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ENERGY HARVESTING FOR WIRELESS SENSOR NETWORKS: OPPORTUNITIES AND CHALLENGES

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ABSTRACT
The spatial distributed nature of wireless sensor networks (WSNs) often requires that batteries power the individual sensor nodes. However, when the battery power is depleted, the sensor node must be manually retrieved and the battery replaced. For long term applications, retrieving thousands of sensor nodes to replace the on-board battery is costly. The battery replacement is not only expensive, but can be a very difficult task in applications such as implanted biomedical devices and cases where sensors are embedded in civil structures. As a way out of the power supply challenge in WSNs, it is critical that alternatives to batteries be aggressively explored. The most attractive alternative which has received great research attention in the last decade is energy harvesting technology. This paper presents the opportunities and design challenges of the latest energy harvesting techniques.

KEY WORDS
Alternative energy, energy harvesting, wireless sensor network.

1. Introduction

Advances in semiconductor integration techniques and the research output from microsystems and wireless technologies have brought increasing interest in low-power electronic wireless devices. The most promising devices being wireless sensor nodes in wireless sensor networks (WSNs) [1]. A wireless sensor node consists has sensing, signal processing, embedded computing and communicating capabilities. The task of each node is to collect and transmit data to the outside world via a radio link. WSNs have wide applications in agriculture and food industry [2], industrial instrumentation and automation [3,4], structural health monitoring of civil structures [5], medicine and healthcare [6], and military applications [6,7]. The spatial distributed nature of WSNs often requires that batteries power the individual sensor nodes. However, when the battery power is depleted, the sensor node must be manually retrieved and the battery replaced [8]. For long term applications, retrieving a sensor node to replace the on-board battery is costly. The battery replacement is not only expensive, but can be a very difficult task in applications such as implanted biomedical devices and cases where sensors are embedded in civil structures. As a way out of the power supply challenge in WSNs, it is critical that alternatives to batteries be aggressively

explored. The most attractive alternative which has received great research attention in the last decade is energy harvesting technology. Energy harvesting is the capturing of energy in operating space of the wireless sensor device and converting it into usable electrical energy to power the device. The harvested energy can be used to recharge, complement or replace the on-board battery. Energy harvesting technologies would enable the realisation of more ubiquitous, long-life and truly autonomous WSNs which do not require human intervention for energy replenishment [9].

In this paper opportunities and challenges presented by different energy harvesting techniques are presented. Section 2 presents an overview of the power requirements of wireless sensor networks (WSNs).Section 3 discusses the energy harvesting sources available for powering WSNs. Section 4 presence the future outlook of energy harvesting technology. Finally section 5 is presents the conclusion.

2. Overview of WSNs Power Requirements

The need to power wireless devices, particularly wireless sensor nodes in a Wireless Sensor Network (WSN) has greatly spurred research in energy harvesting technologies [1-8]. A typical wireless sensor node consists of the following subsystems: sensing, computing and communications. The sensing subsystem consists mainly of the MEMS-based sensors and an analogue to digital converter (ADC) and its task is to convert the physical phenomena of interest into digital signal form. The computing subsystem is usually a microcontroller unit