Design and Implementation of Solar Powered Wireless Mobile Phone Battery Charger Using Electromagnetic Induction

Rahil Imtiyaz [1], Aman Kumar [1], Gitanjali Mehta[1]

[1]*School of Electrical, Electronics and Communication Engineering, Galgotias University, Greater Noida, India.*

Corresponding Author: rahil8797@gmail.com

Abstract: - Wireless charging is a type of charging strategy which utilizes an electromagnetic field to move power through electromagnetic induction. The power is transferred wirelessly between two devices called transmitter and receiver through the process of mutual inductance. Energy taken from solar is converted to AC and supplied as an input to transmitter coil and the second part called receiver coil receives the power wirelessly, further it passes the energy to the battery. As power is transferred wirelessly the efficiency is 11% only that is very less. In future the efficiency will overcome. With the help of wireless charging innovation. Power can be transferred to electric cars, commercial equipment. This innovation also helps to reduce the use of wires in future.

Key Words: —*Wireless Charging, Mutual Inductance, Transmitter, Receiver.*

I. INTRODUCTION

Solar energy is very efficient, eco-friendly power source of energy and also a type of renewable source of energy. Solar panels are made up of photo voltaic cells that are used to convert the sun light energy into electrical energy [1]-[3]. The solar system can be used in various places like domestic purpose, schools, colleges this helps to reduce the generation of electricity from non-renewable source of energy, and also helps to reduce pollution and use of coal for generation of electricity [4]-[6]. So, in this innovation solar power is used as a source of electricity for charging the mobile battery.

Wireless charging is a developing innovation now a days. It is also called as wireless power transfer. In this power is passed to the battery without connecting any wire. Samsung has introduced wireless charging in galaxy S6 in 2015. This emerging technology is also called as inductive charging [7]-[10]. It replaces the requirement of cable for charging. It decreases the wear & tear of hardware ports. Comparison of wireless charging to wired charging as given below:

- Different mobile will be charged in a single charging pad as no requirement of cables and different types charging pin.
- Reliable, durability, water proofing technology and dust proof.

Manuscript revised May 28, 2021; accepted May 29, 2021.
Date of publication May 30, 2021.
This paper available online at www.ijprse.com
ISSN (Online): 2582-7898

- It does not have any radiation effects.

Wireless charging innovation is progressively progressing towards two significant directions, i.e., radiation wireless charging or radio frequency (RF) type wireless charging and inductive charging. Radiative wireless charging embraces electromagnetic waves, by and large microwaves and RF waves are utilized to convey energy in a type of radiation. Inductive charging depends on mutual induction idea where magnetic field couples between two loops. Likewise, the magnetic field of an electromagnetic wave weakens a lot quicker than the electric field thus the power transfer distance is generally restricted. So, for the safety purpose inductive charging is used in today's life [9]-[12].

II. LITERATURE REVIEW

The discovery of wireless power transmission was made by Faraday. He was researching about the conduction of current in the wire. When current goes through a wire then another wire which is near to that wire will take some current in it. But is should be placed near to the current carrying wire. In the publication of Journal Science in 2007, MIT group tentatively demonstrated inductive coupling. Understanding their ongoing hypothetical expectation, the group was able to turn on the light bulb of 60W from a power source which was 2.1 meters away, no physical association existed between the source and the light. The MIT group alluded their idea as "WiTricity. From the above experiment, it was proved that power can be transmitted wirelessly for a distance of 2.1 meters. But the worst thing was efficiency. The efficiency of the system was only 40%. The

amount of energy wasted was 60% which is likely very huge. Work is going on and the efficiency has been improved [7]-[12].

III. PROPOSED SYSTEM

Fig.1. shows the block diagram of the proposed system. As already discussed, the basic concept of this proposed system that is transmitting power wirelessly without any physical connection of wires with the help of inductive coupling. The system is designed in two parts that is transmitter side and the one is receiver side and it also contains solar system that gives DC power supply to the system for charging of battery. Then further the battery passes DC supply to 555 timer and it converts the DC current into Alternative current. The wireless power transfer is dependent on mutual inductance between the transmitter and receiver loops of current carrying conductor which gains magnetic field. The alternative current converted by 555 timer is passed to transmitter and with the help of mutual inductance the AC current is received by the receiver and converted back to DC with the help of bridge rectifier the output of the bridge rectifier is unregulated direct current then it is regulated by a voltage controller. The voltage controller gives the constant voltage and that output voltage is utilized to charge the battery of low power gadgets like portable iPod, smartphone etc.

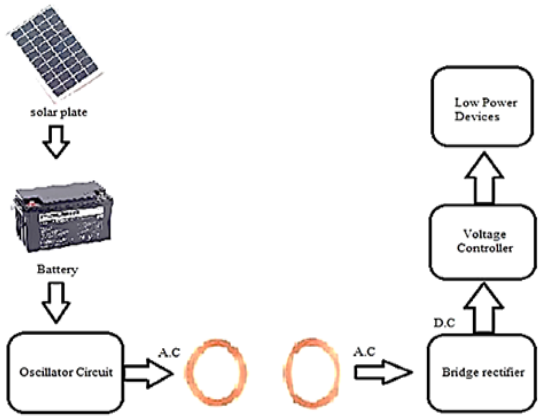

Fig.1. Block Diagram of solar based wireless mobile charger

A. Solar Plate

Solar plates are devices that convert light into power. The most remarkable source of light accessible is the Sun, called Sol by cosmologists. A few researchers call them photovoltaics which implies, essentially, "light -power." A solar panel is an assortment of solar cells. Heaps of little solar based cells spread over an enormous region can cooperate to give enough capacity of electricity to be helpful. The more light that hits a cell, the greater power it produces, so shuttle are generally planned with solar panels that can generally be pointed at the Sun even as the remainder of the body of the spacecraft moves around.

Recently, scientists have created ultrathin, adaptable solar cells that are just 1.3 microns thick around 1/100th the width of a human hair and are multiple times lighter than a sheet of printing paper. Actually, the cells are light to such an extent that they can sit on the head of a cleanser bubble, but they produce energy with probably as much effectiveness as glass-based solar cells, researchers revealed in an investigation published in 2016 in the Journal Organic Electronics. Lighter, more adaptable solar cells, for example, these could be coordinated into engineering, aviation innovation, or even wearable hardware [8]-[12].

B. Battery

Lithium-ion batteries have developed to turn into the most well-known method for solar storage, and are quickly developing and getting more moderate as electric vehicle organizations like Tesla lead their proceeded with advancement and improvement. As a more modest, sleeker, and longer-enduring choice, lithium-ion batteries are an incredible alternative for solar energy storage, however they do accompany a more exorbitant cost tag contrasted with lead-corrosive batteries.

Lithium-ion batteries offer a lot higher DoD over lead-acid batteries (about 80% - 90%), which means you can utilize a greater amount of the battery's charge to control your loads. They likewise have an any longer battery life, which means it will last longer than a lead-acid battery, which can help counterbalance the underlying expense.

C. Transmitter

Transmitter circuit as shown in Fig. 3 fundamentally comprises of an astable multivibrator, power resistor, and inductor. The generated DC voltage from the solar plate is changed over into AC voltage, utilizing an astable multivibrator. Astable multivibrator circuit is constructed utilizing the IC 555 timer, it is a plain oscillator circuit that produces continuous square wave pulses. The circuit frequency can be changed by changing the resistor and capacitor values. The purpose behind utilizing IC 555 is that it is modest, stable & user friendly.

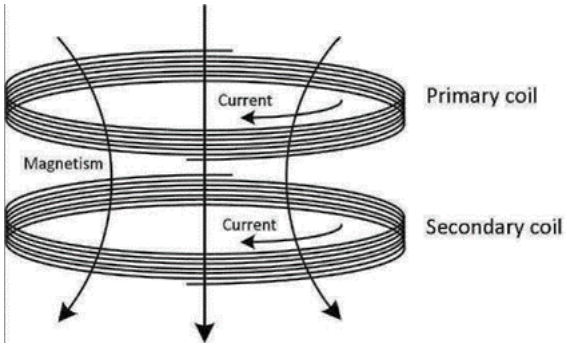

Fig. 2. Inductive Coupling

D. Power Resistor

Power resistors are utilized in electronics to disperse energy by controlling current stream and voltage. The power rating of a resistor characterizes how much power a resistor can securely deal with before it starts to endure perpetual harm. A resistor utilized in electric power system, going in size from 5 watts to numerous kilowatts and cooled via air convection, air impact, or water. Four diodes of bridge rectifier is connected with a voltage controller for controlling the uncontrolled DC voltage and further after voltage controller it directly goes to the mobile charging pin/socket.

E. Voltage Controller

The main purpose of voltage controller is to give constant voltage from the un-controlled voltage. IC LM7805 is utilized as a voltage controller in the proposed system. It gives a constant supply of 5V. The range of input voltage to the controller is 9V-5V. Range of output voltage is 4.2V to 5V.

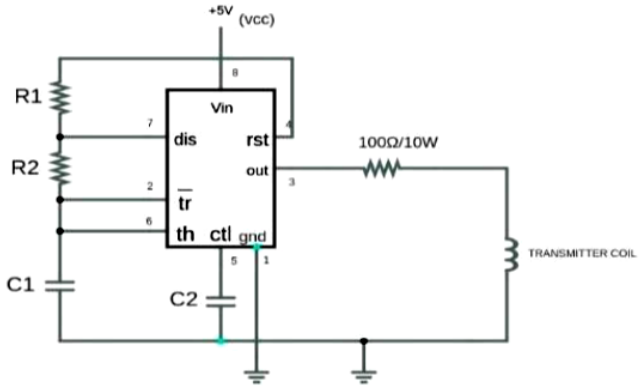

Fig. 3. Transmitter circuit using IC555 timer

F. Receiver End

After the transmitter, the receiver coil takes the energy and passes to the bridge rectifier for conversion from AC to DC, the diode which is utilized in this proposed system is IN4007, the efficiency of the bridge rectifier after conversion was about 80% and also the costing is very effective compared to full-wave rectifier, then the un-controlled DC voltage obtained from bridge rectifier was controlled by voltage controller IC 7805 and it passes constant voltage to the mobile battery charging. Fig. 4 shows the receiver circuit using bridge rectifier.

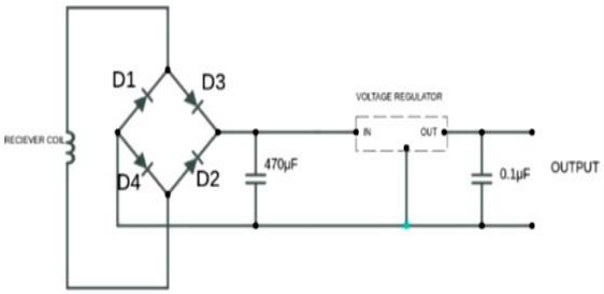

Fig.4. Receiver circuit using bridge rectifier

IV. Result And Discussion

Fig.5. shows the relation between mutual inductance and distance with coupling coefficient (k) according to which when the distance between the transmitter loop and collector loop is expanded the mutual inductance between them is decreased. As the meaning of coupling coefficient (k) is conversely corresponding to the distance between loops. Hence Fig. 6 shows that the efficiency is progressively decreasing with expanding of the distance between loops. The coupling coefficient can be expressed by the following equation [7]-[8]:

$$k = \frac{1}{\left[1 + 2^{\frac{2}{3}}\left(\frac{D^2}{R_1 R_2}\right)\right]^{\frac{3}{2}}}$$

Where, D is physical distance between transmitter coil and receiver coil, R_1 and R_2 are radius of loop-1 and radius of loop-2 respectively. The diameter across the loop fundamentally impacts the coupling coefficient just as the transfer of efficiency. For the most part for short distance Wireless-IPTs, the value of k is in the range of 0.1, when the distance between the two coils is less than the diameter of the coil. For this situation, the transfer efficiency of the system gets 90%. At the point when the resonant frequency is coordinated properly, this efficiency can be improved to about 96.3% [7].

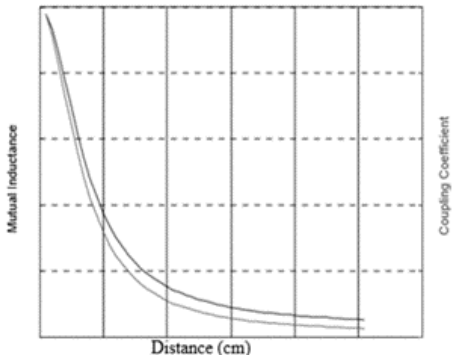

Fig. 5. Relation between mutual inductance and distance with coupling coefficient

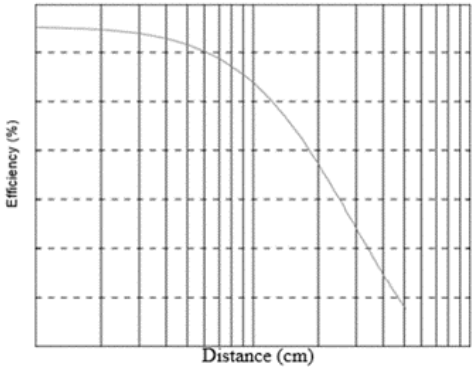

Fig. 6. Distance versus efficiency curve

V. CONCLUSION

This proposed system gradually declares the importance of wireless charging using solar power. Wireless charging reduces the use of cables & chargers for charging mobile phone, and it is ideal for charging any electronic gadgets like camera, cell phones, etc. This system helps the rural area people or where huge power cuts occurs. This independent charging system will overcome with that problems. While travelling people were facing mobile charging issue but with this system it can be rectify. This system is effective and eco-friendly.

REFERENCES

[1]. G. Mehta, F. Ahmad, A. Rai, "PV Array Reconfiguration under Different Partial Shading Conditions," International Journal of Progressive Research in Science and Engineering, vol. 1, no. 3, June 2020.

[2]. Patel P., Kishor A., Mehta G. (2021) Smart Solar-Powered Smart Agricultural Monitoring System Using Internet of Things Devices. In: Shaw R.N., Mendis N., Mekhilef S., Ghosh A. (eds) AI and IOT in Renewable Energy. Studies in Infrastructure and Control. Springer, Singapore, pp. 101-109, May 2021.

[3]. S. Ghosh, V. K. Yadav, G. Mehta, V. Mukherjee and R. Birajdar, "Status Check: Journey of India's Energy Sustainability through Renewable Sources," in proceedings of IFAC Symposium on Control of Power and Energy Systems, 9-11 December, 2015, IIT Delhi, Volume 48, Issue 30, 2015, pp. 456-461.

[4]. G. Mehta and S. P. Singh, "Design and Analysis of Photovoltaic-Fuel Cell Hybrid Distributed Generation System," in proceedings of 39th IEEE Photovoltaic Specialists Conference, 16-21 June, 2013, Florida, USA, pp. 3147-3152.

[5]. S. Danish, G. Mehta and V. K. Yadav, "Assessing the performance of Partially Shaded PV array under different radiations," in proceedings of The Eight International Conference on Computing, Communication and Networking Technologies ICCCNT, 3-5 July 2017, I.I.T. Delhi, pp. 1-3.

[6]. G. Mehta and S. P. Singh, "Improvement of power quality at PCC through grid interfacing photovoltaic system," in proceedings of The Sixth IASTED Asian Conference on Power and Energy Systems AsiaPES, 10-12 April, 2013, Phuket, Thailand.

[7]. Md. Ruhul Amin, Rajib Baran Roy. "Design and simulation of wireless stationary charging system for hybrid electric vehicle using inductive power pad in parking garage", The 8th International Conference on Software, Knowledge, Information Management and Applications, 2014.

[8]. Abu Shufian, Md. Mominur Rahman, Koushik Ahmed, Riadul Islam, Mahmodul Hasan, Toufiqul Islam. "Design and Implementation of Solar Power Wireless Battery Charger", 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), 2019.

[9]. A. Gupta, A. Tandon, A. Jeriya, N. Tanwar, R. Kumar, and D. Kumar, "Automatic wireless mobile charger", IJEER, vol. 4, issue 1, pp. 113-119, January-March 2016.

[10]. S. Pawade, T. Nimje, and D. Diwase, "Goodbye wires: Approach to wireless power transmission", Int. J. Emerging Technol. and Adv. Eng., vol. 2, issue 4, pp. 382-387, Apr. 2012.

[11]. S. Shilpa, H. M. Manasa, S. S. Mariam, and M. K. Kumar M, "Wireless battery charger", Int. J. Eng. Trends and Technol., vol. 35, no. 3, pp. 125-128, May 2016.

[12]. R. Bhutkar, and S. Sapre, "Wireless Energy Transfer Using Magnetic Resonance," in Proc. of International Conference on Computer and Electrical Engineering, Dubai, United Arab Emirates, Dec. 2009.