Charging Of SmartPhone Through Self-Generated Heat

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Abstract

In this age of highly memory intense applications and increasing size of Random Access Memory (RAM), mobile Central Processing Unit (CPU) temperatures are bound to reach high values; the range can even extend up to 48 degree Celsius. In that case, it would only be logical to try and harvest that heat energy, which could help in the phone's performance by actually cooling the device down and simultaneously it can be charged through converting this heat energy into electrical energy. When mobile phones are being charged by motion as well, heat should not be left behind because it is one of the most thermodynamically underappreciated sources of energy. In this paper, a Peltier Module has been used to capture heat from the CPU or the surroundings to generate a voltage that will supply power to the battery. The advantages of this method includes that a phone can be charged at anyplacewhere no power source is available. The only disadvantage in this method would be a low efficiency, because heat itself is of very low quality energy source.

Keywords: Boost Circuit, CPU, Efficiency, Heat Energy, Peltier Module, Seebeck Effect

1. Introduction

According to market researcher Gartner [1] over 1.5 billion smartphones were sold in 2017 and 1.3 billion of them being Android devices. As is inferable, smartphones are available with everyone in the 21st century, and with it, everyone is accompanied by the common problems of possessing a smartphone, the most important issue being charging. While storage issues are not a concern anymore, even for the Random Access Memory, most of these phones acquire a high temperature while running exhaustively in daily use applications, and this heat can be converted to electricity using a new module, using the principle of Seebeck effect and boost circuit. Power banks / Portable Chargers usually get rendered useless because of lack of charge in them. Heat energy is one of the most thermodynamically wasted forms of energy as it cannot get converted into any useful energy form by easy means. With global warming and progressively higher availability of heat dissipating resources around a person, the idea of charging a mobile through this widely available heat energy seems welcome. The method can be used for heated car engines, windowpanes, and even the mobile itself, if need be. This means that power can be generated no matter where a person is. This idea can be extended to areas where tremendous heat energy goes to waste, for example, charging car batteries through heat energy generated by the engine surface with an efficient module. This recycling of heat energy shall reduce dependence on electricity and power in general, which shall contribute to environmental causes as well. For an overall welfare of the consumer, and the surroundings, this idea was taken up

2. Methodology

The work process began with the aim of finding out the average heat energies generated by popular brands of smartphones. All the staple smartphone activities like gaming, calling, etc. were carried out and the phones rested to room temperature before starting the next activity. Six types of smart phones and their heat data at various operating condition has been taken using an laser point thermometer in Indian standard room temperature (around 30 degrees Celsius) which has been shown in table 1:

Table 1. Temperature Data of 6 smartphones

Phone	**Indoor**			**Outdoor**		
Type	**Calls**	**Videos**	**Gaming**	**Charging**	**Calls**	**Videos**
Type 1	36	49	40	40	37	48.3
Type 2	36	51	40	34	39	51
Type 3	33	44	36	37	36	45
Type 4	34	41	41	38	40	46
Type 5	33	41	37	36	36	44
Type 6	33	39	40	37	40	43

The Peltier module will be attached to two aluminum bars that will act as conductors and the heat from the device will be transmitted to the Peltier module. The output will be passed through a boost circuit that will amplify the voltage. The generated electricity is made available at the output of a charging module that will connect to the charging jack of phone.

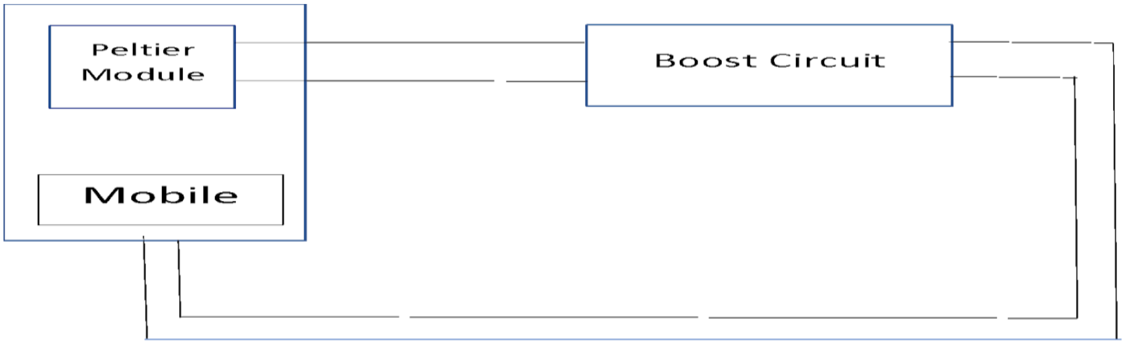

FIG 1. A Basic Diagram of the Proposed Module

3. Working Principle of Peltier Module

When the heat is being transferred to the Peltier module through aluminum bars, it produces some voltage due to Seebeck effect. The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference across the conductors. It is observed that with hot water and ice cold water, the voltage provided by the Peltier Module was around 850 millivolts (Vs), and current was around 140 mill amperes. These outputs were too insignificant compared to the requirements of charging a smartphone. Thus a boost circuit was used.

4. Working Principle of Boost Converters [3]

A Boost converter as shown in Fig 1.consists of DC voltage source (V_s), boost inductor (L) controlled switch (S), diode (D), filter capacitor (C), and load resistance (R), and the output voltage is considered V_O , input voltage as V_S. Voltage across inductor and capacitor is V_l and V_C respectively. We will discuss both on-state and off-state of the Boost Convetrers.

4.1 On-State

When switch S is closed (see fig. 2), capacitor energy supplies the load voltage (if capacitor is charged) $V_0 = V_c$. During on state, voltage across inductor instantly becomes equal to input supply voltage. Current through it increases gradually and stores energy in its magnetic field. For the very first time, when S is closed $V_o = 0$, as capacitor is not charged.

4.2 Off-State

When S is off, inductor voltage reverses its polarity and adds in input voltage to provide output voltage which is equal to: $V_o = V_S + V_l$. During off state, capacitor charges and voltage at it gradually build up to ($V_S + V_l$). This capacitor voltage serves as load voltage when next time S is on. If S is off forever, inductor acts as short circuit. It does not develop any voltage and $V_O = V_S$.

The working formula that we have used here is given as $V_O/V_S = 1/(1-\alpha)$. We have considered $V_O = 5V$,

V_S = 850 mV and putting the above values, we have calculated the value of α which comes as 0.83(approximately), where α is the duty cycle.

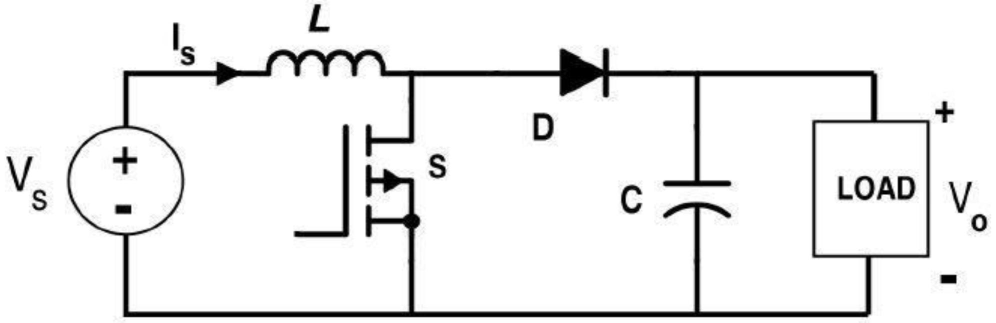

FIG 2. A Typical Boost Circuit

5. Results & Discussions

The experiment was done using a standard smartphone and a Peltier module. The temperature differences and voltages generated corresponding to them has been plotted, a relation between them has been found using curve fitting technology using MATLAB. Here two cases have been considered. The reason is it is being observed that the generated voltage tends to saturate after a certain value of temperature difference. So in the first case normal Peltier module is used, but in the second case some cooling arrangement isdone so that the temperature difference remains fixed to an optimum value.

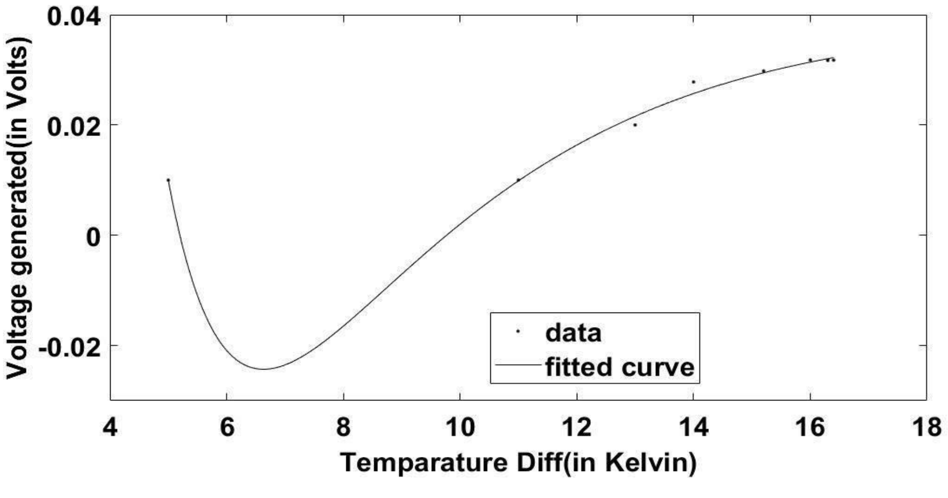

FIG 4. Voltage generated from Peltier module using cooler

General model Rat23:

$$f(x) = \frac{(\mathrm{P}_1\mathrm{x}^2 + \mathrm{P}_2\mathrm{x} + \mathrm{P}_3)}{(\mathrm{x}^3 + \mathrm{q}_1\mathrm{x}^2 + \mathrm{q}_3)}$$

Coefficients (with 95% confidence bounds):

$p_1 =$ 1.895 (-484.5, 488.3)

$p_2 =$ -28.35 (-7764, 7707)

$p_3 =$ 96.19 (-2.937 e^4, 2.956 e^4)

$q_1 =$ -1.14 (-1.106 e^4,1.106 e^4)

$q_2 =$ 15.91 (-1.717 e^5, 1.717 e^5)

$q_3 =$ 2.191 (-8.773 e^5,8.773 e^5)

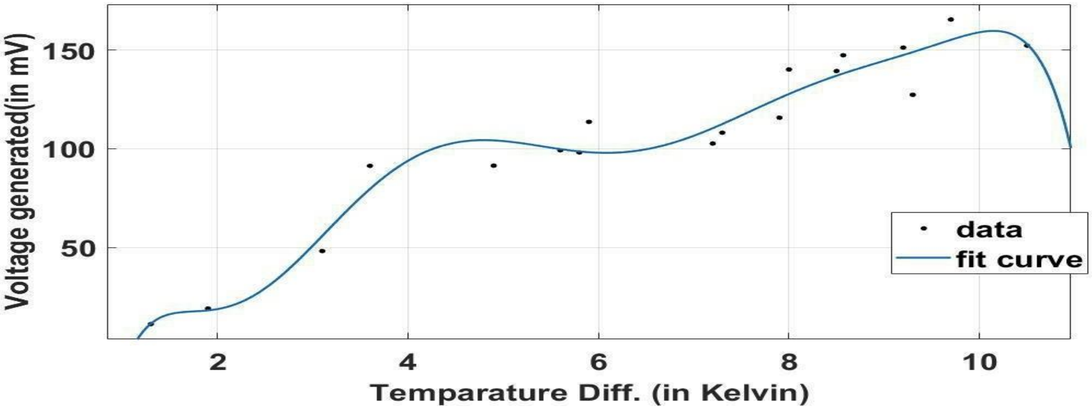

FIG 4. Voltage generated from Peltier module using cooler

Linear model Poly 8:

$$f(x) = p_1x^8 + p_2x^7 + p_3x^6 + p_4x^5 + p_5x^4 + p_6x^3 + p_7x^2 + p_8x + p_9$$

Coefficients (with 95% confidence bounds):

$p_1 =$ -0.002624 (-0.01178, 0.006535)

$p_2 =$ 0.1274 (-0.3072, 0.562)

$p_3 =$ -2.582 (-11.23, 6.071)

$p_4 =$ 28.24 (-65.56, 122)

$p_5 =$ -179.9 (-780.6, 420.8)

$p_6 =$ 672.7 (-1631, 2977)

$p_7 =$ -1418 (-6532, 3697)

$p_8 =$ 1546 (-4398, 7491)

$p_9 =$ -660.3 (-3411, 2090)

It has been observed that the voltage drops to a negative slope during this experiment. The voltage was amplified to 5V, however, the current could not be amplified and remained as 0.1A. Works are being done so that a capacitor can be placed in front of the boost circuit to allow current to amplify. Thus, low efficiency remains the only drawback of this research.

Conclusion

In spite of a low efficiency at this stage, this module can be used to charge phones in case of any emergency, and even car batteries at a larger scale, is possible. Even if the phone does not heat up sufficiently, the module can be placed on any hot surface to function properly, for example, the upper portion of a working microwave oven, etc., thus trapping heat and converting it into something useful instead of wasting it. This research also allows us to utilize such a module to charge car batteries using the huge amount of heat energy that is emitted from the car engine. The current problem can be solved by using a standard Li-Po battery but that approach has been refrained from in this proposition.

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