, antilock braking system. CAN protocols are two types such as 2.0A, 2.0B. CAN 2.0A has identifier of 11bits. CAN 2.0B has identifier of 29bits. The controllers of 2.0B are fully backward compatible. They can send and receive data in anyone format.

GPS: In vehicle tracking systems, the global positioning system is mainly focused on speed, time, and coordinates of location. These details are send to the user anywhere on the globe. Three satellites plus fourth for clock impression is used to calculate a position. GPS receiver with antenna is equipped in the GPS module. One push button and two slide switches are in the gps device.

The UART and the switch which is used for selection of Dline is shown by 1) of figure3. Tx, Rx of GPS device is attached to 3, 2 pins of the controller successively. When Rx is chosen by Dline, Tx will be attached to 0, 1 of the controller in the GPS device when the UART is selected. GPS receiver is at 2) of Figure 3 to get details of the location. The 20 channel EM-406A SiRF3 receiver is used in the GPS receiver module. The GPS device is maximum ready to gather the details of location of vehicles when the GPS and microcontroller have everything assembled.

GPS receivers that are handheld calculate the positions that are known as autonomous solutions. Compared to all other receivers, handheld receivers are independent and to calculate positions uses only satellites. Two gps receivers are used by differential gps to calculate position.
The information of orbit for all the satellites is downloaded when the receiver of GPS is switched on. The procedure takes 11.5 minutes at first time, when the details are downloaded they are saved in the memory of receiver to use in the future. The receiver of GPS needs to know the distance between it and satellites from even though it finds the satellites position in the space.

GSM: For digital cellular systems, GSM (global system for mobile communication) is a standard which is accepted throughout the world. To generate a common standard of European mobile telephone it was established in 1982. There are three major systems in GSM network. They are: 1) switching system (SS), 2) base station system (BSS), 3) operation and support system (OSS).

Switching system: It is responsible for performing processing of calls and functions which are related with subscriber. It includes various working units such as Home Location Register (HLR) is used for data storage and subscription management.

Mobile Services Switching Center (MSC) for performing functions related to telephony switching unit.

Visitor Location Register (VLR) for storing temporary information about subscribers Authentication Center (AUC) for providing encryption and authentication parameters to verify users identity and confidentiality of each call.

EIR has the details about the mobile equipment for the identity to prevent calls from unauthorised, theft or defective mobile units.

BSS performs all functions similar to radio, it contains of base station controllers (BSCs), base transceiver stations (BSTs).

All the functions related to controlling and physical links between MSC, BTS is performed by BSC.

Radio interface to the mobile unit is maintained by BTS.

OSS is used to all the material in the switching system, to the BSC operations and maintenance center (OMC) is connected. OMC implementation is called operation and support system (OSS). The OSS is used to give the customer allow cost support. OSS also provides overview of network and functions of maintenance.

GSM offers two types of services: data and telephony services.

Telephony services provide voice services to communicate one subscriber to another.

Data services provide data signal transmission between two access points.

Some of the other services also provided by the GSM are DTMF, cellbroadcast, voice mail, faxmail. The GSM module is as shown in Figure 4.

Figure 4. GSM module.

Short Message Services (SMS): SMS is the GSM network’s convenient facilitate. A maximum of 160 alphenumeric characters can be sent to or from mobile unit in which a message consists. The message is stored and send back to the user if the user’s mobile unit is powered off or left the area of coverage.

Precipitation or rain fall detection sensor: It makes the automatic ventilation more reliable and it is very consequential. The sensor measures the precipitation and sends a signal to the control station that demands to increase the height of the windows instantly. The precipitation sensor is located on the inside of windshield and above the rare view glass to find the dihydrogen monoxide dropping drops on the mirror as shown in Figure 5. To emit light at a certain angle onto windshield light emitting diode (LED) or infra-red (IR) is used as a transmitting device.

The photodiode in which the light of expected intensity reflects is used as a receiver. The light reflects differently when the droplets appear onto the windshield that causes transmutation in the electronic circuit which is absorbing connected to the microcontroller. The ventilation process gives reliability and safety by integrating precipitation, kinetism sensors.

LDR Sensor: The sensor circuits which are light or black LDR sensors play a crucial role. LDR is a sensor or transducer in which resistance is converted from light. The decrease of resistance is occurred when light ‘brightness increases The LDR is made using cadmium sulphide (CDS). The resistance of LDR is maximum 1000000 ohms but the resistance drops when they are try
to illuminating with light. The rainfall detection sensor is shown in Figure 5.

![Figure 5. Precipitation sensor.](image)

PIR Sensor: PIR sensors detect motion by sensing infrared fluctuations and they are passive electronic devices. A high indication is sent to the signal pin when a motion is detected. These sensors work well in detecting human motions because of the biological characteristics of organisms.

PIR Sensor operation: It has a solid state piezo electric chip which is the heart of the device because when it is exposed to infrared radiation then an electric charge is produced.

Precipitation Sensor: To measure the volumetric water content in environment precipitation sensors are used. It is also used to monitor the soil moisture content in irrigation system. It is used to measure the loss of moisture over time and also used to evaluate optimum soil moisture content. Bottle biology experiments are improved using this sensors.

Temperature Sensor: The type of LM35 sensors are used as temperature sensors with integrated precision in which the output voltage, Celsius temperatures are linearly proportional. In this paper to get fan speed must read the temperature value and it is send to microcontroller. Then the temperature value is sensed. The sensor has to be used like this.

3. Algorithm

The microcontroller follows predefined program, algorithm behavior in a certain situation. The flowchart as shown in Figure 6 is used to represent the algorithm behavior.

Microcontroller initialization and performance of auxiliary variables is done at the beginning. Process starts by verifying the parameters and output state is set after the initialization. The vehicle is stopped in parking or in driver’s use is determined at first. By verifying the ignition lock it is determined, it is not fully conformation but satisfied. Depending on that result the mode of automatic or manual is activated. In manual mode, the controller place very lower part in the security of electric motors from very high load in which a person is using the car.

In the automatic mode, some preconditions are checked. Whether precipitation, some suspicious objects found near the vehicle and is it night. And if it is confirmative then ventilation process is stopped and start when these conditions are not true.

When satisfactory situations are arrived then controller examines the overheating of the windows to allow the air for the ventilation. The ventilation process is suspended if any disturbing factors occurred during the ventilation process.

![Figure 6. Flow chart.](image)

The opening and closing of left and right windows is done separately during ventilation process thus providing efficiency. If any suspicious objects are found at left side
window then only left window will close and partial ventilation is allowed through right side window\textsuperscript{11}.

4. Existing System

Pure analogy: Existing systems need manual operation and does not have any quality sensors to measure the temperature values. The predefined input data is not supported.

Time dependent operation: in the existing systems we cannot give any time for operation. To dynamically alter the search path there is no chance.

Cannot able to establish remote communication: the existing system cannot provide temperature information remotely to the user.

Environmental Conditions: The environmental conditions like temperature, detection of rains are cannot accurately analyzed.

Low throughput: these cannot provide high speed operations because these are analogy systems\textsuperscript{12}.

5. Proposed System

Fully Digital System: Advanced microcontroller is used in the implementation. The system gives accurate results due to digital connection.

Status Monitoring: LCD display is used to monitor the status of the system for comfortable utilization.

Time Dependent Operation: Time dependent operations are allowed by the system. The programmer fixed the time to open or close the window.

Intelligent: The system works depending on situations happened.

Digital monitoring of temperature and rainfall: The system measures these values in digital manner.

Accurate and high speed operation: accurate data and high speed operation is achieved\textsuperscript{15}.

Support remote communication: the system sends temperature regarding information via SMS to the user\textsuperscript{12}.

Working

The system should be directly connected to the vehicle’s battery. Even though the vehicle in off condition the system should be in on condition. The microcontroller switch on the motors automatically for opening the vehicle windows when the temperature of vehicle interior exceeds the predefined level. By using GSM modem it will automatically send a message to the user. When the vehicle interior temperature reaches lower level then it will automatically close the window and operation status is displayed on LCD display unit. During raining also the operation is performed. The proposed system implementation is shown in Figure 7.

![Figure 7. Proposed system implementation.](image_url)

Advantages

- The advantage of vehicle safety is provided by the system.
- It keeps vehicle interior clean and reduction of health problems are achieved.
- The system keeps the vehicle cool and no need to waiting.
- The vehicle interior life time is increased by preventing excess heat and rain water.
- The fuel is saved by reducing the usage of AC
- Money saving is archived by the system.
- Maintenance is easy by using this system.

Applications

- This system meets the requirements of CABS and it is very useful.
• The system is useful in transport business.
• The system is useful in home and own vehicles for comfortable living.

6. Test Results

The outside temperatures ranges from 20 to 200 is used to test the module in some vehicles under real operating conditions. The temperature values of vehicle inside are taken for windows which are totally opened or closed for best evaluation. The values were taken for a long period of time.

When the temperature reaches above 190 temperature value then the vehicle windows are automatically opened. Whenever the temperature reaches below this value then the windows are automatically closed. It is required to reduce the windows of the vehicle above 11 cm. The windows which are opened more height or which are completely opened can give very good results.

The CAN module has given the more accurate results than the existing one. GSM and GPS was used to send the vehicle location information and other details via SMS to the user.

Consider the presented results as informative because the values were not taken in exactly with the same weather conditions. It can be remarked that many factors such as outside temperature, direct sunlight and position of windows effect the quality ventilation. Weather conditions such as wind accelerates and improves ventilation. Vehicle body color, vehicle size and its orientation with sun makes difference. With closed windows and without module, the temperature of vehicle inside which is parked in the outside, 26°c temperature is reach over 60°c. Considering that this method is passive of cooling overheated interior and achieves better results.

7. Conclusion

Even though a prototype, this module is fully a working device and it can perform its functions more efficient, reliable and safe. There is no limit to this application and it is not restricted to ventilation of vehicle. In both ways this device is ultimately expanded: it is compatible for integration into some existing systems and it is upgradeable to new tasks. For several other functions, nearly each component can be used and this can be arrived by upgrade of software. To upgrade the software, upgrading of hardware allow a greater possibility and capabilities are countless. The question remains irrespective of all positive areas of the device, whether the device can achieve its applications in the market. It is needed to adapt this module to any individual vehicle due to the impartibility as a physical unit. The individual installation of this module is not cost effective. The vehicles which are same type the system is used, the device can find its economic efficiency and purpose.

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