Chapter 8
Review of Applications of Energy Harvesting for Autonomous Wireless Sensor Nodes

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ABSTRACT

Energy harvesting has been the empowering innovation in the internet of things to power the wireless sensors envisioned to be deployed ubiquitously. In recent decades, there has been an increasing drift towards remote sensor systems from wired networks in commercial and industrial applications due to expensive cabling and their non-feasibility in remote locations. The challenge is to convert these remote sensor systems into self-powered wireless sensor networks using energy harvesters. A brief review of current trends in the applications of energy harvesting in remote sensor systems is discussed in this chapter. A generic architecture of the energy harvesters and their transduction mechanisms and the design methodology of energy harvesters is introduced. The existing business products and the potential prototypes of the energy harvesters with their application domains are reported.

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INTRODUCTION

The emergence of global computing or Internet of things (IoT) is feasible by massive deployment of inexpensive sensors(Miller 2015) (Weber et al. 2010) in the things that need to be controlled using internet protocols for remote sensor networks. The dependence of the energy consumption of wireless sensor nodes (WSNs) on their batteries is a significant barrier to such a widespread deployment (STMicroelectronics 2013). Batteries are unreliable and cumbersome to be replaced if the WSNs are located at hard to reach locations or hazardous areas such as radiation dose monitoring in nuclear plants(Liu et al. 2017). Another drawback of the batteries is their size when estimated to the shrinking size of the wireless sensor motes. Energy harvesting has thus emerged as a replacement to these batteries for powering the sensors using the ambient energy sources present in their vicinity. The objective of this chapter is to identify the state-of-art as well as the potential applications of energy harvesters. A brief review of the energy harvester concept, how energy harvesters need to be designed and the current energy transducing technologies is done in the introductory part followed by detailed review of each application.

ENERGY HARVESTER AND ITS NEED IN WSNS

Energy harvesters are energy transducers that generate negligible amount of electrical energy from the ambient energy sources available around the wireless sensor nodes and power them (STMicroelectronics 2013). Over the years, the cost of sensors has drastically decreased from an average of $1.30 to 60 cents per sensor as reported by Goldman Sachs (Jankowski et al. 2014) and is assumed to continuously decrease in the future thus fueling the deployment of smart sensors everywhere as envisioned in the concept of internet of things (IoT).

A typical smart WSN is as shown in the Fig.1 (a). It comprises of a microcontroller for processing sensor data, wireless antenna, a single sensor or range of sensors and battery. The new concept for IoT is to replace the battery with an energy harvester and rechargeable battery as shown in Fig.1 (b). Also, the microcontroller is replaced by the ultra-low powered microcontrollers such as MSP430 (Borgeson 2012) or the STM8L/32L series (STMicroelectronics 2017), thus reducing the power consumption. The power required for such sensor is less and intermittent.