ICY BAG WITH SOLAR

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***Abstract*— Refrigerator is a home necessary that used to conserve the quality of food products. The quality of food products were depends on temperature and air distribution inside the compartment to keep the freshness of the food. Presently, most of the refrigerators that available in marketplace are powered by electricity. This will become problem to people to use refrigerator for outdoor activities such as camping and medical purpose for instance to deliver medical to village. Because of this limitation, this project introduces a portable refrigerator in convenient design which is bag pack and powered by solar system using Bluetooth application. The system of refrigerator is utilizing a thermoelectric device that use temperature gradient and create an electric voltage, which can be used to heat or cool an object. The solar power generated from the sun for energy supply so, this project do not need to use electricity for charging the battery. Additionally, with Bluetooth application that make user can control the temperature from a distance.**

***Keywords*— thermoelectric, peltier device, solar powered Arduino, Bluetooth**

I. INTRODUCTION

Recently the foremost environmental concerned regarding on conservative refrigerator technologies in term of involvement to ozone layer depletion and global warming. Normal refrigerators which contain ozone depleting and global warming material such as chlorofluorocarbons (CFCs) [1] will be the most harmful to our nature. Another substance is hydrochlorofluorocarbons (HCFCs) [1] that also give bad impact to our environment. Both are environmentally long-suffering as global warming chemicals. The use of solar energy refrigerator can minimize the harmful impact refrigerators on the atmosphere. Refrigerators existing in the market have been designed in assorted sizes and different purposes but it is limited for indoor handling since it large and powered by electricity. In this project, we draw attention to on designing and produce a small solar powered refrigerator in form of bag pack with Bluetooth application. This design can be very convenient and useful solicitation especially in outdoor activities such as picnic and camping. It also can help doctor to deliver the medicine at the village or rural area.

Solar power is an energy that is obtain from the sun and converted into electricity [2]. It is a flexible source of renewable energy that can be used in various applications such as in providing power for the whole lot things from cars [2] and boats to houses [2] and spacecraft [3]. This solar power is also clean and pollution-free. Energy from this sun was converted into solar power using solar panels. It is consist of solar cells that were designed to capture light from the sun [2]. In this project, we use photovoltaic cells (PV) in converting energy from the sun into electricity. These photovoltaic cells are regard as low maintenance and suited to inaccessible applications [3]. It is use semiconductor material like silicon to transform energy from the sun into electricity. The light energy that captured from the Sun can be converted into electrical energy and used immediately or stored in batteries [3].

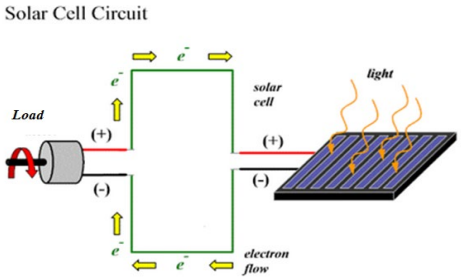

Fig. 1: Energy changes from one form to another

These projects also apply the thermoelectric effect [4] in give cold surroundings which it is the straight conversion of temperature differences to electric voltage and otherwise. The fundamental idea behind this thermoelectric technology is the Peltier effect. This Peltier effect happen when electrical current flows throughout two different conductors and it will depend on the route of current flow while the junction of these two conductors will either absorb or release heat [4-5]. The Peltier effect is utilize to rapidly cool and heat a block of metal in polymerase chain reaction machines also to cool down the central processing units in computers and in many other applications[5]. It has numerous advantages [6]:

- Small size and weight
- Ability to cool below 0 “C
- Ability to cool and heat with the same device
- Precise temperature control
- High reliability
- Electrically quiet operation
- Convenient power supply
- Environmentally friendly

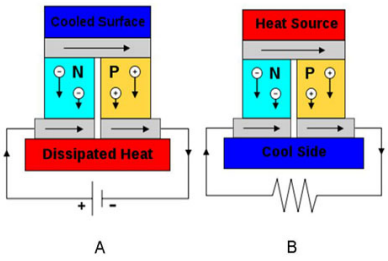

Fig. 2: Peltier device consist of n-type and p-type semiconductors

In this Peltier cooler, it is use solid-state components that consist of n-type and p-type semiconductors. Figure 2 shows how Peltier devices work as a cooler when a voltage is applied in panel A and as a voltage source when a temperature gradient is applied in panel B [7]. This effect can be apply to produce electricity, determine temperature or change the temperature of certain matter. Because of this direction in heating or cooling temperature were determined by the polarity of the applied voltage, this thermoelectric devices are efficient in temperature controllers [7-8].

The Peltier modules have been used for medical devices [5], for Sensor technology [6], for cooling chips and devices[6], for automotive applications[5] and for military applications [9]. Their application for thermoregulation of an inner chamber is not new refrigerant in both liquid and vapour form neither. However, this project is intended to proposed new idea in portable refrigerator using solar powered Arduino and user can control it using Bluetooth application.

II. DESIGN AND ASSEMBLY

The objective of this project is to design and developed a portable solar power refrigerator prototype with solar panel and user can control it using Bluetooth application for storage food when doing outdoor activities and medicine intention. To make this dream become reality, there are few steps that required during this project.

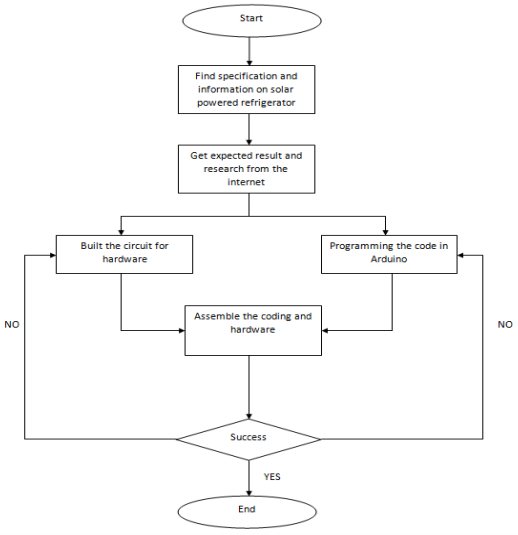

Fig. 3: Flowchart on making Icy Bag with Solar

A. Circuit Designing

In the beginning, we must understand the configuration of each component especially Arduino Microcontroller, Peltier device and Bluetooth module. As shown in Figure 4, Peltier device were main component that act as cooler for this bag and were control by user whether use potentiometer or Bluetooth application in Android to operate and control the temperature of this bag. The LCD display will show how many battery left and present temperature. Meanwhile, the temperature sensor will detect the temperature inside the bag and send the data to the Arduino and show it at LCD display. All this circuit construction was power up using solar panel and lithium battery to make this circuit work properly.

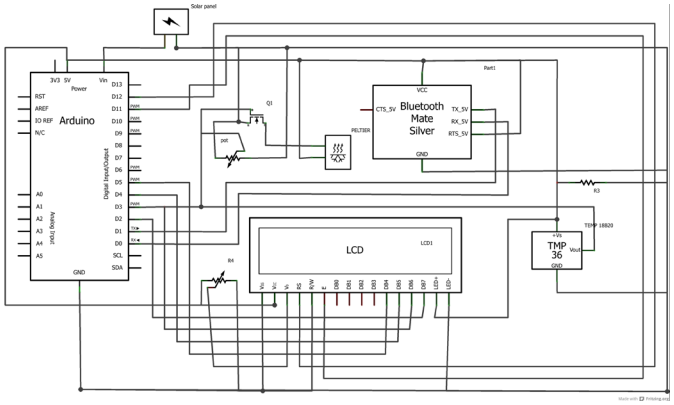

Fig. 4: Circuit Schematic

B. Hardware Implementation

When the circuit design is done, the entire component were assembly on the breadboard to check functionality and make sure the circuit is work properly before soldering on the Veroboard. Figure 5 below show one of the parts in completing this project which is using Bluetooth application for android to send instruction to Arduino and adjust the temperature.

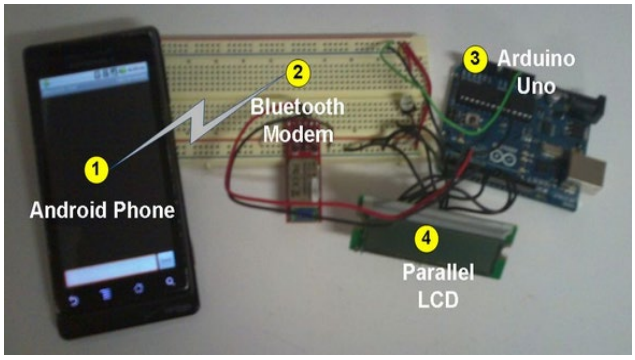

Fig. 5: Bluetooth Assembly module

C. Code Development

This part is very important because the instruction from Arduino Software will be read by Arduino microcontroller and each component will act accordingly.

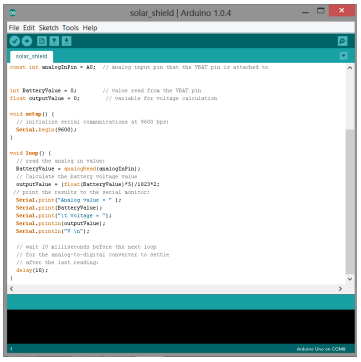

Fig. 6: Arduino Software Interface

D. *Troubleshooting*

It was carried out through the implementation of this project and makes sure all the connections is correct and get the desired output. After the software has been embedded with the hardware, more troubleshooting needed to be done to make sure the project run according to plan.

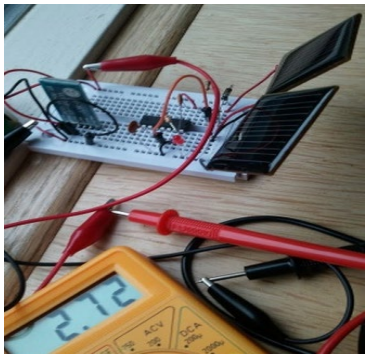

Fig. 7: Voltage Measurement in Solar Panel

III. RESULT AND DISCUSSION

From this project, we can obtain several measurement that show how internally this component interact with each other and comply with objective to design portable mini refrigerator with solar and Bluetooth application.

A. *Result on Peltier Device*

The Figure 8 below show graph on how many current needed for every 5 ‘C temperature increase. From here we can see that it takes around 0.1A to take every change in 5’C temperature. This shows that our device do not need high current to operate the cooler device and make it friendlier user. In this project, we limit the range value of Peltier device around 0’C until 50’C so it will not harmful to the user and the design package too. Meanwhile, in Figure 9 show graph on how many Temperature ‘C take times in second to change from different value. As starting, the Peltier device takes time about 15 second to get initial value of temperature which is 0’C. Here we can say that when the temperature is increasing and the value is high. It will take more time to reach that value example to get 45’c it takes 14 second from previous value.

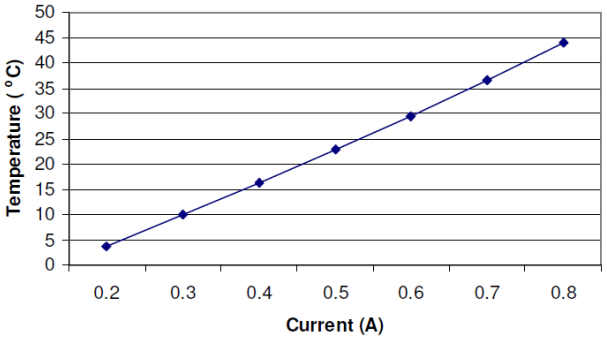

Fig. 8: Graph Temperature vs Current

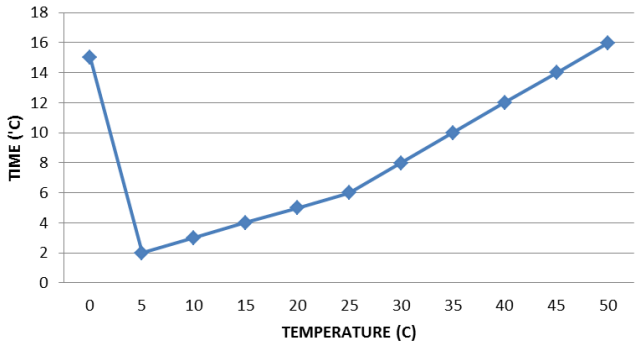

Fig. 9: Graph Temperature vs time

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Minutes,TempC,CoolingPercentage,CoolerState
0,15.6,100,1
1,15.8,100,1
2,15.4,100,1
3,16.0,100,1
4,14.5,100,1
5,14.8,100,1
6,15.5,100,1
7,15.0,100,1
8,15.7,100,1
9,16.2,100,1
10,16.0,100,1
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Fig. 9: Serial Monitor on Peltier reading

Figure 9 above show the data that get from serial monitor in Arduino software. It shows the temperature in ‘C of the Peltier device in 10 minutes. Cooling percentage is cooling duty cycle over last minute and cooler state is range 1 until 4 that mean 1 is in cool state.

B. *LCD Display*

The Figure 10 below show the temperature inside the bag that was detected by temperature sensor. It will make user know how cool is the temperature inside the bag and also user can see the changing temperature when user adjust it.

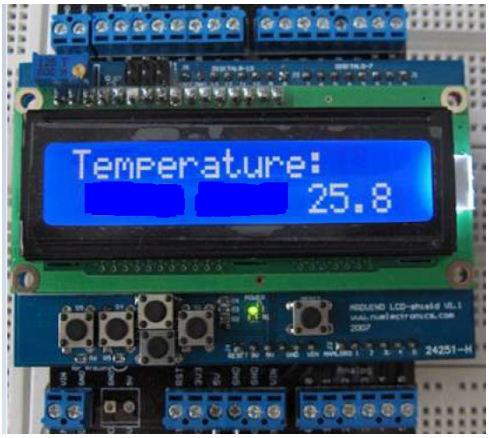

Fig. 10: LCD display

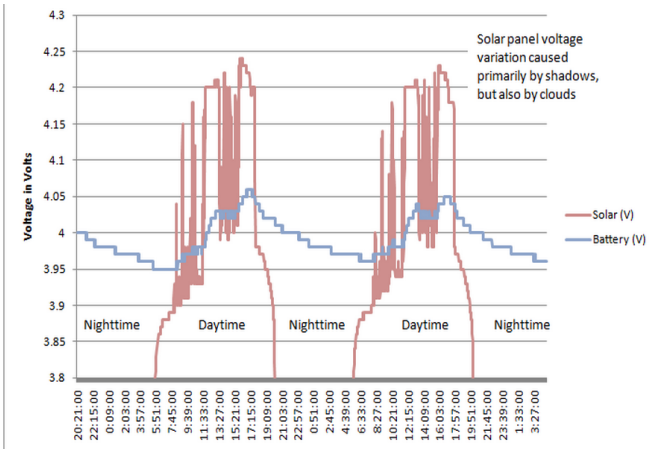

Fig. 12: Graph Solar Panel charging lithium battery

C. *Result on Solar Panel*

The measurement on solar panel is to know the output current and voltage that delivered to the Arduino. The method of measuring the power output of a solar panel is to connect resistors of various values to the panel and measure the voltage. The measurements can be used to calculate the power output also to plot the power output and create a performance graph for the panel.

TABLE 1: MEASUREMENT ON SOLAR PANEL

Resistance (Ω)	Voltage (v)	Current (A)	Power (W)
Open Circuit	4.5	0	0
100	4	0.58	2.32
50	3.7	1.08	3.9
25	3.1	1.80	5.58
3	2.5	2.15	5.37
Short circuit	0	2.20	0

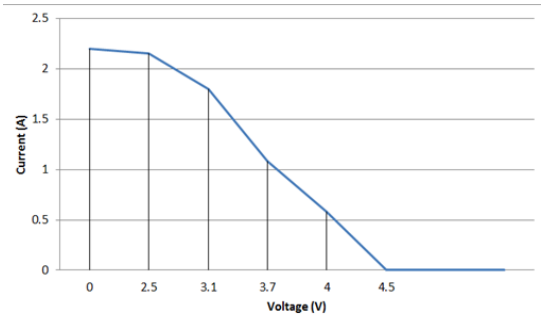

Fig. 11: Graph on Solar Panel Output

Here is a table 1 that show data from a set of measurement on solar panels. In this example power resistors of 100, 50, 25 and 3 ohms were used. The power is calculated by multiplying the voltage times the current. From here we can see that no power is generated when the open circuit voltage and short circuit current is measured. A more intuitive view of the data can be gained by plotting a graph of the voltage versus current as shown in Figure 11.

The Figure 12 shows the graph on voltage of the battery lithium pack and the solar panel for three nights and two days. During the night, the battery voltage drops from a high of 4.05 V to a low of 3.95 V due to powering the device and self-discharge. During the day, the solar panel voltage fluctuates between 3.9 V at this time the battery pack supplies power to the device and 4.25 V when this time the solar panel both powers the device and recharges the battery pack. However, sometimes, due to shadows or clouds, the battery pack seamlessly takes over powering the device.

Because the shape of the solar panel voltage appears similar for each day, it is likely that shadows of nearby fixed objects are the primary cause of solar panel voltage droops during this experiment. This shows that the circuit allows the solar panel to continue to supply power even without the batteries. The effect of light shadows and clouds did not impact device operation, since the solar panel still had enough capacity now that it didn't have to recharge the batteries.

D. *Result on Bluetooth Application*

The advantage of this project is the user can control this bag from distance whether to on or adjust the value of temperature. The wide range is about 5 until 10 meter from the bag and hand phone user. Figure 13 show the interface on the Android phone that need user insert the command 1 to switch on the bag and 0 to switch off. Meanwhile, figure 14 show the serial monitor on Bluetooth in the Arduino software. It is show the serial ID name of the phone and the speed of data byte that sends to the Arduino itself.

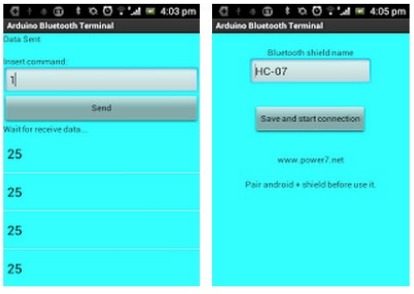

Fig. 13: Bluetooth Interface in Android

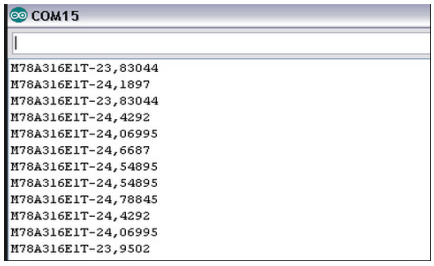

Fig. 14: Bluetooth serial monitor on Arduino software

E. Result on Temperature sensor

The sensor that use in this project was DS18B20. This temperature sensor were used to detect the temperature inside the bag and send the data to the Arduino microcontroller then show the value to the LCD display for the user information. Figure 15 below show the serial monitor on Arduino software how the data in temperature sensor were processed and the output value were matched on LCD display. The temperature reading was come from the Peltier device that can act as cooler with the thermoelectric principle.

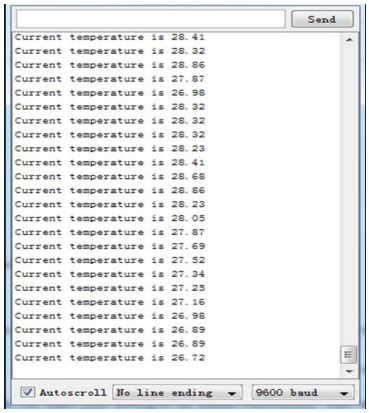

Fig. 15: Temperature sensor serial monitor on Arduino software

IV. CONCLUSIONS

This project has achieved the main objective whereby to design and create portable mini refrigerator using Arduino and powered up by solar energy with Bluetooth application for android. It is convenient and green environment within the technology and it can improve human daily life in term of conserve food quality in small compartment without worrying the electricity source. Besides that, this portable refrigerator are convenient and saving our mother nature by using the renewable energy, solar energy as electricity power that stores the energy in battery to use in this small refrigerator. It is also green technology that did not produce harmful gasses like CFC into atmosphere. Within the market demand, it is an expectations product from the community because of the useful and convenient applications. In the future, this project can make more improvement in term of weight in this product and consider the air ventilation inside the bag. All the difficulty and challenging that occur during this project were overcome it properly. This project is to proposed new idea in improvement of human life and saving mother earth. So, it can be enhance in new level that can be more productive.

V. ACKNOWLEDGEMENT

I take immense pleasure in thanking towards my parents and my supervisor, Dr Fuziah Sulaiman for their kind co-operation and encouragement which help me in completion of this project. I would like to express my special gratitude and thanks Faculty of Electrical Engineering, UiTM for giving me this opportunity and give permission to use faculty's facility. My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

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