AUTOMATIC WIRELESS BATTERY CHARGER FOR PERMANENET PACEMAKER

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***Abstract*— A Pacemaker is a medical device that is placed under the skin of your chest (just below collar bone) uses electrical impulses, delivered by electrodes to stimulate heart muscles to make it contract. As pacemaker consists of lithium - iodine battery which last in 4-5 years and it is not replaced but a new pacemaker is implant through surgery. In this paper a new method for charging pacemaker battery is proposed. We will be using micro-electromechanical device which convert very low frequency into electrical energy. This device place inside pacemaker which sense the body vibration when microcontroller pass command when battery get low(50%) & give power source to charge its battery. This will prevent the patient from undergoing surgery for replacement of pacemaker when its battery gets low. This technique will be also be used for charging many other devices such as laptop, mobile etc. This going to best eco-friendly method of generating & preserving energy**

Keywords — Pacemaker, Microcontroller, Vibration sensor, Battery, Micro-electromechanical.

I. INTRODUCTION

A pacemaker is a small device that's placed in the chest or abdomen to help control abnormal heart rhythms. This device uses electrical pulses to prompt the heart to beat at a normal rate. A pacemaker is a small unit that helps your heart beat more regularly. It does this with a small electric stimulation that helps control your heartbeat. Your doctor puts the pacemaker under the skin on your chest, just under your collarbone. It's hooked up to your heart with tiny leads .You may need a pacemaker to keep your heart beating properly. This helps your body get the blood, oxygen and food that it needs. Some people just need a pacemaker for a short time (like after a heart attack) and may use a kind that's outside the skin.The battery unit for this type can be worn on a belt [1-2].

A. Types of Pacemakers

- **Single chamber pacemakers** set the pace of only one of your heart s chambers, usually the left ventricle, and need just one lead.
- **Dual chamber pacemakers** set the pace of two of your heart s chambers and need two leads. These are more sophisticated and use information about the electrical activity of the atria to set the ventricles pumping rate. Dual chamber pacemakers are ideal if you have heart block (when electrical signals can't get through to your ventricles), but are not suitable for everyone [3].
- **Biventricular pacemakers** use three leads, one in the right atrium (one of the top pumping chambers in your heart) and one in each of the ventricles (left and right).
- **Biventricular pacemakers** are a newer type of pacemaker and are complex devices.

Fig.1 Internal structure of pacemaker

II. APPLICATION OF PACEMAKER

Pacemakers are basically used to treat arrhythmias (ah-RITH-me-ahs). Arrhythmias are problems with the rate or rhythm of the heartbeat. During an arrhythmia, the heart can beat too fast, too slow, or with an irregular rhythm. Faulty electrical signaling in the heart causes arrhythmias. A pacemaker uses low-energy electrical pulses to overcome this faulty electrical signaling. Pacemakers can:

- Your heart beats too slow or too fast.
- Your heart doesn't beat regularly
- There's a block in your heart's electrical pathways.

A. Battery Descharging

Pacemaker batteries are designed to become depleted in a slow and predictable fashion. When followed over the telephone, the steady decline in energy can be followed. When the battery is low but still has significant power left, the pacemaker will still work just fine, but indicates that the time for replacement is nearing.

B. Related Complications

There are various types of complication but a possible complication of dual-chamber artificial pacemakers is *pacemaker-mediated tachycardia* (PMT), form of reentrant tachycardia can be defined as a condition in which a pacemaker paces the ventricles at rates that are inconstant. This can be due to the following

(1) A rate response setting that is too sensitive.
(2) Electromagnetic interference.
(3) Inappropriate pacemaker manipulation with rate response turned on.
(4) Tracking of an artery rate related to upper rate settings. Treatment of PMT typically involves reprogramming the pacemaker.

Another possible complication is "pacemaker-tracked tachycardia," where a supraventricular tachycardia is tracked by the pacemaker and produces beats from a ventricular lead. This is becoming exceedingly rare as newer devices are often programmed to recognize supraventricular tachycardia and switch to non-tracking modes.

III. CHARGING OF PACEMAKER BATTERY

In present time, normally pacemaker battery don't get to charge but the whole pacemaker is replaced via surgery, when its battery get low. Also a method of wireless charging of pacemaker has been developed by WiTricity & the technique known as highly resonant wireless power transfer.

But we have generated a new idea which can charge pacemaker battery automatically when it get low. Here, When the pacemaker battery charge comes upto 50%, which is already connected with microcontroller, detects it and send the signal to MEMS device (discuss below) . The function of this device is to convert low frequency into electrical energy. From the body it can observe vibration (<190 Hz) & perform it function. Finally an electronic circuiting will be done which use this energy to charge battery.

This technique can also be used as the replacement of battery of the pacemaker. But due to this we might have a serious problem for example when a person got sick, his /her body vibration decreases (for ex: blood pressure & hearing strength of ear get weaken etc.). Hence MEMS will not be able to perform its functioning properly, then battery will be in action.

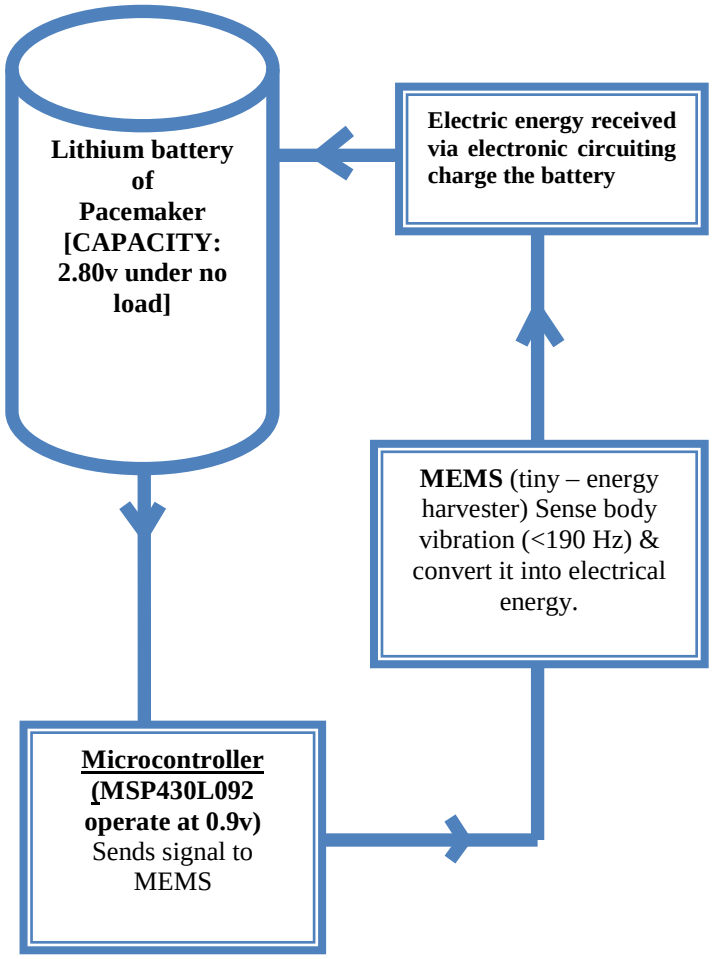

Fig.2. Block diagram for automatic charging of pacemaker

A. Units

The lithium/iodine-polyvinyl pyridine battery used as a power source for cardiac pacemaker. The battery chemistry provides a long shelf life and high energy density. Lithium Iodine has two characteristics that make it an excellent power source for cardiac pacemaker applications.

(1) The self-discharge rate is very low resulting in a long shelf life.
(2) It has a stable voltage through much of the useful life then tapers down in a gradual.

Its volume is around 11.2 cm3 & voltage is 2.80v under no load with nominal capacity 2.3 Ah, energy density 530Wh/dm3, 200Wh/kg. It get self -discharge of less than 10% in 10 years [4-5].

TABLE 1 CHARACTERISTICS of Lithium Battery [6]

LITHIUM BATTERY	SPECIFICATION
NOMINAL SIZE	23*45*13.5 mm
VOLUME	11.2 cm3
Weight	30 gm
Density	2.7g/cm3
Lithium area	17.1cm2
Voltage	2.80V under no load
Nominal capacity	2.3A h
Energy	6.0Wh
Energy Density	200W h/kg
Self discharge	<10% in 10 years
Insulation Resistance	>10 Ω from pin to case
Storage temperature	40 or 50Ċ

IV. MEMS (MICRO ELECTROMECHANICAL SYSTEM)

Micro-electroelectromechanical system is small integrated devices or system that combines both electrical and mechanical systems. They ranges from the sub-micrometer level to millimeter level .These systems are fabricated to develop the relation between integrated circuit industry to add mechanical elements such as beams, gears, diaphragms and springs to device. These systems consist of two components sensor & actuator, which can sense, control and activate mechanical processes on the micro scale, and function individually or in arrays to generate effects on the macro scale [7].

A. Design & Application of Mems

Micro-electromechanical system (Tiny Energy-Harvester) produces electricity from Low-Frequency Vibrations of our body. A new energy harvesting device converts low-frequency vibrations into electricity. IC fabrication technology or micro-fabrication has so far been the primary enabling technology for the development of MEMS.

The rumbling you feel driving along a bridge may soon serve a purpose beyond just waking you up behind the wheel. This tiny energy-harvester is able to harness low-frequency vibrations like those made by a bridge or pipeline and converting them to electricity for wireless sensors [8].

Wireless sensors are used for all kinds of things, from monitoring factory machines and oil pk8ipelines to keeping track of pollution. While the efficiency of their energy consumption has improved, the sensors' batteries still need to be changed occasionally. It is a micro-electromechanical system (energy-harvester) makes electricity from the vibrations of foot traffic and other low-power energy sources from the environment, potentially removing the need for batteries completely. The energy-harvester consists of a microchip with a bridge-like structure anchored at either end. This design picks up a wider range of vibrations and produces 100 times more energy than any other harvester available

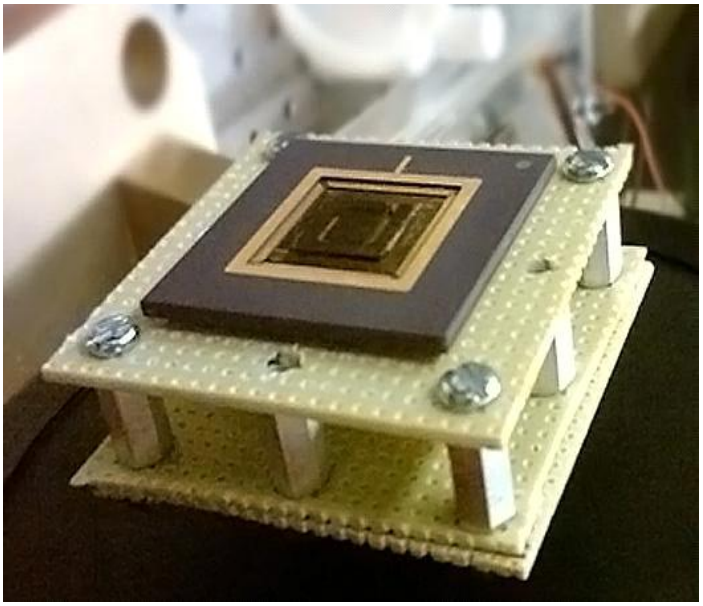

Fig.3. MEMS (Energy-Harvester)

B. Devices role

As we mentioned above, pacemaker battery is rechargeable but it is not used to charge instead of it get replaced from body. Pacemaker battery is of lithium-iodide, our idea is to use a microcontroller of very low operating voltage & the most important component i.e. MEMS device having the ability to convert atmospheric vibration or body vibration (of wind, sound, movement of body, Heart beat etc.) into electricity.

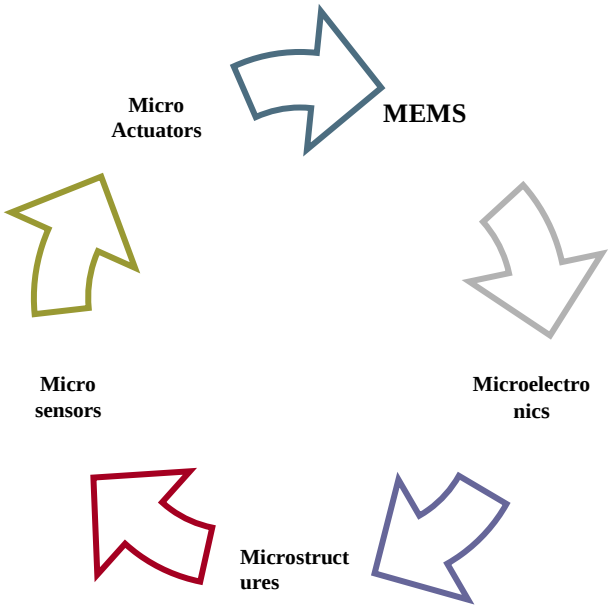

Fig.4. Flow Diagram of MEMS

V. CONCLUSION

This paper has discussed the proposal of a wireless device which Charges the Pacemaker battery automatically and the reasons to have an automatic charging of a pacemaker battery. The artificial pacemaker, its drawbacks and the requirement of wireless charger for pacemaker were also presented in this paper. There are three existing types of pacemaker single, dual and biventricular, which need to replace after a limited time-span of 4-5years and its has many limitations & complications. We proposed a technique of charging a pacemaker using wireless device from the small vibration so there is no need of replacing the pacemaker after few years. In this project when the pacemaker battery discharges upto 50%, which is controlled by microcontroller, send the signal to MEMS (Micro Electromechanical System) device. MEMS Device converts low frequency into electrical energy from the body & it can observe vibration (<190 hz). Finally an electronic circuitry will be done which uses this energy and limits the power to charge the Pacemaker battery automatically. This technique can overcome the replacement of battery**.** The benefit of this automatic charging provide comfort & prevent the patient from undergoing surgery for replacement of pacemaker when its battery get low. This method is eco-friendly & does not produce any waste and harmful effect to human body. This comes in fewer budgets & give application of automatic wireless charging for many other devices such as mobile, laptop charging etc. Considerably more work and more information on automatic charging of a pacemaker need to be done to determine & would help us to establish a greater degree of accuracy on this matter.

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References

[1]. Amasha, H.M.; Ghazzawi, Z.K.; Al-Nabulsi, J.I., "A wireless multi bundle concentric coil for charging the battery of a total artificial heart or a pacemaker," Computers in Cardiology, pp.201- 204, 2007. doi: 10.1109/CIC.2007.4745456

[2]. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1502062/

[3]. http://web.mit.edu/newsoffice/2011/power-from-vibrations-0914.html

[4]. Dr. morris kesler, “Highly Resonant Wireless Power Transfer: Safe, Efficient, and over Distance”, Witricity Corporation, 2013.

[5]. Thomas Roy Crompton, “Battery reference book”, Newnes, 2000 - Technology & Engineering

[6]. Clive D. S. Tuck, “Modern battery technology”, Ellis Horwood, 1991 - Science.

[7]. heart information, “National Heart Foundation of Australia”, ABN 98 008 419 761.

[8]. pacemaker,thefreeencyclopedia http://www.lboro.ac.uk/microsites/mechman/research/ipm-ktn/pdf/Technology_review/an-introduction-to-mems.pdf