WIRELESS CHARGING FOR MOBILE DEVICES

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Abstract— Our purpose is to develop a project in which an inductive charging pad allows a convenient, easy to use battery charging method for mobile phones and other mobile devices. This would significantly help in the reduction of e-waste. De-cluttering of home and office space can be achieved by eliminating the need for power cords through the implementation of wireless charging system.

Through this project, we intend to achieve timed power transfer between a power transmission pad and a compatible receiver in a portable device in order to charge the device's battery. In addition to this there would be an android based application installed in the Smartphone which would help in the monitoring of the battery status and would communicate to the transmitter side to transfer only the required charging for the phone. After that the transmitter circuit would switch off thus stopping the charging and the battery could be avoided from getting overheated and overcharged. With the need to constantly plug and unplug the device eliminated, the durability of the device and its battery life would increase and its usage would become more convenient. Also GSM would provide the information about the mobile phone that is getting charged currently to another secondary cell phone via message.

Keywords—Wireless Charging, Mutual Inductance, Inductive Coupling, Mobile Device

I. INTRODUCTION

The invention of mobile phones has completely revolutionized the communication methods among humans. The dawn of the portable battery-powered electronics and communication devices since the 1980s has brought huge benefits to us. However, each portable battery-powered electronic product comes with its own charger thus increasing electronic waste issue. Wireless power transfer allows a convenient, easy to use battery charging of mobile devices providing no hassle with cables and plugs, just place the device on a pad and charging begins. This wireless power transfer system uses inductive coupling i.e. the coupled magnetic fields are used to transfer electromagnetic energy from a charging base to receiver in a portable device. An application installed in the cell phone would monitor the charging of battery and provide a duplex communication so that once the cell phone gets charged completely it would inform the transmitter circuit to switch off the transmission process avoiding the overheating and overcharging of battery. A GSM module would provide the information about the mobile phone which is getting charged currently to another secondary cell phone via message that the charging is completed in case the owner is quiet far away from his cell when it is getting charged for e.g. at public charging booths.

II. INTRODUCTION TO WIRELESS CHARGERS

The basic principle behind the working of this project is mutual Inductance. Wireless charging technologies can be classified into non-radiative coupling-based charging and radiative RF-based charging. Whereas the former consists of three techniques-inductive coupling, magnetic resonance coupling and capacitive coupling, while the latter can be further divided into directive RF power beam forming and non-directive RF power transfer.

This concept of wireless power transfer was realized by Nikolas Tesla which could make a remarkable change in the field of the electronics engineering which eliminates the use of conventional copper cables and long current carrying wires. Based on this concept, the project is developed to transfer power within a small range of distance to maintain efficiency.

III. RELATED WORKS

The topic of Inductive power transfer has been looked upon by many researchers all around the world and presently it is one of the hot topic among the researchers. It has been known that as the distance increases between primary side and secondary side, transfer efficiency decreases and thus a better contactless transfer control mechanism and selection of good quality metal with high mutual coefficient is required. To increase the transfer efficiency compensated capacitors is used in both primary and secondary side.

Xiao Lu, Ping Wang, Dusit Niyato, Dong In Kim, and Zhu Han, "Wireless Charging Technologies: Fundamentals, Standards, and Network Applications", IEEE Communication Surveys and Tutorials, 14 Nov 2015 [1] have given a very detailed historical background, technological issues, engineering applications and fundamentals of inductive power transfer. Types of wireless charging technologies are discussed and compared to understand which one is better when used in applications. The authors had also shared their vision and arguments on the engineering challenges and future developments of charging using wireless mode.

S. Y. Hui, Fellow IEEE in his Invited paper "Planar Wireless Charging Technology for Portable Electronic Products and Qi", Vol. 101, No. 6, June 2013 [2] has given a review on the Recent Progress of planar charging system for portable electronic products and the Critical issues and technologies involved in planar wireless charging systems giving complete practical setup calculations for the wirelessly transferred power.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 5, May 2014 "Inductive Charging Pad", Elizabeth Sebastian, Biji B, Pranav V, Rahul A P, Vishnu N Nair [3] have provided a detailed overview on the respective number of turns of the primary and secondary and how it changes the value of voltage and current passing across it wirelessly in their paper.

IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) Volume 9, Issue 1, Ver. VI (Feb. 2014 "Wireless Power Transmission for Mobile and Vehicle" Vithyaa.M, Marthandan.R [4] have developed this principle of wireless charging for charging of not only mobile devices but also for vehicles successfully and have provided the mechanism in the paper.

In ISTP Journal of Research in Electrical and Electronics Engineering (ISTP-JREEE) (IOCRSEM 2014), "Review paper based on Wireless Charging" Tripti Bijalwan, Ruhi Parveen, Pooja Uniyal, Kavita Panwar, Ashish Bagwari [5] the authors have have discussed the entire work which is done till date related to wireless charging. The Wireless Power Consortium standard is a set of guidelines that allows manufacturers to develop solutions with the confidence that their components will mesh with a variety of other Wireless Power Consortium certified components designed for inductive power transfer which are mentioned in this paper.

International Journal of Engineering Trends and Technology (IJETT) – Volume 4, Issue 4 April 2013, "Inductive Charging

Technique", Basharat Nizam, K L University [6] shows the study of Faraday's law, in which EMF is induced in a coil when it is linked with the flux produced by another coil. This induction principle, is applying to hybrid electric vehicles & thus Inductive charging uses the electromagnetic field to transfer energy between two objects.

ScieTech2014 IOP Publishing, Journal of Physics: Conference Series 495, "Low wireless power transfer using Inductive Coupling for mobile phone charger", M Fareq, M Fitra, M Irwanto, Syafruddin Hasan, M Arinal [7] demonstrates an experiment that has been conducted to get the WPT efficiency. The transmission inductive coupling was developed with diameter 4.5 cm number of turn is 20 while the receiver using diameter 4.5 cm number of turn is 20. The distance between these two inductive coils are varied to obtain the optimum distance for wireless power transmission. The DC output voltage getting lower as the distance is higher. And they conclude that the wireless power transmission is higher when the distance is nearer.

IJETTCS, Volume 2, Issue 3, May – June 2013, "A Wireless Battery Charger for Mobile Device", Tarique Salat, Shilpak Raich, Supriya Mahto and Shilpa Togarwar [8] shows a laboratory prototype of the proposed wireless battery charger solution that has been realized and experimental tests have been performed in order to evaluate the power conversion efficiency. As shown by experimental results in the paper, the measured efficiency of the proposed receiver lies within the range 96.5% to 99.9%, so that the overall system's power losses can only be imputed to the magnetic coupling.

International Journal of Emerging Technology and Advanced Engineering (IJETAE) Volume 4, Issue 3, March 2014, "Study on Wireless Power Transfer Using Resonant Induction Technique", Tushar Supe, Aishwarya Joy, Neha Kadam, Asmita Bhagat [9] have focused on the various applications of wireless charging in Consumer electronics, Industrial, transportation and other applications.

This literature survey helped us in deciding the objectives of our project. It also provided us with problem definition solution to some extent.

IV. SYSTEM DESIGN

The Block Diagram is as shown in fig. 1 with the flow of each block. It has two main sections: Transmitter and Receiver. This project is built using an electronic circuit which converts AC 230V 50Hz to AC 12V that is High frequency. The output is fed to a tuned coil forming as primary of an air core transformer. The secondary coil develops a voltage of High frequency 12volt. Thus the transfer of power is done by the primary (transmitter side) to the secondary that is separated with a considerable distance (say 3cm). Thus receiving coil would receive the power due to mutual inductance and the voltage regulator circuit would regulate the voltage to the required value for charging of the mobile phone i.e. 5V. The application used is android based that will use Bluetooth to communicate with the PIC18 microcontroller in order to control the SPDT Relay that will switch on or off the transmitter circuit as per need. A 16x2 LCD is interfaced with PIC to display the current sensed and the indications of the charging would be displayed as messages.

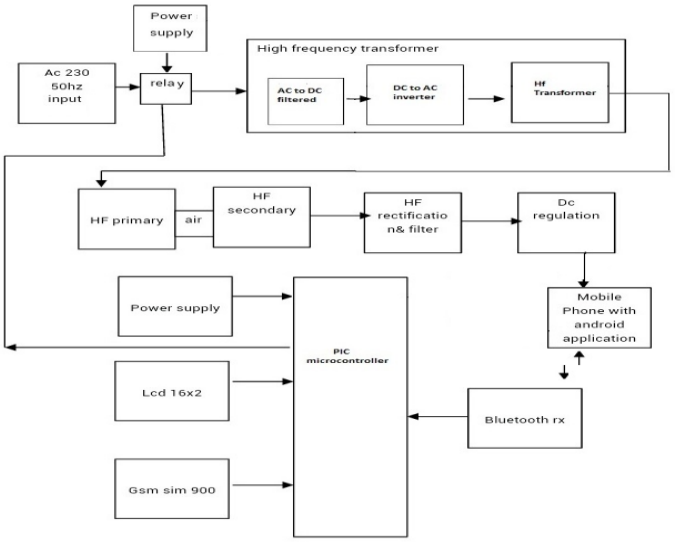

Fig. 1. Block Diagram of the system

V. METHODOLOGY

The figure shows the block diagram of wireless charging of mobile devices .It requires coil at transmitter side and receiver side. Transmitter coil is connected to 230V, AC 50Hz power supply. This AC power is converted into 12V using step down transformer. 12V AC is converted into 12V DC using AC/DC filter. DC/AC inverter then changes DC to AC. Commercial AC operates at 50Hz, which is very low to drive wireless charging. Hence this voltage is converted to high frequency AC power that is 12V, 40KHz. This high frequency power gets transferred from transmitter coil to receiver coil using inductive coupling method. At receiver side the circuit converts AC to DC & reshapes the voltage used to charge mobile device. At the receiver side PIC microcontroller is placed. The liquid crystal display LCD displays the message "Welcome" or "mobile is charged" etc. Also it displays the voltage & current values used for mobile charging.

Mobile phone having the android app is used to monitor the status of battery. In this user sets a percentage value that they want to charge mobile phone up to. This app sends the battery status to PIC microcontroller using Bluetooth. Bluetooth is interfaced with PIC. If mobile charged then we get message that "mobile is charged" by using GSM module. In app user provides a secondary mobile number on which message is received. This feature can be used for public wireless charging booths. If mobile is charged the user gets a message and user can remove and collect the mobile phone, this is going to increase life of battery because it avoids overheating and overcharging as the technique of timed charging is being used.

VI. EXPERIMENTAL RESULTS AND ANALYSIS

We did the simulation of our project on proteus software. After the successful simulation was achieved following were the results shown in fig. 2 and fig. 3. When there is no phone connected for charging the LCD displays "connect ur phone" indication. When the cell phone is connected and charging is in progress the LCD displays "mobile charging" message.

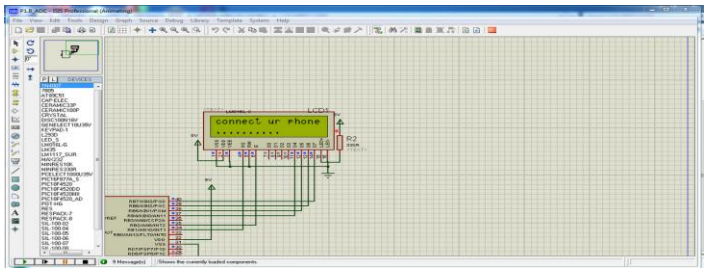

Fig. 2. Output on Proteus software showing "connect your phone" for charging indication.

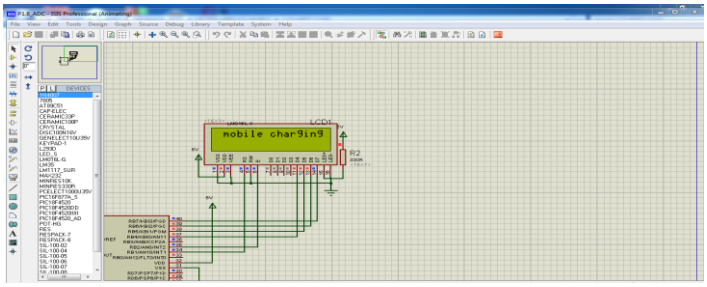

Fig. 3. Output on Proteus software showing the "mobile charging" status that the phone is successfully getting charged.

Fig. 4 shows the user interface of the android based application the works with the enabled Bluetooth in the cell phone. We can set the percentage up to which we need the charging to be done. As seen in Figure there is an option to feed an external mobile number where the whereabouts of charging statistics can be seen. Once the start button is pressed the charging begins and the battery status can be seen in the below box

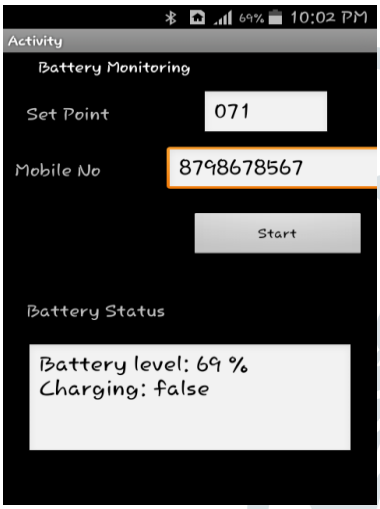

Fig. 4. Android Application User Interface

VII. HARDWARE

The project photograph is as shown in the fig. 5. The mobile phone getting charged with the running android application on display can be seen. The hardware kit with the transmitting and receiving section along with the coils can be seen as well.

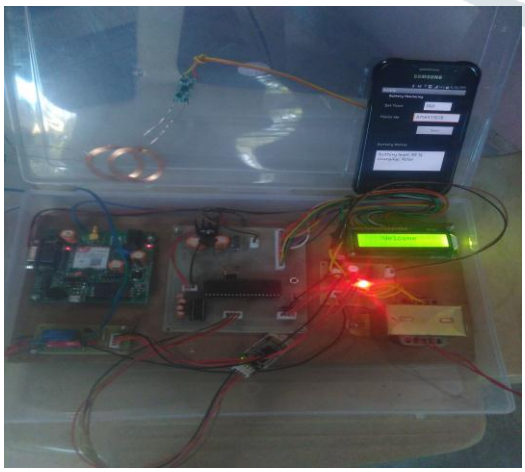

Fig. 5. Hardware Photograph

VIII. ADVANTAGES

- It improves user-friendliness as the hassle from connecting cables is removed.
- Different brands and different models of devices can also use the same charger.
- It renders the design and fabrication of much smaller devices without the attachment of batteries.
- It provides better product durability for contact-free devices.
- It enhances flexibility, especially for the devices for which replacing their batteries or connecting cables for charging is costly, hazardous, or infeasible (e.g., body implanted sensors).
- Wireless charging can provide power requested by charging devices in an on-demand fashion and thus are more flexible and energy-efficient.
- Wireless electricity is suitable for most working and living environments.
- The power can be delivered in any direction i.e. Omni directional.
- Aesthetic appeal by de cluttering of office or living space.
- Reduction of e-waste by eliminating the need for power cords.
- Single inductive charging pad can be used for any mobile device irrespective of its manufacturer. But it must have the receiver circuit installed in it.
- Wireless charging gives a protected connection .This offers no corrosion as the electronics are all enclosed, away from water or oxygen in the atmosphere.
- The use of phone application helps in controlled charging i.e. up to an adequate percentage the transmitting circuit is closed or switched off in order to stop the power supply thus avoiding overheating and overcharging leading to long battery life.
- GSM module provides the information of the cell phone when it is being charged via message to another cell phone owned by the user thus helping user to know about the whereabouts of cell phone while it is being charged. This promotes the feature of public booth charging in the mere future.

IX. APPLICATIONS

- Can efficiently be used to power the various home appliances without cables.
- There are many applications of wireless charging in consumer electronics.
- Automatic wireless charging of mobile electronics (phones, laptops, game controllers, etc.) in home, car, office etc. while devices are in use and mobile.
- Direct wireless powering of stationary devices (flat screen TV"s, digital picture frames, home theatre accessories, wireless loud speakers, etc.) thereby eliminating expensive custom wiring, unsightly cables and power supplies.
- Direct wireless powering of desktop PC peripherals (wireless mouse, keyboard, printer, speakers, display, etc.) eliminating disposable batteries and cabling.
- The use of GSM module can help this project to be utilized in public places as a charging booth.
- On large scale can be used in charging of car batteries. Charging stations help to fulfill this feature when practically applied.
- More development in this technology would lead to a lot of new applications in any vast field making everything wireless.

X. CONCLUSION AND FUTURE WORK

In this paper we have provided the information regarding our implemented project which proves to be a better solution for wireless technology in application. Moreover this technique can be used in number of systems, like to charge a mobile phone, iPod, laptop battery, propeller clock wirelessly. Also this kind of charging provides a far lower risk of electrical shock as it would be galvanically isolated.

This method comes with many advantages the most important of which are convenience, de cluttering of wires, reduced e-waste and multiple devices can be charged using the same transmitter. This technology shows a lot of scope as an alternate to wired charging in the coming future. It is an Emerging Technology, and in future the

distance of power transfer can be enhanced as the research across the world advances.

Wireless charging will only be used on a large scale if the efficiency of the power transmitted increases. In mere future it can be used in a form that there would only be one power transmitting circuit in one room and all the devices could get charged by it eventually that come under the calculated radius region providing no harm to the human beings. Also the future scope of this emerging field will be to reduce the amount of power lost when the distance between the charging pad and the devices increases. Also, the system must be made more cost effective to make it a viable alternate solution to wired charging. It has been demonstrated that it is feasible to transmit a significant amount of power at a high efficiency that has never been achieved previously.

Despite this significant development, its effective transmission distance is limited by the size of the resonator. In many applications, it is highly desirable to extend the distance of transmission and allow the route of transmission to follow a curved path in space. In this work, we take advantage of the relay effect in resonant physical systems and present an effective solution using more than two resonators. Both theoretical and experimental results show that this approach overcomes the drawbacks of two-resonator system, allowing much longer and more flexible power transmission without sacrificing efficiency.

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