A Review on Energy Harvesting Techniques in Wireless Sensor Networks

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Abstract: Wireless sensor networks are highly prone to energy deficiency problems. Since the star of the wireless technology the requirement of a setup which is very efficient in terms of power was required. The start of the inventions of new protocols and routing schemes was very prominent in the modern era of wireless communication. Because of the wireless behavior of wireless sensors networks it is very necessary that we make our routing schemes and protocols very efficient. The scope of work is very large but due to scarcity of different resources and being new in the field of wireless research we have covered some very bright aspects of the topic. Energy harvesting thus also become very important and in our study we have covered two techniques described in this paper that are Harnessing thermal and vibration energy.

INTRODUCTION

Electronics and electrical equipments have become an important part of our daily lives. From refrigerators to smart phones, almost every facet of our daily life is based on some type of electrical device. However, we often take into account that how much amount of electricity is required to maintain our habits. The evaluation of the monthly bill does not give us the exact idea or decision that how much electricity is used by us in one single day and how that have effect on our environment. If we leave any electrical device plugged in the socket is a prime. Even if when we turn off the electrical devices then to the passive power is dissolve in continuous manner till the time they are connected in the electrical outlet. This leakage power is called as vampire power or standby power. According to Energy Star, “the average U.S. household spends $100 per year to power devices if they are working or not. On a national basis, standby power accounts for more than 100 billion kilowatt-hours of annual U.S. electricity usage and more than $10 billion in annual energy costs”. When the energy of the source is depleted then it cannot fulfill its role until and unless the source of energy is replenished. Therefore it is generally believed that when the battery runs out the use of the wireless sensor expires. Most of the researchers on wireless sensor networks till now have considered the use of portable as well as limited energy source likes batteries so that they can provide power to the sensor and they mainly focus on increasing the lifetime of the network with minimum use of energy. The portable energy sources such as batteries will experience the leakage of current that will
lead to the drainage of the resource when they are not in use, also there can be flaws in the packaging because of the long term wear and tear which would result in the environment problems. Limitations of using aircrafts can arise in some areas which are prone to low altitude clouds and this can cause more obstacles in terms of visibility. Wireless sensors have become an interesting topic to tackle this issue. But this technology also has its own challenges. The high power consumption of combustible gas detection systems is a restricting factor which needs to be considered. Sensors designed for this purpose and having on board batteries cannot have a long time life cycle and moreover in some applications like structural health monitoring of critical infrastructures and buildings, it is difficult to replace or recharge batteries. These methods also attempt to handle stochasticity in the energy profile by comparing observed energy input with expected input (given by the model) and adjusting the duty cycle accordingly. We present an alternative, model-free approach to solving this problem using techniques from adaptive control theory and show that our system achieves better performance on a wider class of environmental data sets than previous approaches. Additionally, our system does this while making no assumptions about the nature and dynamics of the energy source, making our approach more easily implemented in real systems where data about the energy source may not be available beforehand. We have further defined the ideal WSN which is powered only by energy harvesting which is referred as Wireless Sensor Network which is powered by Ambient Energy Harvesting (WSN-HEAP) and then further we have discussed about the challenges that we will face in designing the networking protocol for such type of WSN’s which are starting from the characteristics of the energy source. Therefore, demands on response time require that the measurement of gas concentration for example of combustible gases be done no more than every 120 s. Nature provides us with variety of energy sources which can be harvested and implemented for wireless sensor systems.

**LITERATURE SURVEY**

[1] In this paper the author says that wireless sensor networks (WSNs) study has mainly assumed the use of a portable and limited energy source, viz. batteries, to power sensors. Without the use of energy the sensor is also of no use and it will not be able to contribute in the utility of the network as a whole. Frequently substantial research efforts have been made on the designing of the energy-efficient networking protocol to increase the lifespan of WSNs. After that, an alternative to powering WSN’s has also been studied, which was to convert the ambient energy from the atmosphere into electricity to provide the power to the sensor knobs. Since the renewable energy technology is not new to the systems in use are too heavy for
Those small are sufficient for the use in wireless sensors are most likely to provide only and only sufficient energy to the power sensor intermittently and not continuously. Sensor knobs need to take advantage of the intermittent availability of energy so that it can sense it quickly and can transmit the data. The authors on this paper research and describe about the challenges in designing networking protocols for such WSN’s powered by ambient energy harvesting.

[2] Authors in this paper explain about how with the wide use of wireless sensor, the management of their energy resource has become the main title of research. Wireless sensors mostly use batteries as their power supply but in few applications battery replacement take considerable amount of time which can affect the process which is been monitored. It is has the possibility to harvest energy from the sources in nature for wireless sensors. In this paper the authors have given the review of the current alternative energy sources which have been illustrated in order to address the achievability of their integration with the wireless sensor network.

[3] In this paper authors explains the effect of increasing in number of wireless sensor network arrangements are using harvested environmental energy to expand system lifespan. Since the temporal information of such energy sources demonstrates huge variableness due to active weather stencil, the main issue was in designing an adaptive duty-cycling mechanism which would permit the sensor node to maintain their power supply at adequate levels by adapting to changing environmental conditions. They introduced a new method for solving this difficulty based on outcome from adaptive control theory and show that we attained improved presentation than earlier approaches on a broader class of energy source data sets. And they also included a tunable device for reducing the discrepancy of the node’s duty cycle over time, which is a significant characteristic in tasks such as event checking. They obtained drops in discrepancy as great as two-thirds without negotiating task act or ability to preserve energy unbiased process.

[4] Authors in this paper discuss about the issues which are addressed in this paper, their work proposed a novel, plug-through power checking system for profitable and inhabited use. The device detected any appliance’s power utilization via a current logic transformer, which wirelessly combines magnetic energy from the
machine to output an electromotive force voltage. The voltage signal was passed on to the analog to-digital converter of a GINA radio mote, which wirelessly broadcasts the data to laptops or smart phones via the Internet using 6LoWPAN wireless protocol. This permitted patrons to outlook their real-time power practice from the expediency of their handheld device. The optimized design cost less than $5 to make and is effortlessly installed, since the device not at all requires electrical contact with the opening but is in its place powered by searched magnetic energy, which charges an on-board storage space capacitor. For a main current of 12.6 A RMS, the device harvests up to 7 mW. Compared to at hand power checking devices in the market, their device shows off at least 6 times decrease in size and cost, serving as a troubleshooting technology to the power monitoring business while encouraging extra meticulous electricity usage.

[5] Load balancing in the cloud computing atmosphere has an significant impact on the presentation. Good load assessment makes cloud computing well-organized and improves user contentment. This paper introduces a better load balance model for the public cloud based on the cloud partitioning concept with a switch mechanism to choose dissimilar strategies for dissimilar situations. The algorithm applies the game theory to the load balancing strategy to advance the competence in the public cloud atmosphere.

[6] In this paper the author discuss about the wireless sensor networks (WSNs) research which has largely assumed the use of a transferable and limited energy source, viz. batteries, to power sensors. Without energy, a sensor is essentially of no use and cannot add to the utility of the network as a whole. Consequently, substantial research efforts have been spent on designing energy-efficient networking protocols to maximize the lifetime of WSNs. However, there are emerging WSN applications where sensors are required to operate for much longer durations after they are deployed. Recently, an alternative to powering WSNs is being actively studied, which is to convert the ambient energy from the environment into electricity to power the sensor nodes. While renewable energy technology is not new the systems in use are far too large for WSNs. Those small enough for use in wireless sensors are most likely able to provide only enough energy to power sensors sporadically and not continuously. Sensor nodes need to exploit the sporadic availability of energy to quickly sense and
transmit the data. This paper surveys related research and discusses the challenges of designing networking protocols for such WSNs powered by ambient energy harvesting.

Harnessing Vibration Energy for Harvesting Energy in WSN
Harnessing the vibration energy for harvesting energy for WSN is a very cost efficient solution of energy harvesting for remotely located Wireless Sensor Nodes in a Wireless Sensor Network. The concept of vibration-driven energy generator (micro-generators) is basically designed on two principles. These are categorized into two types of micro-generators; those that utilizes the direct application of force (piezoelectric devices) and those that utilizes inertial forces acting on a proof mass (strain gage). A new MsM (Magneto resistive) vibration harvesting technique is also devised. The energy harvesting system utilizes the ambient vibration to generate energy.

A Mass to spring unit is connected which is associated with a damper in order to reduce effect of shock on spring unit. A piezoelectric element is associated with the mass which on vibration strikes on piezoelectric element causing piezoelectric element to generate small impulses of electric current. These impulses are passed via a power regulation unit which conditions the impulses into a steady voltage. This energy is then stored into battery unit which then drives the device.

![Figure 1: A block diagram model of a piezoelectric vibration based energy harvesting unit](image)

**Fig1: A block diagram model of a piezoelectric vibration based energy harvesting unit**
Harnessing Thermal Energy for Harvesting Energy in WSN

Thermal energy harvesting in WSN is another popular technique of generating energy in Wireless Sensor nodes in order to make them self-sustained unit. When there is a difference of temperature between two bodies, the current starts to flow between them. This general concept is utilized in designing high efficiency thermal energy harvesters. Thermal energy harvesters utilizes the Seebeck effect i.e. if there is a temperature difference between two dissimilar electrical conductors, a voltage difference is produced between two elements. A thermocouple is used which utilizes this Seebeck effect to generate energy using the difference of temperature. The hot object is generally the heat sink of the device itself and cold surface is the environment. The system’s efficiency is about 7-8% as Carnot efficiency puts an upper limit on heat energy that can be recovered.

![Fig 2: A Block Diagram of Thermal Energy Harvesting System in a WSN](image)

Conclusion

In this review, we reviewed two of the most used techniques in Energy harvesting in Wireless Sensor Networks. The vibration energy harvesting technique is very efficient system and utilizes ambient vibrations to harvest energy. The thermal energy harvesting technique is also very powerful technique in energy harvesting and utilizes Seebeck effect using thermocouples to generate energy. Both techniques have their merits and demerits based on efficiency, cost, robustness etc. Thermal based system is highly robust has it has no mechanical part. Vibration based system has higher efficiency than thermal based system since Carnot efficiency has an upper limit on heat energy that can be recovered.

REFERENCES


