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SOLAR ENERGY POWERED MOBILE CHARGING STATION USING BISMUTH TELLURIDE-BASED THERMOELECTRIC GENERATOR

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Abstract - *This paper mainly presents the design, implementation, and simulation of solar powered mobile charging station using a bismuth telluride-based thermoelectric generator. Thermoelectric power generation is a promising alternative technology for the electricity generation in the future because of no moving or mechanical parts, low costs or their long lifespan. Since there is an excessive concentration of heat on building roofs, this application of Thermoelectric Generators for mobile charging stations on any public sector places is feasible. On meeting the increased demand for mobile charging units in public sector places, we come forward with the solution of the low-cost generation of renewable source of energy for mobile charging units.*

***Key Words*: Low Cost, Mobile charging station, solar energy, thermoelectric generator.**

1. INTRODUCTION

The demand for electrical energy in public places leads us to find better solutions to provide electrical energy for various commercial applications, which until now are powered by Electricity Board (EB) supply. Our approach focuses on the direct conversion of heat energy, available in abundance, to electrical energy by utilizing a small amount of solar heat with the help of Bismuth Telluride-based thermoelectric generators (TEGs). Various researchers suggested the different types of TEGs design according to the heat flow through the device and the layout of Thermocouples. In lateral/lateral type the heat flow is lateral and the thermocouple layer is also lateral. In vertical/lateral type the heat flow is vertical and the thermocouple layer is lateral. In vertical/vertical type the heat flow is vertical and the thermocouple layer is also vertical. Thermal contact to heat source and sink is improved with a vertical design. This is because of the increased contact surface area. This increases the temperature gradient at the junction between the cold and hot side. Since the output voltage is proportional to the temperature difference, voltage output increases and is considered for our application [1].

The output voltage is proportional to the temperature difference between the cold and hot junction. The material selection is also an important factor to increase the performance of the thermoelectric generator. The performance of the TEG mainly depends on its electrical and thermal conductivity. For the performance to be relatively high its thermal conductivity should be less and the electrical conductivity should be high. Power output highly depends on the availability of heat.

Here in our project, Bismuth Telluride thermoelectric generator is used for generation purposes.

Figure 1 Bi_2Te_3 Thermoelectric generator

II. METHODS

The Bi_2Te_3 based TEG with heat dissipater at the cold side is fixed on the rooftop of the buildings in public sector places. Then six thermoelectric modules are connected in series and parallel which harvest a sufficient amount of energy for charging a 12V battery. The charge stored in the battery can be used for mobile charging applications. Here the mobile charging station is based on the paid method, in which the user can insert a coin and charge a mobile for a fixed period of time.

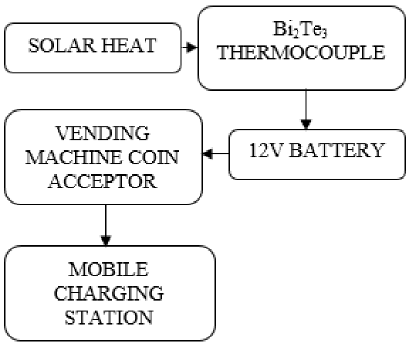

Figure 2 Block Diagram for the Solar Powered Paid Mobile Charging Station.

A. Vending Machine Coin Acceptor

Vending machine coin acceptor used in mobile charging station enables the people who are in need of charging mobiles in public places by inserting coins. This machine enables to recognize six groups of coins in different denominations. (Can exceed to eight groups if needed). It enables to forbid accepting all coins.

Coin Size:

Diameter: 17 - 30.5mm

Thickness: 1.25 – 3.2mm

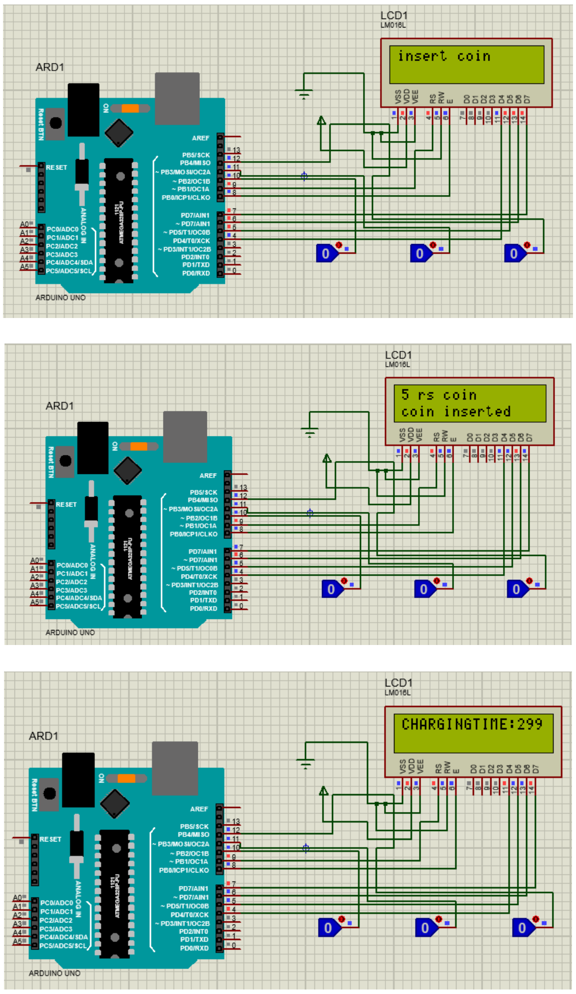

Figure 3 Proteus Simulation of Vending Machine Coin Acceptor

B. Microcontroller

The microcontroller unit used in vending machine coin acceptor is the Arduino Uno R3 as shown in figure 4, which is interfaced with the LCD (LM016L) and passive infrared (PIR) sensor. The Arduino has ATMEL Atmega328P is an 8-bit microcontroller with 32KB flash memory and speed of 16MHz. The Arduino is selected because it simplifies the process of working with microcontrollers and relatively less expensive compared to other microcontrollers.

Figure 4 Arduino Uno R3

C. Liquid-Crystal Display (LM016L)

Commonly used Character based LCDs in the coin-operated machine is manufactured with Hitachi's HD44780 controller. The most commonly used LCDs found in the market are One-Line, Two-Line or Four-Line LCDs which have only one controller and support nearly 80 characters, whereas LCDs which support more than 80 characters uses two HD44780 controllers.

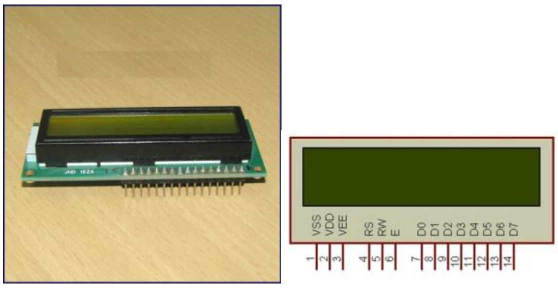

Figure 5 LM016L

D. Passive Infrared (PIR) Sensor

Commonly coin-operated machine uses passive infrared (PIR) sensors, which not like optical sensors that use an LED transmitter and an infrared receiver and does not emit anything. Rather than radiating, the passive infrared sensor responds to infrared energy emitted by any nearby objects. Any object with a temperature above 0°C emits infrared energy, through black-body radiation. The magnitude of this radiation varies with temperature invisible to the human eyes, which is what actually makes the PIR work.

Figure 6 Passive Infrared (PIR) Sensor

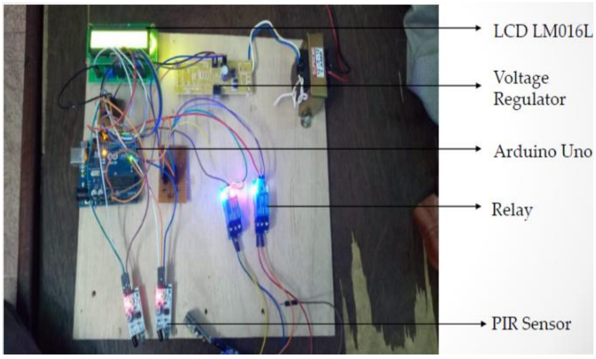

Figure 7 Circuit for Vending Machine Coin Acceptor

The PIR sensor initially responds to the coin been inserted and trips the respective relay as programmed in Arduino Uno. Once the relay is tripped the LCD starts its timer for the specific period of time as it is programmed and charge the mobile through 5V USB DIY converter. The energy generated with bismuth telluride thermocouple is given as the source to this circuit.

III. RESULT AND DISCUSSION

In this system, we are going to interface two technologies as below

- Harvesting Solar Energy using Bi_2Te_3 based Thermocouple.
- The Smart Coin based Mobile Charging Station with Automatic Coin Acceptor Vending Machine.

Energy harvesting using Thermoelectric-generator is eco-friendly in nature which converts the waste heat into a useful form of energy at low generation cost. It is a reliable source of energy and the device can be applied to any size heat source from the water heater to manufacturing equipment.

Smart coin-operated mobile charging system which charges the mobile phone for a fixed amount of time on inserting a coin. The system is to be used in public places like railway stations and bus stands to provide a continuous mobile charging facility. So the system which has a coin recognition module that recognizes valid coins and then gives the signal to the microcontroller for further action. If a valid coin is recognized, it gives the signal to the microcontroller and then the microcontroller starts the mobile charging mechanism by providing a 5V supply through a power supply section to the mobile phone, now the system needs to be monitored for the amount of charging to be provided. So the microcontroller starts with a reverse countdown timer and displays the charging time for that mobile phone. Now if the person inserts another coin in that time, the microcontroller is programmed such that it adds the time to currently remaining charging time and again starts with the reverse countdown, displaying the charging time. So this set-up can be used in any public places for mobile charging.

IV. CONCLUSION

In this work, the design, implementation and simulation of solar powered mobile charging station using Bi_2Te_3 based thermoelectric generator is proposed. The recent research and development pave a good pathway for reaching more efficient and cheap thermoelectric devices, which can be used in all domestic and commercial applications in upcoming years or decades.

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