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Energy harvesting from sound waves for low voltage devices

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Abstract— Energy harvesting techniques provides an excellent alternative to the existing energy sources. These include wind, solar cells, Power and Vibration energy. Radio frequency (RF) energy is currently broadcasted from millions of radio transmitters around the world including radios, mobile phones and mobile base stations. The ability to harvest RF energy, from ambient sources, enables wireless charging of low-power devices and has ensuing benefits to product design, serviceability, and dependability. In this paper, we present a study on ambient RF energy harvesting techniques and also present a new technique for charging mobile phone battery by using RF energy.

Keywords— RF Energy, Energy harvesting, Wireless sensor node, Wireless power transmission, Ambient source

1 INTRODUCTION

The uses of wireless devices are increasing day by day in many applications especially in mobile phones and sensor networks. This increment has generated an increasing use of batteries [1]. The charging of mobile phone batteries is although an easy task because the user can do it easily. But for other applications, like wireless sensor network, the charging of the sensor node batteries (which are located in difficult access environment condition) remains a major problem [2]. This problem increases more, when the number of devices is large and is distributed in a wider area or located in inaccessible places. In these cases, use of the Wireless Power Transmission (WPT) to the sensor node can provide an easy way to overcome these problems [3].

2 PROBLEM ANALYSIS

The main problem in wireless sensor networks is battery resource constrained for the field nodes. Here we consider a situation of multi-hop wireless communication in a sensor network in which the information from a node is transferred to the sink node (base station) using ad hoc multi hop network. It means the sensed information from a field sensor node is forwarded to sink node by multiple intermediate nodes.

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If one of the nodes which participate in multi-hop forwarding is switched off or dies due to low battery power, the sensor network is disconnected and the information can be lost on the way [4]. While sensor networks use energy efficiency communication protocols for extending nodes lifetime, but battery drainage problem still remains in sensor node. In various applications, it is very difficult or infeasible to replace the exhausted batteries of sensor nodes, due to the deployment in terrain condition or because of the sheer number of field nodes. The means to recharge the sensor nodes without shutting down the wireless network is very important for uninterrupted operation of the sensor network and it is also important to keep the network maintenance cost at a minimum [5].

3 PROBLEM SOLUTION

One technology which can be used for this purpose is energy harvesting. Energy harvesting is a process by which energy is derived from an external ambient source (which can be a kinetic energy, solar power, RF, thermal energy, or wind energy). It can also define as conversion of renewable energy or ambient energy into electrical energy in terms of DC power. While there have been various proposals on tapping the non-network ambient energy sources, such as solar, thermal, wind, etc., but they are not universally available. Recharging of battery from RF sources is being investigated by several researchers, which propose is to use very high power external energy source, such as microwave source, and it includes a significant use of RF energy. Propose of this paper is to use the RF energy that is already available in the network due to

regular communication among the sensor nodes or mobile phone etc. Energy harvesting techniques are best due to its availability in the environment and long time uses.

Ambient energy sources which are generally used for energy harvesting process are [4]:

1. Solar energy
2. Wind energy
3. Heat energy
4. Electromagnetic waves or radio frequency wave energy.

In this paper we use electromagnetic waves or radio frequency wave energy and convert this into DC power.

4 ENERGY HARVESTING THROUGH ELECTROMAGNETIC WAVES

As we know that solar energy is a big source of energy but it is not available at night time, that's why we need to convert ambient RF energy into electrical energy. Therefore RF energy can be served for energy purposes at the night and day time. Radio waves are available everywhere because of mobile communication, TV broadcasting, and Wi-Fi communications etc. The omnipresence of electromagnetic (EM) fields is implied just by simple current flow. As we know that we all are surrounded by electric charges. These electric charges are produced for information transfer. Being capacitive, they can carry more energy. These fields can be harvested with the help of high frequency diodes and coils [6].

Dennis siegel invented a device that captures the EM fields like radio waves and WiFi and converts them to stored energy in batteries. His device is able to tap into several EM fields to exploit them, so it can gain redundant energy from the power supply of a cell phone, a coffee machine or an overhead wire by holding the harvester directly into the EM field whose strength is indicated by a LED on the top of the harvester [6].

Depending on the strength of the EM field it is possible to charge a small battery within one day. This system is meant to be an option for granting access to already existing but unheeded energy sources. With the possibility of these sources it can create a new awareness of the invisible electromagnetic spaces while giving them a spatial dimension. There are two types of harvester for different electromagnetic fields: a smaller harvester that is suitable for lower frequencies below 100 Hz which can find in the general mains (50/60 Hz, 16 ,7 Hz) and a bigger one that is suitable for lower and higher frequencies like radio broadcast (~100MHz), GSM (900/1800MHz) up to Bluetooth and WLAN (2,4 GHz) [7].

5 OUR METHODOLOGY

5.1 Sound Energy Harvester

Acoustic Sound is available at most of the places in environment free of cost by human voice, traffic sound, loudspeakers sound and the others. This available sound energy can be harvest for charging the low voltage devices. In this way we developed a device which can be able to charge the mobile phone battery to use sound energy.

When sound appears at the input of microphone it converts the sound into electrical energy. This energy is fed into charging circuit then rectifier circuit thus at last output of rectifier circuit provides the significant amount of voltage to charge the mobile phone battery.

5.2 Result of sound energy harvester:

1. Sound wave of low frequency (20 hertz to 20k hertz) applied at the input stage of sound energy harvester.
2. At input stage of the circuit Microphone acts as transducer and convert sound energy into electrical signals at its output stage.
3. In input stage of bias stage resisters are used to provide proper biasing for microphone circuit.
4. Output of microphone bias stage is an electrical signal which is applied at the input of next stage that is amplified stage.
5. At the output end of amplified stage amplified A.C. sine wave of 5 volt is achieved for applied input frequency of 60 hertz.
6. This A.C amplified signal is to be given at rectifier stage.
7. At the rectifier stage the A.C signal of 5 volt is converted into Direct current and then applied to the Battery of cell phone.
8. It is noticed that the output voltage is the function of input frequency which is applied at the microphone input end of sound wave.
9. Output voltage changes with respect to change in the frequency of input sound wave.

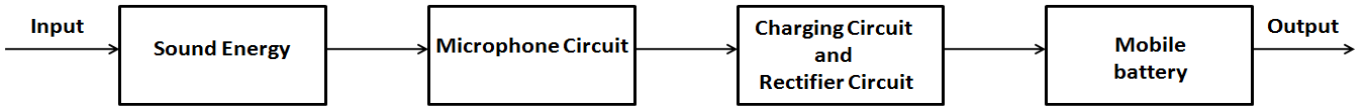

Fig. 1. Block Diagram of Sound energy harvester for charging mobile phone battery

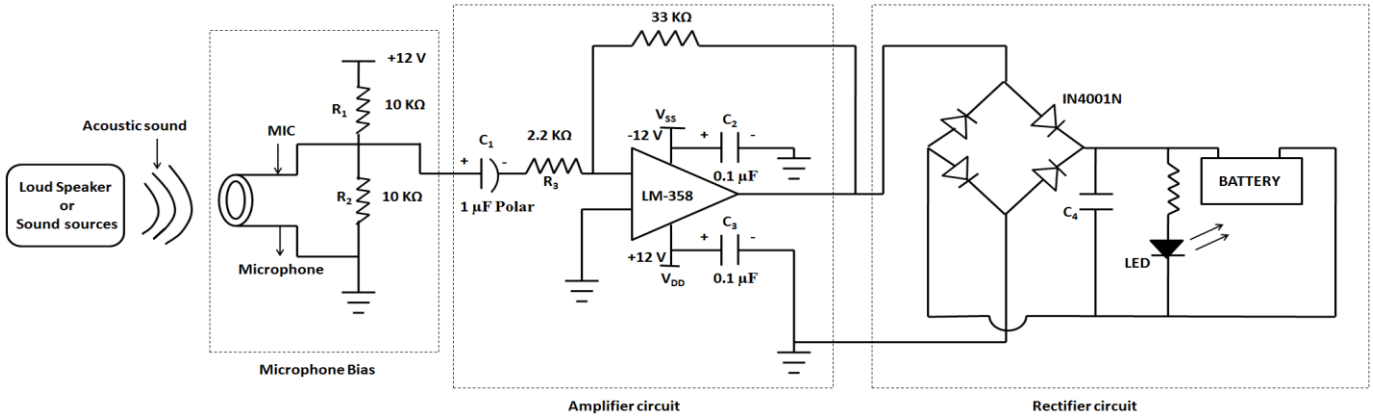

Fig. 2. Design circuit for sound energy harvester for charging mobile phone battery

6 FUTURE ASPECTS

Mobile Phone No Need To Be Charged: A mobile phone that never require recharging sound too good, Nokia says it's developing technology could draw enough power from ambient radio waves to keep a mobile phone battery topped up [8]. Markku Rouvala, a researcher from the Nokia Research Centre, in Cambridge, U.K says that ambient electromagnetic radiation emitted from various sources could be converted into enough electrical current to keep a mobile phone battery topped up [9]. In our project work we get sufficient DC voltage from radio waves to charge small voltage battery.

- This project is made to utilize the renewable energy sources which are available in the environment, but this project is still depended on non-renewable energy sources (such as biasing voltage). Therefore by using multiple harvesting techniques (such as solar energy) we are trying to make this project almost independent from non-renewable energy sources.
- The significant amount of sound energy is available on environment most probable at whole day. Thus utilization of this sound energy (traffic sound, music sound etc) to charge the mobile phone battery is the next phase of our project and we are working on this direction.
- Is the available sound energy enough to operate the cell phone in a day? Or how much time a person applied sound to charge this device for operating mobile phone in a day? We are calculating to provide the correct answer of above questions.
- There may be plenty of devices in general life which can operate at low voltage. Therefore we are going to make sound energy harvester for versatile use of charging the batteries of various devices (e.g. Mobile phone battery, sensor node battery, WiFi modem etc), which are operating on low voltage.

7 CONCLUSION

In this paper we presented the significant possibility to harvest the low frequency sound energy. Sound energy is available at wide level in the environment and it can be harvested. This paper focuses on the utilization of sound energy which can be harvested. Sound energy harvesting technique can be utilized for fulfilling energy requirement at rural areas as well as urban areas. By applying this methodology till now we achieved the output voltage from 0.5 volt to 7 volt and it would be increased by varying the circuit parameter. This paper is presenting an effort to overcome the energy requirement problem by using the sound energy harvesting technique.

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