Rf Energy Harvesting & Data Analytics

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Abstract: With the increasing use of non-renewable sources of energy in today's world, it becomes very important to preserve the resources for the upcoming generations. So in this paper we present an alternative source of energy as RF energy. This RF energy can be converted into electric energy and be used in low powered wireless devices. And we can find maximum energy at particular location by Data Analytics. Machine learning proves to be one of the best way to do the data analytics. Thus, in short, having a continous source of electricity with its data analysis proves to serve a better way of using and preserving energy.

Keywords - Radio Frequency, Energy Harvesting, Antenna, Data Analytics.

I.   Introduction

The use of non renewable energy soureces are increasing day by day and it it may lead to its extinction at some point of time. Hence it becomes very important to look after this issue. Thus energy harvesting can be used at this point of time. Energy harvesting is a process by which energy sources can be converted from one form to another. Some of the well known sources are solar energy, wind energy, tidal energy, and the wide electromagnetic spectrum. But among all these, the one with the least disadvantage or in other words; the most beneficial energy source is the RF energy source.

Radio Frequency Energy Conversion (RFEH) technique is used in converting the electromagnetic energy into electric energy(i.e. voltage or current). Here, in India there are cell towers which transmit in the frequency range of 869- 890 MHz in CDMA, 935-960 MHz in GSM 900and 1810-1880MHz in GSM 1800 bands. It transmits 10 to20W per carrier; there maybe 3 to 4 carriers and 3 to 4 operators on a single tower or spread over the roof top of buildings.

The signal strength can be calculated using Friss transmission formula as

$$Pr=PtGtGr*[\lambda/(4\pi R)]2$$

Where,

Pr = Received Power

Pt= Transmitted Power

Gt= Gain of the transmitted Antenna

Gr= Gain of the receiver Antenna

R= Distance between the transmitter and receiver antennas.

In particular, RFEH is a very appealing solution for use in body area networks as it allows low-power sensors and systems to be wirelessly powered in various applications scenarios.Data analytics is a process by which the whole output of the RFEH be figured out in terms of graph which will clarify the peak values of the current at different places in different times. Unsupervised machine learning is a process by which the data can be feed into the machine to obtain a peak i.e. maximum and minimum values at different places at at different times.

Figure 1 shows the block diagram of circuit,
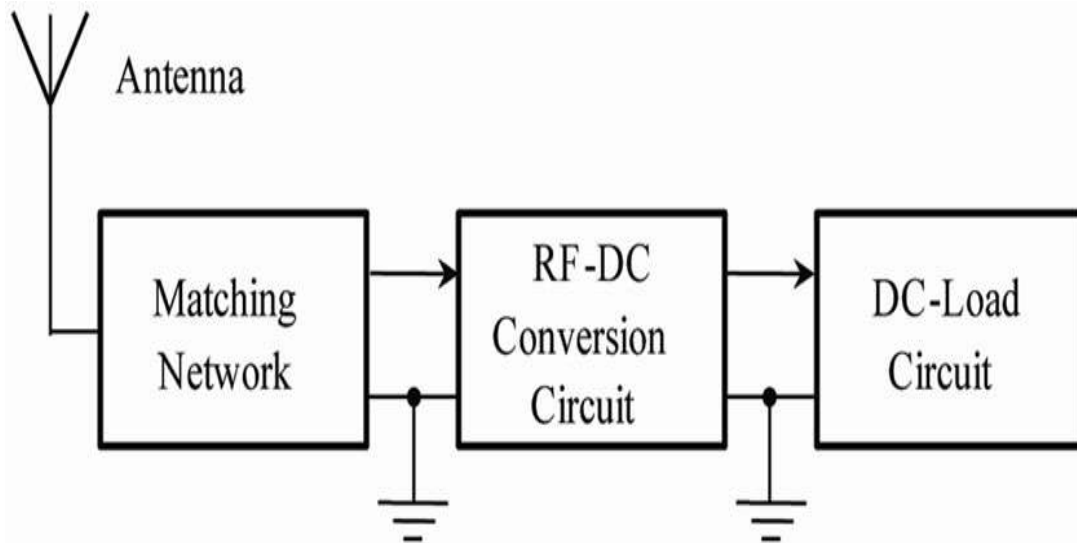
II.   Circuit Diagram

The detailed information about the RF Energy harvesting and the details about the basic compoents are given in this section.

A. Antenna

The most complicated part of the RFEH is the antenna since it decides the maximum power output. The gain of the antenna is decided by the Antenna. The use of antenna has increased a lot due to its ease of installations and its thin planar profile which can be easily installed on the consumer's product , aircrafts, ships, radars and missiles. A square microstrip antenna (SMSA) is used for the RF energy harvesting system. The Antennas gain is basically 9.1dB. the antenna is designed for GSM 900 (935-969MHz), but it also captures frequency of CDMA(869-890 MHz).

B. Patch Antenna

A patch antenna(also known as a rectangular microstrip antenna) is a type of radio antenna with a low profile which can be mounted on a flat surface. It consists of a flat rectangular sheet or patch of metal mounted on a large sheet of metal called as ground plate. A patch atenna is etched on a metal surface connected to a insulating dielectric substrate like peb, which is again connected to a metal surface on another side forming a ground plate.

C. Rectngular patch:

Rectangular patch antenna is the most common type of microstrip antenna. Its length is one half wavelength long approximately. And in case when air is used as a dielectric medium type its length becomes one half of free space wavelength. The length of the antenna is inversely proportional to the dielectric constant of the substrate.

D. RF to DC Conversion Rectifier:

The Radio Frequency is a AC signal, to get a DC signal from a AC signal, a rectifier is used.
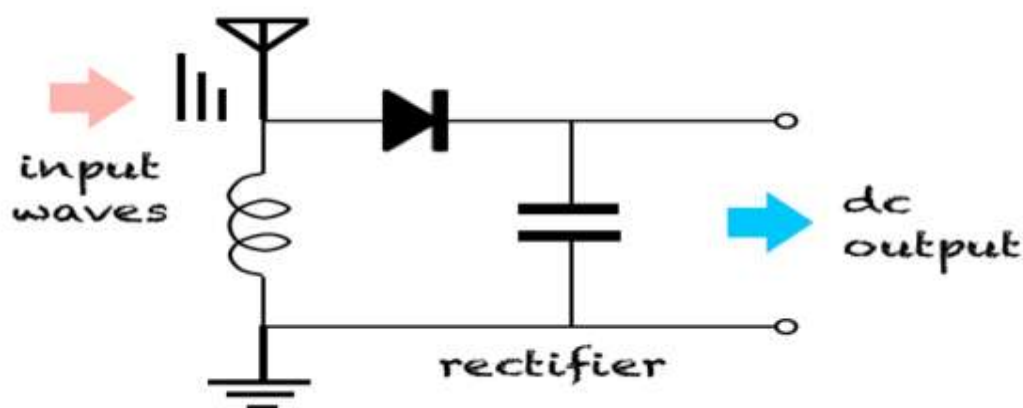
Rectifier are of three types:
1. Single stage voltage doubler.
2. Double stage voltage doubler.
3. Triplet stage voltage doubler.

A rectifier is made up of a matching circuit and a voltage doubler circuit.

Matching circuit:

      In electronics, impedance matching is the practice of designing the input impedance of an electrical load or the output impedance of its corresponding signal source to maximize the power transfer or minimize signal reflection from the load.

Voltage doubler circuit:

      It is a circuit which takes input voltage and ideally gives double voltage at the output side. It needs to be matched with the matching circuit and ideally it gives double voltage as per the input voltage. Basically it is voltage multiplier and it is used to boost the output voltage .

III. Data Analysis

      Data analysis helps us to determine the number of observations and to find a linear relations between all of them. This further helps us to find us the maximum and minimum values of the output at a particular place at a particular time. Basically PCA(Principal Component Analysis) is used for data analysis to find out the data at different place at different time. And basically k-mean is used for clustering of data.

IV. Conclusion

      We converted RF energy into a suitable energy form which becomes suitable to charge low powered devices.   And finally we concluded that this RF energy can be obtained from mobiles, WiFi, cell networks. A continous form of renewable energy available to this generation, saving the non renewable resources for the upcoming generations, thus serving the society in a better way is the aim of this system.

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