PELTIER RADIATOR: THE SMART HEATING/COOLING SYSTEM FOR VEHICLES WITH IOT REPORTING

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ABSTRACT

Radiators are one of the major integral parts used in vehicles, construction, and electronics to regulate heating/cooling effects. Starting from a simple car, to aircraft, radiators are the compulsory arrangements for all mechanical engines. In current time every vehicle including, car, bus, trucks, tractors, etc. use radiators to cool down their engines. Being one of the most important, Radiators are one of the most vulnerable mechanical components of vehicles too. Radiators are used in the vehicle to stabilize the excessive heat of the engine.[1] In extreme weather countries like Canada, the USA, Russia, etc. temperature is very cold which mostly freezes the distilled water in vehicles.[2] The countries like Dubai, Brazil, Egypt are very hot were present in Radiators easily boils. One another issue with the Radiators is their heavyweight, bulky design and continuous wear and tear like leaks and damage. The heavyweight gives an extra burden to the engine and reduces vehicle fuel efficiency.[3] In very cold regions engines takes additional time to start with the help of engine heating coils and in hot regions, engine temperature rises very easily. To overcome all these issues we propose automatic sensor-enabled and Peltier-operated Radiators. It can automatically switch in between hot and cold modes based on engine temperature. If it finds the engine is hot it switches to cold mode and starts to cool the engine. If it finds the engine is too cold to start, it automatically heats the engine to reach an optimum temperature to start. It is the first of its kind of hot/cold automatic smart Radiators. It is lightweight, low cost, low maintenance, and very compact. Even to repair the Radiator all parts are detachable to repair. Peltier plates are small in size and multiple pieces work together to cool and heat the system. Any damage in the Peltier-based radiator needs only the replacement of few grams of Peltier, not the whole unit. It hardly takes few minutes. This can surely help the vehicle sector get reliable, cheaper, compact, lightweight, and smart radiators soon. The system is controlled by Atmega 328 P PU Microcontroller which uses the LM-35 based temperature sensor to sense the engine cooling and heating situation in real-time. The sensor data is processed by the microcontroller to analyse the temperature value and activate the heating and cooling effect of the Peltiers. The whole data is uploaded to the cloud server using ESP8266 based IoT system. It has worldwide coverage and so unlimited reporting range

Keywords: Radiator, Peltier, Atmega 328 P PU Microcontroller, LM-35 Temperature Sensor, ESP8266, etc.
I. INTRODUCTION

Thermoelectric cooling uses the cooling effect to moderate the rising vehicular engine temperature with the help of electrical energy. Peltier is a thermoelectric semiconductor device that emits heat from one end and cools at another end when the electric charge is applied on the poles of the input connectors. The amount of cooling and heating production is directly proportional to the level of charges applied in watts. Peltier can be used as a heating or cooling device due to its efficiency, size, and cost. The major advantage of using Peltier is its immovable parts compared to conventional vapor compression refrigeration.[4] Recently Peltier is used in several applications like beverage coolers, heaters, and thermoelectric power-based toys. The main application we use here is to cool and heat the vehicle engines based on the sensor input provided by the real-time engine temperature. The temperature sensor senses the engine temperature and feeds the data to the microcontroller.

![Figure 1. Peltier Based Thermoelectric Cooling System](image)

The microcontroller analyses the data and as per the logic provided in the microcontroller program activates the Peltier cooling and heating effect. The complete information is uploaded to the cloud server for further processing, analysis, and storage. Peltiers can further subsequently reduce the complexities of conventional radiators like bulky size, wear and tear, damage, cost, repairing complexity, etc. The microcontroller used is Atmega 328P PU, and the IoT module used is ESP2866. We can use the cloud server of different IoT platforms like Cayenne or Blink to have a record of data being uploaded. This makes our system efficient against manual errors and complexities.

II. LITERATURE SURVEY

[1] Dr. I.D. Soubache et al. explained the details of using Peltier in different unconventional applications. The use of Peltier in his paper deals with the efficient usage of Peltier for sanitization of the wound as in foot ulcer. From his paper, we came to the idea that the Peltier can operate in hot/cool mode based on polarity and to mitigate the heating side there is always a need for a heat sink and cooling fans. The efficient utilization of Peltier for the cooling effect is well demonstrated in the paper. Along with the Peltier, their paper describes the proper power ratings used to provide energy to the Peltier circuitry. The block diagram and circuit diagrams are well labelled to properly explain the necessary connections. The microcontroller used is the same as our proposed system i.e. Atmega 328P PU. Vibration motors are also used to accelerate the skin repair process. Overall their paper explained the proper usage of Peltier for health science under regulated conditions. [6]
[2] Agnieszka Zelazna et al. explained the renewable energy and efficient utilization of Peltier plates as photovoltaic (PV) cell-powered, thermoelectric (TE) cooling systems. The specifically designed power calculation system efficiently measures the power production by PV cells and their corresponding usage with thermoelectric Peltier. The detailed analysis of renewable power sources their efficient contribution in reshaping the degrading condition of the earth's environment is labeled in their paper. The three-stage laboratory test is conducted to identify the heat recovery and possibility of feeding direct photovoltaic energy to the TE system. In stage 1- Initially, the thermoelectric system is powered by a PV system including a PV panel, the battery, and necessary charge controllers were also included. In stage-2 the thermoelectric Peltier is powered by the laboratory-based power supply, the supplied power is similar compared to low solar light particle condition. In stage-3 the thermoelectric system is powered directly by the photovoltaic cells, there is no inclusion of battery or solar charge controllers. The average power supplies provided to the TE Peltier system for cooling effect is found to be maximum in the case of stage-1. The cooling effect was found to be most prominent in stage-3. [7]

[3] Nandini K.K et al. in detail explained the cabinet cooling system based on Peltier plates. The heat dissipated is tried to be cooled using the thermoelectric Peltier. The heated side of the Peltier is connected to the radiator system which has water-based heat conductivity. This absorbed heat from the heated side by water is cooled down with the help of Peltier from its cooling side. The liquid-based heat sinks are found to be 4-6 times more efficient than normal aluminum-based heat dissipation conventional systems. The LM-35 based temperature sensor is used to measure the temperature of the cabinet. The voltage provided to the Peltier is controlled by the microcontroller that adjusts the voltage based on the temperature of the cabinet. The experiment was conducted with different temperature values and results were analyzed to reach the efficiency parameter of Peltier plates used for thermoelectric cooling application in the cabinet. [8]

III. OPERATION AND WORKING PRINCIPLE

In this framework, the process of Peltier based engine cooling system is to be developed. The overall framework works on the concept of thermoelectric cooling and reporting of information based on IoT. The concept mainly coordinates with the new system of vehicle engine cooling based on Peltier plates. The identification of engine temperature is performed by the LM-35 Temperature Sensor. Overall engine temperature and the cooling effect are displayed with the help of a 16X2 LCD Display unit. The overall system is powered by the car battery.

3.1 Circuit Diagram

The circuit diagram represents the overall system connection and pin configurations. The components and their assembling with a line diagram are drawn in the figure. It represents the Atmega microcontroller as the central intelligence core and thinker of logic controls. The relay connection, IoT page, display, and sensing unit is well labeled and demonstrated in the circuit diagram.
The display unit and its interfacing with Arduino Nano are mentioned with pin configuration. The reason for selecting Arduino Nano as the controller system is because of its efficiency, small form factor, and low power consumption features. The process of engine cooling, pump control through relay and temperature sensor is in detail explained in the circuit diagram.

### 3.2 Block Diagram

Block diagram represents the overall system functionality and working. The components and their schematics are drawn in the diagram. It represents the Atmega microcontroller as the brain of the overall functionality. The IoT updates on the page demonstrate the working of the reporting system as well.
3.3 Microcontroller Program
#include <LiquidCrystal.h>

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);
const int sensor=A0;
float tempc;
float tempf;
float vout;

void setup()
{
  Serial.begin(9600);
  pinMode(sensor,INPUT);
  pinMode(7, OUTPUT); // Buzzer

  // Other code...
}
pinMode(6, OUTPUT); // Relay

lcd.begin(16, 2);

lcd.setCursor(0, 0);

lcd.print("PELTIER RADIATOR");

lcd.setCursor(0, 1);

lcd.print("AN IOT SYSTEM");

delay(2000);

lcd.setCursor(0, 1);

lcd.print("TO CONTROL");

delay(1000);

lcd.setCursor(0, 1);

lcd.print("ENGINE HEATING");

delay(1000);

lcd.setCursor(0, 1);

lcd.print("AND COOLING");

delay(1000);

delay(1000);

lcd.clear();

lcd.setCursor(0, 0);

lcd.print("TEMP SENS. STATUS");

Serial.print("*");

Serial.print("PELTIER BASED ENGINE COOLING SYSTEM");

delay(2000);

Serial.print("---SYSTEM ACTIVATES---");

Serial.print("#");

}

void loop()
{

Serial.print("**");

vout=analogRead(sensor);

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vout=(vout*500)/1023;

tempc=vout; // Storing value in Degree Celsius

tempf=(vout*1.8)+32; // Converting to Fahrenheit

lcd.setCursor(0,0);
lcd.print(" Celsius = ");
Serial.println(" Celsius = ");
lcd.print(tempc);
Serial.println(tempc);
delay(2000);
lcd.setCursor(0,1);
Serial.println(" Fahrenheit= ");
lcd.print("Fahrenheit=");
lcd.print(tempf);
Serial.println(tempf);

if(tempc>=50)
{
    Serial.println("Temperature is High Cooling mode activates ");
    lcd.setCursor(0,0);
lcd.print("COOL MODE");
    lcd.setCursor(0,1);
lcd.print("ACTIVATES");
delay(2000);
digitalWrite(7,HIGH);
digitalWrite(6,HIGH);
delay(2000);
}
Serial.print("#");

3.4 Major Advantages

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- Peltier System is much compact to fit in the vehicle
- It’s cost-effective and lightweight
- It can provide more space in the engine
- IoT makes it highly efficient for the implementation

IV. DISCUSSION AND CONCLUSION

Thus we developed a system of Peltier-based radiator system which also is equipped with an IoT system to update the overall information in real-time. This is our approach to make the radiator system not only in vehicles but also in different machines. The system is highly compact and implementable in real-time. The proposed concept can be highly useful for our future innovations to work in the field to cool down medical equipment, electrical vehicles battery, space and aviation cooling needs, and a lot more. The reduction in the weight of car will make it more economical, cheaper and efficient against fuel consumption due to light weight design. The optimum cooling will also reduce the chance of any engine damage.

REFERENCES