MECHATRONICS BOOK SERIES SYSTEM DESIGN AND SIGNAL PROCESSING

VOLUME 1

Editors
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CHAPTER 1

Energy Harvesting for Wide Area Sensor Networks

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1.1 Introduction

Energy harvesting, the process converting ambient energy to electrical energy, is an attractive method to power sensors network in cost effective and practical ways, especially for low power and small scale devices. Exploitation of ambient energy through harvesting eliminates or at least reduces the need of batteries. Batteries have finite operating lifetime and thus require periodic change. This can be troublesome for sensors that are placed in several locations in a network. Energy harvesting approach offers the possibility to power sensors network almost indefinitely, thus increases the reliability and performance of sensors network. This paper highlights various aspects of energy harvesting system for use in a wide range of sensors network. The basic concept of harvesting system, harvestable energy sources and harvesting circuit architecture are presented. Further, this paper points out existing energy harvesting systems and their applications.

The emergence of technologies such as very large scale integration (VLSI), Micro-electro-mechanical systems (MEMS) and wireless devices enable sensors network used for various monitoring applications such as in industrial equipment, vehicle systems, buildings, healthcare and so on. A sensors network consists of a tiny computer called sensor nodes that can perform sensing, processing and communicating processes.

1.2 Sensor Nodes

Sensor nodes comprise four major components: (1) power supply component, (2) sensing components, (3) processing components, and (3) communicating components [1]. Sensing components consist of a set of sensors that interact with physical world, while data measurement and storage are done by processing components like microcontroller. Communication components are to communicate with the outside world and other nodes through wireless communication devices. Application of sensor networks improves the data accuracy since the networks are able to collect large number of measurement data from an interval of a few seconds to several hours directly. This capability can be used to provides a time-lapse view of desired phenomenon [2].

The major challenge of sensor networks system is to ensure long term operational stability through the use of suitable power supply. Conventional primary battery cell to power sensor nodes fail to meet sensors network operation and design goals in term of lifetime, cost and size. The major limitation of primary cell battery is its finite life times which required replacement once the battery reach the end of life time. Generally, replacement of battery becomes tedious and it is an expensive task for remote sensors that are located in forest, building structure and space station. Furthermore, in biomedical applications, the replacement of battery is almost impractical since the device is implanted inside the human body and it requires continuous power supply. The use of large capacity battery could extend the lifetime and operation of nodes, however it will increase the size and