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Research Article

Optimizing the AC Operation for Energy Management and AC Failure Monitoring System Through GSM Technology for School Bus

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Abstract: This paper presents an ideology of optimizing the energy consumption through the controlled operation of Air conditioning system in school bus or any transport system. This includes two concepts, one is on/off the AC by measuring the temperature inside the bus and the second is in case of any failure of AC in the bus, informing the condition to the maintenance people. The main devices used are Arduino, temperature sensor (DS18B20) and SIM900. The temperature sensor used to sense the temperature and send the signal to Arduino. Based upon the temperature value the Arduino will operate the relay to turn on/off the AC. If the temperature is keep on increasing beyond the predefined value, then the AC is not working. This information will be send to the mobile number of maintenance team in charge.

Keywords: AC, Temperature Sensor, Arduino, SIM900, Temperature Control, School Bus.

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1. Introduction

This paper mainly concentrates on reducing the power required by the Air Conditioner (AC) in school bus for best energy management [6], [7], [11] and also detecting the faulty operation of AC and informing the same to the maintenance team of the school. Air conditioner is a major part for ensuring the best atmosphere in the bus, especially in the areas of the earth where summer lasts for a long period of the year [10]. This system is planned for controlling the AC, by switching it on and off automatically depends on the surrounding temperature, in addition it is also designed for detecting the AC failure and sending SMS messages to the maintenance team in case the AC is not working as it is intended for. In order to accomplish this project temperature sensor is used along with GSM and GPRS shield, Relay and fan, which all are controlled by Arduino microcontroller. The temperature sensor is used to measure the temperature inside the bus. If the temperature is more than the preset value, the relay connected to the Arduino will be operated to turn on the AC. If the temperature is equal to or less than the preset value, the relay connected to the Arduino will be operated to turn off the AC. If the temperature is keep on increasing in case of AC failure, the Arduino will send the failure information to the maintenance team in charge mobile phone through SIM900.

In this paper, we will discuss the methodology of the project by describing the used components, design consideration and the electronic circuit connection. Then, the results and a review about testing the project will be given.

2. Literature Review

There are many researches were done in bus AC controlling system and sending the required data through the GSM shield. Qiuhua et.al [3] suggested an AC operation controlling system using PIC microcontroller. The value of temperature and humidity was measured and the same given as input to the microcontroller after it has been converted into digital value. Based on the input the AC operation is controlled. Seong et.al [4] used a microprocessor as controller. The system detects the temperature and humidity based on that controlling the AC in order to maintain the good environment inside the bus. It has different modes of operation such as cooling, heating and dehumidifying modes. Mei et.al [1], [8] discussed the energy management of electric bus by proper control of AC based on number of passengers inside the bus. To optimize the power required by the AC, it uses Dynamic programming. The passengers count, climate condition and fuel required are taken for the discussion to implement the system for AC control [2], [5]. Nur Aira et.al [9] described a model which sends the SMS regarding the radiation level. A microcontroller is used to interface the devices. An alert signal will be given in case of high radiation as SMS. An air conditioning system which works smart is proposed [12]. It uses smart sensors from

mobiles phones or some sensors placed in the human body also. Ganghong et.al [13] proposed a model which sends SMS to farmer's regarding the agricultural information. It is very helpful for the farmers to know the latest information. Jay et.al [14] delivered an efficient system to monitor the environmental changes. This system uses temperature sensor and humidity sensor, using this a cooling system is controlled. This system used GSM technology to send message in case of undesired variations.

3. Methodology

To achieve the aim of this paper, there are six main components which are used in this paper. Arduino microcontroller in figure 1 is considered as a basic microcontroller, it can be connected with the computer by connecting a USB wire, and programmed by C or C++ programming language through Arduino software. The used type of Arduino module in this project is Arduino mega. The operating voltage of it is 5V, it has 54 digital I/O pins, 15 digital I/O pins with PWM, 16 Analog input pins, and other pins for I2C, SPI, I2S and URAT. It cannot be connected directly with WIFI neither Bluetooth.

In this paper one temperature sensor (DS18B20) is used as shown in figure 2. It is a digital temperature sensor, which senses the temperature then converts the analog readings to digital. It measures the temperature within a range of -55° c to +125° c. It communicates with the microcontroller through one wire, which allows connecting more than one temperature sensor with the same line. It has three pins, data, ground and VCC. Figure 3 shows SIM900 is a GSM and GPRS module, it can be used to send SMS or make a call. It consumes low power, around 9V in terms of voltage. It has number of pins which can be used for the given purpose. But the main pins which are needed for SMS are TXD, RXD and ground.

Fig. 1. Arduino Mega board

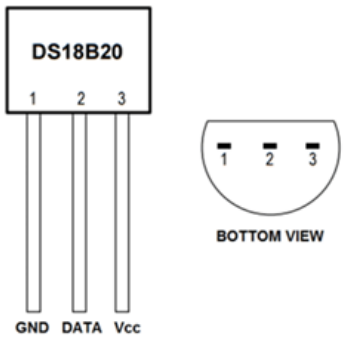

Fig. 2. Temperature sensor

Fig. 3. SIM900

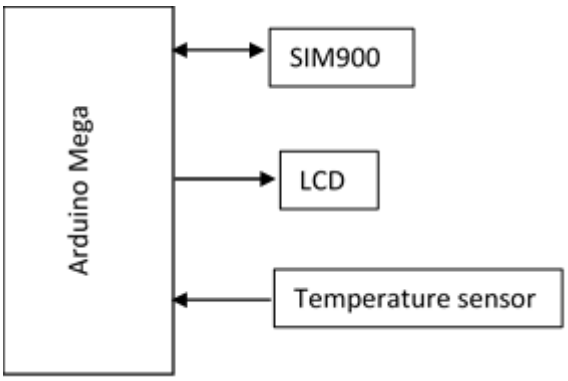

Fig. 4. Block diagram

LCD is short for the liquid crystal display as it employs liquid crystal for its operation. LCD is offered in several sizes. It can be big as the TV or small as what the smartphones screen. The 16x4 LCD, 16 columns and 4 rows is utilized. Relay in simple word is a contact and a coil. It works on the principle of magnetic induction. As when the coil is energized the normally opened contact is attracted and the open circuit by this way is closed. The relay which used here has 8 channels, each one has three terminals: NO, NC and common. The relay module has terminals for ground, 5-volt, 3.3 volt and for relay channel. In addition, this relay has overcurrent protection, for that it is better than using one channel relay. In this paper a prototype model of the idea is given. Thus instead of AC on/off control an electrical device such as fan is used. The fan is a DC motor, this fan works with 5 volt, and more than 1 A current.

Regarding the project's design, figure 4 shows the block diagram. The SIM900 has a bidirectional communication with Arduino, but in this system, it is only used for sending SMS messages. The temperature sensor gives the readings to Arduino, while LCD receives the data that is wanted to be displayed. Through SIM900 the required message is sent to the mobile phones.

4. Circuit Connection and Flowchart

The figure 5 shows the complete circuit connection including both temperature based AC controlling and sending message to maintenance team in case of failure. About the circuit connection, first, connected the AC failure detector circuit which is shown in figure 6 and figure 7. The temperature sensor data pin is connected with PWM (pulse width modulation) pin 2 in Arduino, and this is done for allowing connecting more than one temperature sensor to the same pin, beside that the ground with ground pin and VCC with 5v. On the other side, SIM900, TXD (transmitting) is connected with pin 9 and RXD (receiving) with pin 10, in all cases the pins must be PWM for operating the component.

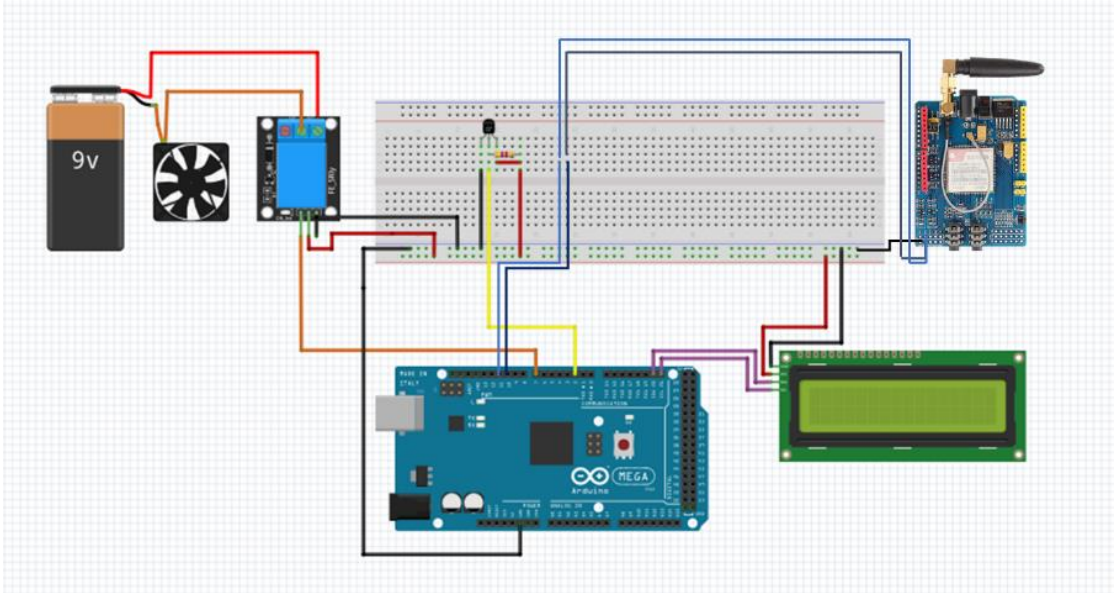

Fig. 5. Complete circuit connection

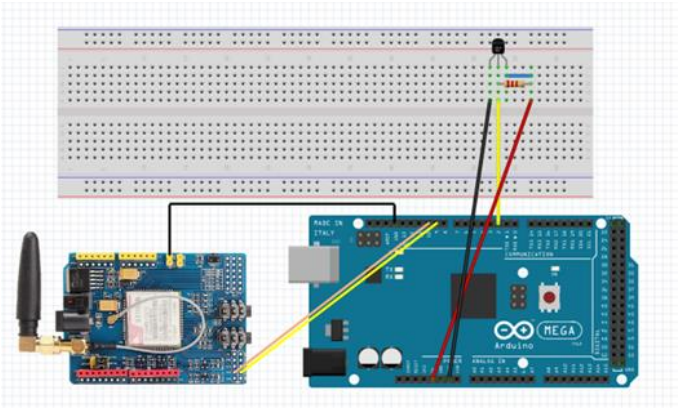

Fig. 6. Circuit connection of GSM module

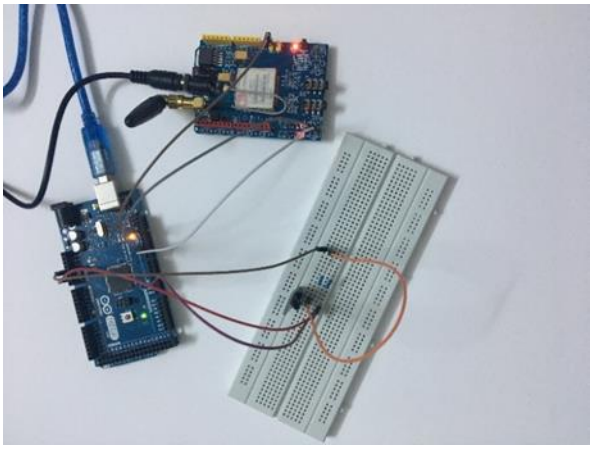

Fig. 7. Actual connection of GSM module

In the below figure 8, an 8-channel relay is used for controlling the fan in place of AC, which is connected with normally open contact of the relay and the second terminal is connected with a battery which goes to the common. In general, three wires were taken from the relay (5volt, ground and channel 2) to Arduino. Besides adding the relay and the fan, we have added the LCD for displaying the temperature's degree.

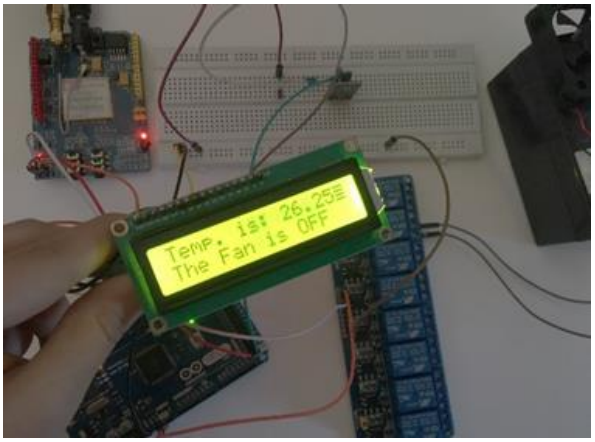

Fig. 8. Actual connection of AC on/off control

The below flowchart in figure 9 describes the working of the system. That is, initially, the temperature sensor will get the temperature and Arduino microcontroller will check the temperature degree (in Celsius) with the first if condition. So, if the temperature is above or equal to 28 which means the AC is not working properly, the Arduino will communicate with the GPS and GPRS sim to send a SMS message to the maintenance team.

If that condition wasn't true, then it would check again if the temperature was between 23.6 and 28 then a signal would be sent to the relay to close the normally open contact, which causes the fan to be on, else the fan will be remaining in off condition, and by saying else it refers to the temperature which is less than 23.6 Celsius.

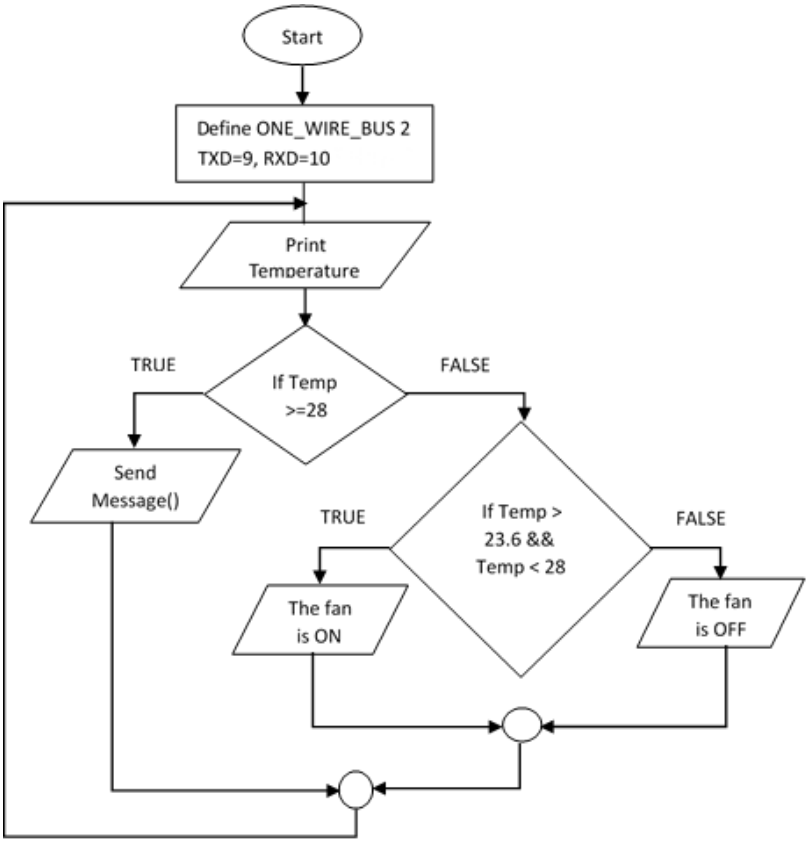

Fig. 9. Program Flowchart

5. Results and Discussions

For testing the circuit, we have used Arduino IDE for writing the code. Figure 10 shows the output in the serial monitor of Arduino IDE, that the temperature in Celsius is printed. Figure 11 represents the SMS (last two) which are sent by SIM900 when the AC fails. While testing the model, the minimum temperature was 27 and we couldn't reach lower temperature in the testing room, but in all cases, it is only about the given preset value.

Fig. 10. Arduino result

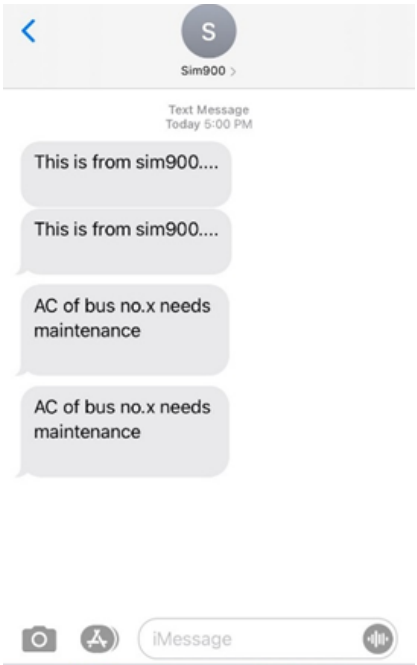

Fig. 11. SMS received by mobile phone

6. Conclusion

To conclude, in this modern world parents prefer to use AC school bus for their children relaxed travelling. In AC buses the temperature should be maintained properly for better comfort and also from the side of energy management. This paper dealt with the working of the AC controller and AC failure detector system which can be fixed with the bus AC for maintaining the optimal temperature in school buses. There are so many ideas were discussed in literature survey, but this paper presents a simple and convenient system for controlling the AC operation.

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