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INVESTIGATION OF THE DISTRIBUTIONS OF THE HARVESTING POWER USING SENSOR NETWORK : A CONTEMPORARY SURVEY

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Abstract:- *This paper formulates the Radio frequency (RF) energy transfer and harvesting techniques have lately become alternative methods to power the next generation wireless networks. In this paper, a new design has been proposed for the energy harvesting device, which enables radio frequency (RF) to remove energy from electromagnetic wave . Compared to general alternative energy sources such as solar and wind, there is minimal energy density in RF storage. Existing sophisticated solutions are only effective with narrow frequency range, efficiency is limited in response, and higher levels of input power are required. We study the total available and harvesting power distribution across the entire WSN.*

Keywords: *- RF energy harvesting circuit , voltage multiplier*

1. Introduction: Energy harvesting is a promising research area in the wireless sensor network but is associated with complex research challenges. Regardless of the problem of EH-WSN deficiency problem, the level of power available from harvesting of state's energy is quite small, i.e. 1 to 50 μW (indoors) or several MW (External) for electricity There are insufficient wireless sensor nodes continuously [2]. The ability to transfer energy through at least radio frequency (RF) will ensure that sensor nodes continue for long periods,

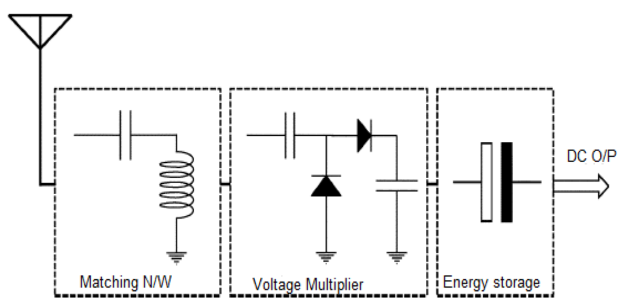

Fig.1. Ambient RF energy harvesting.

without the cost of expensive battery replacement [3]. The current prototype of RF transfer has limited charging range (some meters) and efficiency (40 to 60%). It implements the concurrent and integrated use of multiple ET for a complete WSN power [1]. The concept of wireless energy storage and transfer is not new, but it was displayed 100 years ago by Tesla [5].

Fig 1 shows the components of our introduced energy harvesting circuit. The event is converted into DC power by RF power voltage multiplier. Milan network, made up of inductive and capacitive elements, ensures maximum power distribution from antenna to voltage multiplier. Energy storage ensures smooth power distribution to the load, and when external energy is unavailable, it is reserved for the reserve. Such a design should be carefully prepared: the increase in the number of multiplier level gives high voltage on the load, and yet reduces the current through the final load branch. This may lead to unacceptable charging delay for energy storage capacitor. On the contrary, the lower phase of the multiplier will ensure the quick charge of the capacitor, but in order to reduce the sensor, the voltage generated throughout it may be inadequate (at least 1.8 V that becomes the +Vcc for Mica 2 sensor). Along with similar lines, minor changes in matching circuit parameters turn into a fairly wide range of frequency, with maximum efficiency of conversion of energy, often by several MHz.

To ensure high energy transfer rate, many ETs are required, but they interfere with RF waves from various ATs, which can be important and different constructive and destructive combinations on the network deployment area. Being able to calculate the energy of harvesting at any given point in space is a non-trivial task, as it is a relative location of active ET, path loss information, and at a distance from ET at that time and on a receiver depends on.

The rest of paper is organized as follows. In section 2 we discribed Wireless Sensor Network and Energy Harvesting. In section 3 we detrmine the harvestable energy in the plain. In section 4 we deployed rand node and their uses. Finally, Section 5 concludes the paper.

2. WIRELESS SENSOR NETWORK AND ENERGY HARVESTING

Energy harvesting is a method or process to gain energy from the environment , for examples solar, thermal, air, kinetic, etc. The type of energy harvester is chosen according to the application location and requirements. This ambient energy is captured in small storage devices such as super capacitors or rechargeable batteries.

Energy efficiency has been the focus of WSN Research for a long time because nodes have been operated by batteries. Once node energy is eliminated, node is considered "dead".Due to wireless sensor node locations, sometimes it is not possible to replace or recharge the battery. For example, nodes in or near a volcano [4] are removed from an airplane and therefore, they are not humanly accessible. Therefore, different ways have been proposed to reduce the battery, including electrical control [8] and duty cycle based operation. The latter technique works low
power of the wireless transceiver, whose components can not be used to save energy [7].

In Figure 2, charging and discharging cycles of EH-WSN and Traditional Battery operated WSN has been shown. It is evident from the curve that energy transmission is an unexpected operation and can sprinkle in very small amounts of energy. Latency is another issue because it takes time to charge for proper operation of the network for storage.

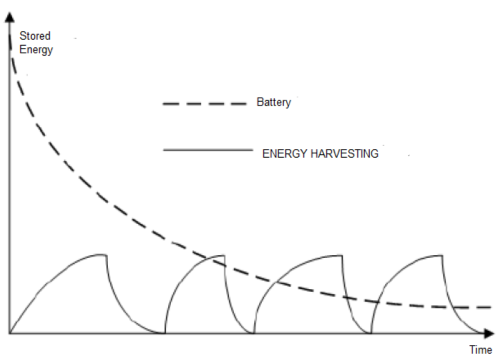

Fig.2. *EH-WSN versus battery-operated WSN*

Each energy harvesting nodes typically have one or more energy harvesters, which convert ambient energy into electrical power. An energy storage device (eg supercakejetter), which is to store harvesting energy, a sensor to understand a volume, a microcontroller for data processing and a transceiver for communication.

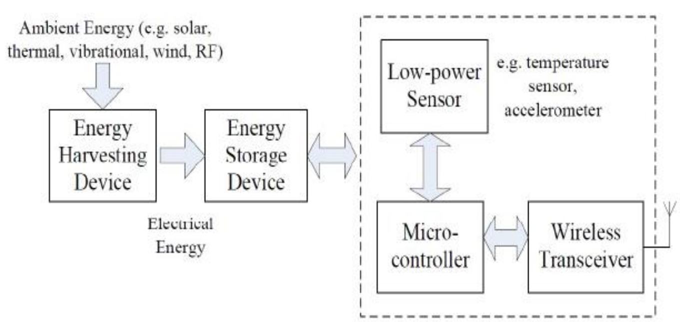

Fig.3. EH-WSN node energy module

EH-WSN node is shown in Figure 3. Different energy sources are being considered for EH-WSN but for a single application, a single energy storage source is not so efficient. For example, solar cutting may be useful in most external applications but not suitable for indoor applications. It is important to make sure that the generated power is suitable for proper operation at the voltage and current level. EH sources are classified as ambient and external sources.

3. 2D ENERGY MODEL: In this section we develop analytical expressions for the total crop energy from two ET on any place in the plane. We extend these prices in the matter of N ET in the plane. ET and sensor are considered to be equipped with ubiquitous dipole antennas, and ET transfers

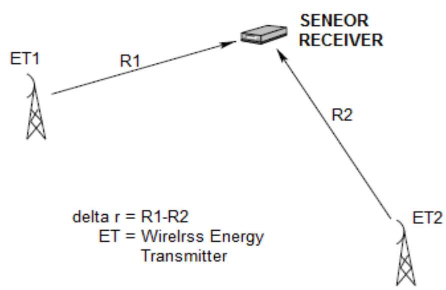

fig .4. Transfer the distance to R1 and R2 for a receiver node at two ET at the same frequency

RF waves with the same initial stage. RF waves carry energy in the the form of electric field. At the distance R is measured by a receiver device from the electric field (E):

$$E = \sqrt{Z_0 S} e^{-jkR} = \sqrt{Z_0 S} e^{-j(\frac{2\pi}{\lambda})} R$$

Where Z_0 is a physical constant indicates the wave impedance of a plane wave in free space [9].

S is the power spatial density at distance R and k is the wave number of the energy wave. Here $S = \frac{P_t G_t}{4\pi R^2}$, where P_t is output power and G_t is transmitter gain of the ET.

Total electric field E_T at receive both Ets transmitting energy:

$$E_T = E_1 + E_2 = \sqrt{Z_0 S} e^{-jkR1} + \sqrt{Z_0 S} e^{-jkR2}$$

Where the first term is the electric field from ET_1 and the second terms is the electric field from ET_2 the magnitude of the field can be expressed as:

$$|E_T| = \sqrt{|E_1|^2 + |E_2|^2 + 2|E_1||E_2|\cos(k(R_1 - R_2))}$$

Therefore, density of the total transferred power at the recriver is:

$$S_T = \frac{|E_T|}{Z_0} = S_1 + S_2 + 2\sqrt{S_1 S_2}\cos(k\Delta r),$$

Where $\Delta r = |R_1 - R_2|$ is the difference of the distances between the two Ets and the receiver.

$$S_T = \frac{G_1 P_1}{4\pi R_1^2} + \frac{G_2 P_2}{4\pi R_2^2} + \sqrt{\frac{P_1 P_2 G_1 G_2}{R_1^2 R_2^2}} \cos(k\Delta r),$$

Where P_1 and P_2 are transmission powers and G_1 and G_2 are the transmission gain of ET_1 and ET_2 respectively.

$$P_T^r = S_T A = S_T G_R (\frac{\lambda^2}{4\pi}),$$

Where G_R is the gain of RF harvester antenna. The total received power from two ET_S would be as follows:

$$P_T^r = P_1 G_1 G_r (\frac{\lambda}{4\pi R_1})^2 + P_2 G_2 G_r (\frac{\lambda}{4\pi R_2})^2$$
$$+2(\frac{\lambda}{4\pi\sqrt{R_1 R_2}})^2 G_r \sqrt{G_1 G_2}\sqrt{P_1 P_2} \cos(k\Delta r).$$

If two energy transmitters have same gain (i.e., G_t) and transmission power (i.e., P_t),then total received energy at the receiver node simplifies to:

$$P_T^r = P_t G_t G_r (\frac{\lambda}{4\pi})^2 (\frac{1}{R_1^2} + \frac{1}{R_2^2} + \frac{2\cos(k\Delta r)}{R_1 R_2}).$$

According to the RF wireless charging model, the amount of harvested power by the RF energy harvesting receiver would be

$$P_H = \eta P_T^r$$

Where η is the RF-to-DC conversion efficiency. The harvested voltage could be found by $V_H = F(P_T^r)$ where the function F relates input power to the harvested voltage and depends on the energy harvesting circuit[10].

Similarly weca obtained the total receivrd power from N ET_S as follows:

$$P_T^r = G_r (\frac{\lambda}{4\pi})^2 \left[\sum_{i=1}^{N} \frac{P_i G_i}{R_i^2} + \sum_{\substack{i=1 \\ i \neq j}}^{N} \sum_{j=1}^{N} \frac{\sqrt{G_i G_j P_i P_j}}{R_i R_j} \cos(k(\Delta r_{ij})) \right]$$

Where P_i and G_i are the transmission power and transmission gain of ET_i respectively.If all ET_s have same antenna gain and transmission powers, then the total received energy at the receiver node simpllifies to:

$$P_T^r = P_t G_t G_r (\frac{\lambda}{4\pi})^2 \left[\sum_{i=1}^{N} \frac{1}{R_i^2} + \sum_{\substack{i=1 \\ i \neq j}}^{N} \sum_{j=1}^{N} \frac{\cos(k(\Delta r_{ij}))}{R_i R_j} \right]$$

4. OUTAGE ANALYSIS: In this section, we analyze the performance of wireless energy transfer over sensor networks with more than one ET. A variable number of ET has been randomly deployed in the 50/50 m^2 grid. Center frequency transmits RF energy in 915 MHz with effective isotropic radiated power (EIRP) equivalent to each AT 4 W, which is the maximum transmission power allowed by the Federal Communications Commission (FCC) for Omni-Directional Energy Transfer. All

ET Transmission parameters of the same are considered equal. The parameters of the energy harvesting receiver have been determined with the linear antenna benefit of 6 dBi, according to our double phase energy harvesters [6].

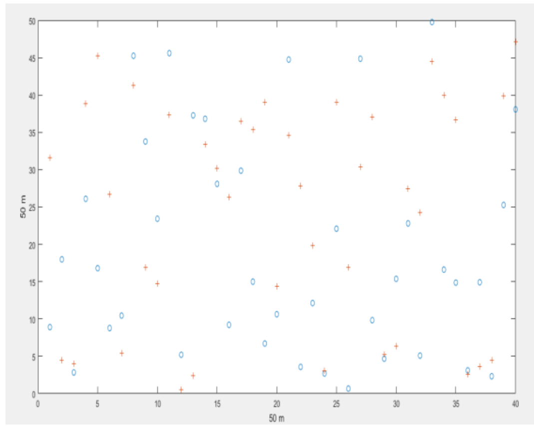

Fig.5. For 40 RAND node deployed

A. FOR RAND NODE DEPLOYED: If I have deployed 40 sensor node randomly on target area . I have problem in representing sensing radius of each sensor node using binary disc model or using 50*50 m^2 grid. In figure 5 we depict that the sensor node random and have shown sensing radius using filled circle. In this figure '+' and 'o' sign denotes RAND function present on x and y axis respectively.

5. CONCLUSION: In this paper we concluded closed matrix forms for total crop production at any place in any WSN with multiple ET by capturing spatial correlation between ET and their constructive and destructive energy transfers. We provide formulas for plane and 2D WSN deployments. In this paper we also deployed RAND node on x and y axis respectively. Which will help us to calculate the distance between two nodes.

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