Smart Assisting Kernel and Hover Interface (SAKHI) For Medical Aids

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Abstract - *Statistical data from worldwide survey shows an alarming increase in the users of medical aids including pacemakers and hearing aids. These medical aids have brought about marked difference in their lives. However the invalids are still depends on the other human beings for charging their implants and devices. It is in this connection that our smart assistance device would be of paramount significance.*

Smart Assisting Kernel and Hover Interface System (SAKHI) is one essential device that enables these implants such as pacemakers and hearing aids to be wireless compatible. SAKHI is designed for use of paralysed and bedridden patients to keep their pacemakers in charge. SAKHI employs an auto or smart system which receives signals from a pulse sensor which allows SAKHI to detect any variations in the heart beat rates of the patient thus detecting drainage in pacemaker charge. SAKHI then automatically starts the recharge of the pacemaker thereby keeping it charged at all times.

In addition to keeping a pacemaker in charge the SAKHI also helps keep the hearing aids charged. SAKHI allows wireless compatibility for the hearing aids as well.

The primary side is powered from a resonant class E converter which in turn receives power from the solar panels. This makes the SAKHI way more efficient device as compared to already existing systems.

***Key Words*: Class E converter Topology, Magnetic Resonant Coupling, Resonating coils, Pacemaker, Pulse sensor, Wireless charging**

1. INTRODUCTION

Our project the Smart Assisting Kernel and Hover Interface(SAKHI) for medical aids is designed keeping in mind the need of the aged, paralyzed, bedridden or invalid person's .Considering that there has been an 80% increase in the number of persons having body implants since 2005 and the data only seems to be rising further. We found it only the need of the hour to make a project that charges these implants wirelessly [8] using our smart assist system. The implants include pacemakers, hearing aids etc.

SAKHI uses the resonant Class E converter topology making it simple at the same time more efficient than the existing systems for the purpose of wireless charging [2].

The pacemaker is implanted under the skin of your chest with wires attached into the heart. It monitors your heartbeat and provides electrical stimulation when it beats too slowly or stops. Its power is supplied by a battery that must periodically be replaced. The aim of SAKHI is designed to charge a rechargeable battery wirelessly for the purpose.

Moreover our SAKHI also uses a pulse detector to detect the change in the person's pulse and thereby charge the pacemaker automatically. SAKHI quite effectively solves the problem and burden of surgery for the replacement of the pacemaker.

The pacemakers and hearing aids use non rechargeable batteries which when replaced after the surgery becomes simply electronic waste. SAKHI makes pacemakers and hearing aids wireless compatible thus eliminating this bio waste production almost permanently.

Bedridden and paralyzed patients require constant assistance in fulfilling their desires be it listening to their favorite's music or answering their mail etc. the charging of these electronic devices that they use such as mobiles and mp3 is again another burden. This situation is also to an extent solved in our smart assist system which takes care of the wireless charging of these devices keeping their batteries charged and their usage hassle free.

The problem of increasing electricity consumption has been addressed in this project with the use of solar panels for powering our smart assist system.

This Smart Assisting Kernel and Hover Interface(SAKHI) for medical aids is one of a kind innovation has it assists the person by keeping in charge the most important implants such as pacemakers [1] which includes sending of signals from a pulse sensor to the wireless charging circuit. The pulse sensor checks for variations in the person's pulses occurring by change in his heartbeat occurring from drainage of pacemaker charge [9]. The SAKHI receives these signals initiates the automatic charging of the pacemaker. SAKHI allows the auto/smart charging of the pacemaker is also made possible. SAKHI keeps the pacemaker charged all throughout contributing to its higher efficiency. In addition SAKHI helps in keeping the hearing aids wirelessly charged avoiding major inconveniences due to drop in its charge. SAKHI is also compatible for charging phones and mP3 making the paralyzed/bedridden person more self reliant.

The Smart Assisting Kernel and Hover Interface (SAKHI) is essentially economic and a smart investment to make.

The SAKHI helps wirelessly charge the various medical aids used by a bedridden or paralysed patient. Pacemaker is an implant that works on a battery which drains out in time. Thus for the person to survive would require him to perform the surgery of replacement of pacemaker which is both time and money consuming. The SAKHI helps to avoid and eliminate the surgery for replacement of pacemaker. SAKHI thus helps save both money and resources by making the implant wireless compatible. In addition to pacemaker SAKHI also aids in charging the hearing aids thereby replacement of its batteries can also be eliminated. SAKHI is essentially a money and time saver!

2. SYSTEM DESCRIPTION

The block diagram of the proposed system is shown in the fig -1.The main key part of the model is the class E converter. This is in turn powered by a solar panel, if there is no availability of sunlight we can also relay on the ac power supply. The triggering of the class E converter is given by the PWM controller. There is also a driver circuit for providing the required amount of current for the class E converter. Mainly there are three coils primary coil, secondary coil and resonating coil [5]. The primary coil is powered by the class E converter. The resonating coils are sandwiched between the primary and secondary coils. Secondary coils are placed along with the pacemaker inside the body. Pulse sensor is also provided in order to provide the feedback that makes the system more efficient.

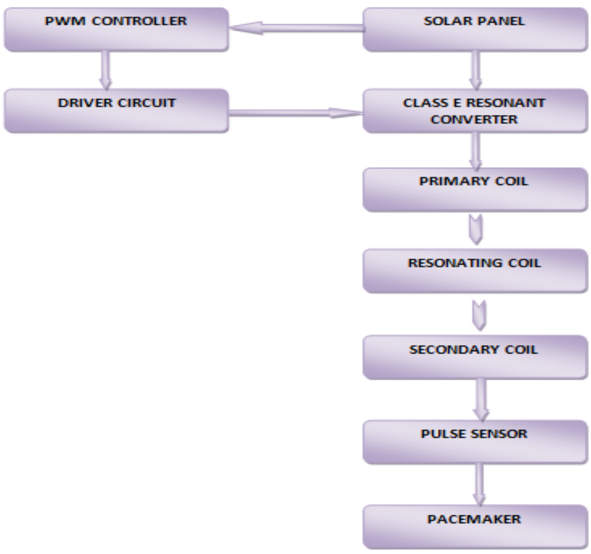

Fig – 1: Block diagram

2.1 Class E converter Topology

The Fig - 2 shows the standard Class E Converter Topology in which the load is supplied through sharply tuned series resonant converter. Hereby result that result in an essentially sinusoidal current io. As the input is passing through a large inductor so that source acts as a current source. During switch off, the capacitor voltage builds up slowly allowing zero-voltage turn off of the switch. The converter operates for a frequency fs, slightly than resonant frequency as shown in (1)

$$fo = 1/(2\pi\sqrt{(LrCr)}) \quad (1)$$

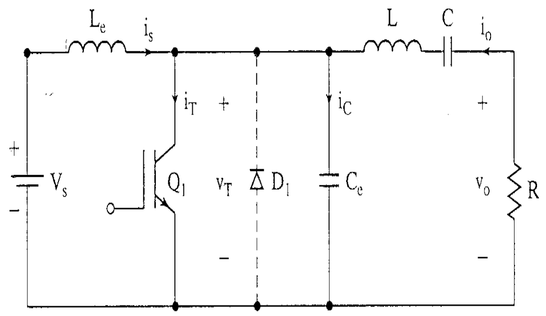

Fig – 2: Class E Converter Topology

Quality factor Of Lr, Cr, R circuit Is kept high Q>=7
High Q factor results in essentially sinusoidal load current i0 Hence slight variation in fs is needed to vary the output voltage. As fs increases (fs>f0) i0 & Vr decreases. Average voltage across R & Lr are zero Cr blocks dc current to load Peak switch current approximately 3Id, peak switch voltage 3.5 Vd. Suitable for low power applications less than 100W

Here the Fig - 3 shows the waveform of the class E converter.

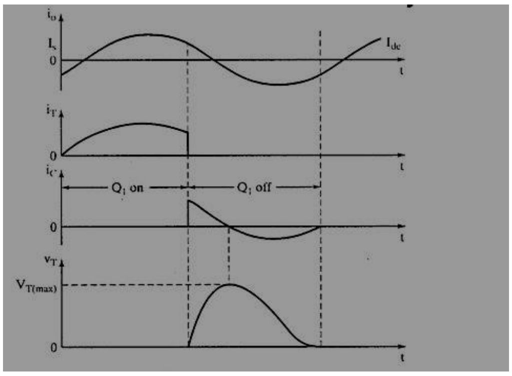

Fig – 3: Class E Converter Waveform

The switch is turned OFF when the output voltage becomes = 0 and the current is “transferred” to the branch containing the capacitor.

3. PROPOSED SYSTEM

Class E converter is the main component in constructing the circuit, the switch used in IRF510A.To trigger the switch it requires a pulse as well as sufficient current. The pulse is provided by the IC 555 timer circuit, and the current is provided by the driver circuit Fan IC 7392. Class E converter is provided with a 12V supply from the battery. The 555 timers and Fan IC require only 5V supply so we use a regulator IC 7812.When the switch is triggered of the Class E converter a voltage is induced in the primary coil and through the resonating coils gets transferred to the secondary coils [5]. A bridge rectifier circuit is used for the rectification a capacitor of 10uF is used for filtering out the ripples. The glowing of LED indicates the wireless transmission has taken place. Its Fig is shown in Fig - 4

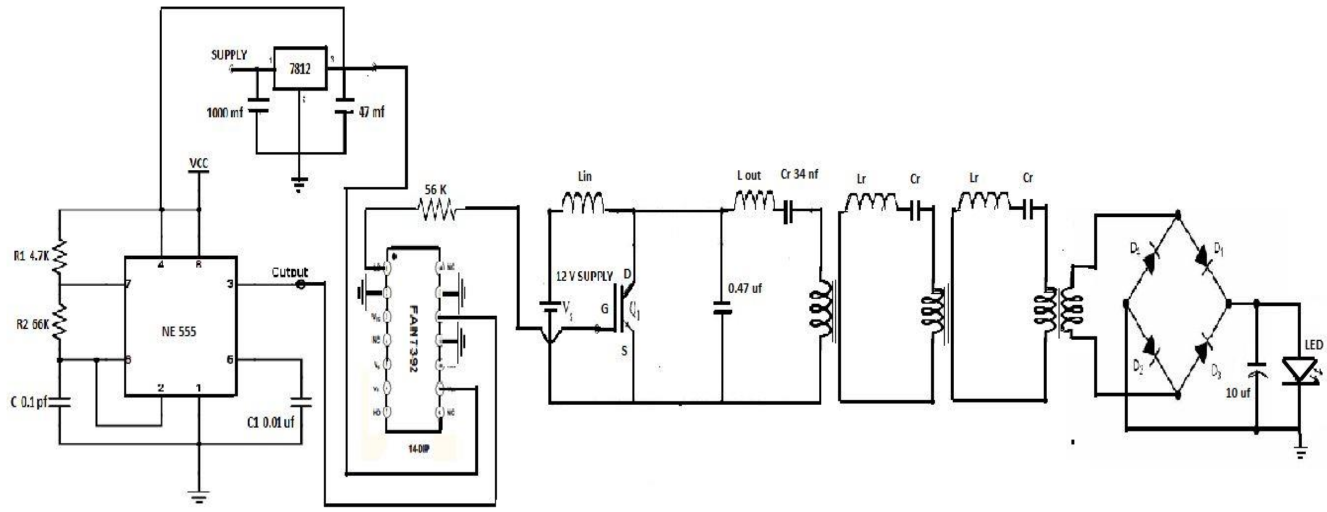

Fig – 4: Equivalent circuit of the proposed system

Ws = 2*pi*f (2)

Ws Lr – 1/WsCr = .3533R (3)

Where R = 6 ohms, Cr = 34*10^-9

So Ws Lr = 59.91

Lr = 0.1 mH

Where:

r1,r2=Resistors

C= Capacitor

f=Frequency

Lr= Inductor

Cr=Capacitor

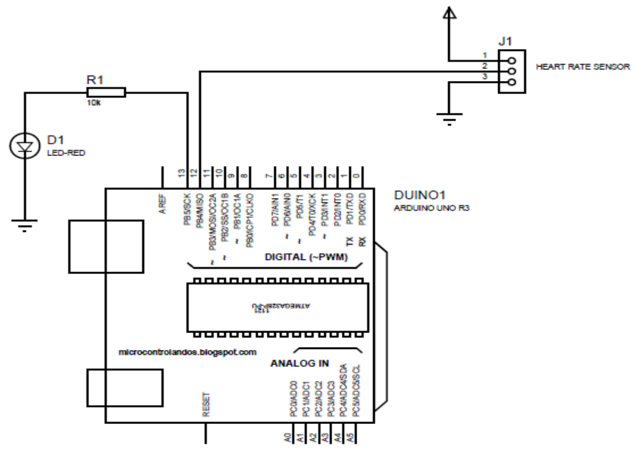

Fig – 5: Pin out Diagram of Pulse sensor

For efficient and smart charging of the pacemaker we are also providing a pulse sensor. It is programmed by aurdino IDE. Here the pulse rate of a heart patient will be less than 60 pulses. So it is programmed such a way that it will read the pulse rate and if the pulse rate is around 70 to 100 then the blinking of LED will become constant. For the patient using pacemaker the pulse rate is read by the aurdino and indicate the blinking rate.

Digital pin 13 is used for connecting the red LED that mainly used for detecting heart rate and shows the output. Digital pin 12 is used for connecting the Heart rate Sensor and Fig - 5 shows the pin out diagram of pulse sensor connected to the arduino uno board.

Table - 1 shows the components required in the proposed model and also its specification.

Table – 1: Components Required

Component	Specification
Capacitor	1000uf,10uf,.1pf,68(*2)nf,047uf
Resistor	4.7k,6.6k
Inductor	.1mH
Fan Driver IC	FAN7392
MOSFET	IRF510
IC 555	NE 555
Voltage Regulator	7812
Ferrite Core	Iron powdered core
LED	Red

3.1 Resonant Coupling

Resonant magnetic coupling [7] is one of the effective ways of wireless power transfer. Here as suggested by resonance, the power transfer takes place only if the sending end frequency and the receiving end frequency should be the same. To understand the effect better, it can be compared to mechanical resonances. Consider a string tuned to a certain tone as mechanical resonator.

Even a far away and low level sound generator could excite the string to vibration, if the tone pitch has been matched. The concept of resonant coupling [11] does provide better efficiency in case of charging of medical aids in the human body. The Fig - 6 shows the pictorial representation of the principle Resonant Coupling is shown here.

Firstly it provides a weak magnetic field [4] and secondly it charges only at frequency matching so unlike induction if the person has any iron parts in his body, charge is not induced in it ,thus leaving the patient unharmed. The only remaining limit for the power transmission is the winding resistances of the coils, which impedance is one or two orders of magnitude lower than that of the inductances. Therefore, for a given generator source, much more power can be received.

The key feature of resonant coupling is sending end frequency and receiving end frequency want to be same then only the wireless power transmission takes place.

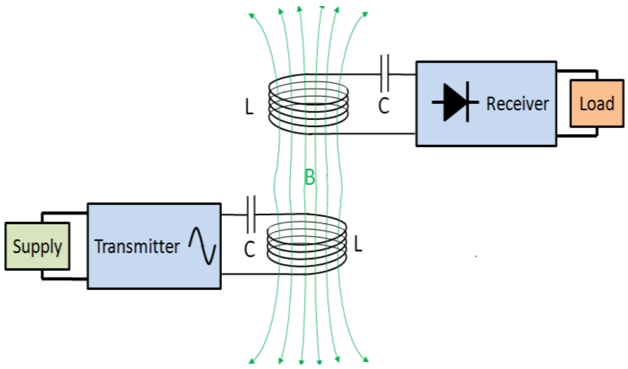

Fig - 6: Resonant Coupling

4. RESULT AND DISCUSSION

We conducted our project on "Smart Assisting Kernel and Hover Interface (SAKHI) for Medical aids" and we were able to get the output successfully. We brought all the components. We had done the class E converter design. We have also done simulation in the Matlab and also convert its circuit in the PCB using proteus software. Then we connected all the components in the bread board as per the circuit diagram in the fig – 7

It was found in our project that medical aids could be charged wirelessly using the principle of magnetic resonant coupling. The class E converter was used as the main component in our hardware model. We have been able to obtain a distance of seven centimeters for which we can wirelessly charge the medical aids implanted in the human body, in our project we are concentrating on the charging of pacemakers. The blinking of the Led is used to indicate the wireless power transfer. We are also using two resonating coils that have been wound and designed to a frequency of 88 KHz. The concept of our project has been formulated theoretically and proven practically in the lab. The following shows the hardware representation of our project:

Fig – 7: Hardware Model

The blinking of LED indicates the wireless transmission. Pulse sensor provide as a feedback loop to the system. To get more distance we are using two resonating coils between the primary and secondary.

5. CONCLUSION

The Smart Assisting Kernel and Hover Interface(SAKHI) used for wireless charging of the medical aids and also phones of the patient making him/her more self reliant.

The SAKHI essentially works on solar power but a switch over system can be provided so that it can work in its absence as well. This would be of aid especially when the person is travelling. The SAKHI can be so used so as to suit the paralyzed, bedridden, aged peoples and thus providing efficient charging of these medical aids almost at all times.

Apart from being a socially relevant innovation the SAKHI uses resonant Class E converter making it more efficient at the same time simple as compared to the already existing wireless charging circuits.

In the future this system is a multipurpose assist system that can be tuned to the need of the invalid. Currently we are working on the pacemaker charging but this same way can also be used for charging of hearing aid also. Moreover we can also develop the SAKHI into its portable version where we can provide the charging using power banks.

The SAKHI essentially works on solar power but a switch over system can be provided so that it can work in its absence as well. This would be of aid especially when the person is travelling. We can also add many more devices to this aiding system like MP3 Player, Mobile phones etc.

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