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Nano Antenna for Energy Harvesting

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Abstract
In this paper, the design & development of a Nano Antenna for Energy Harvesting is presented in a nutshell. The ever-increasing demand for energy in today's world has compelled us to seek alternative energy sources. While photovoltaic devices are being researched and developed to improve their efficiency, they can only extract energy from the visible region of the electromagnetic spectrum. Consequently, a new device called a Nano antenna has been developed that can convert thermal energy from the infrared region of the spectrum into electricity. In the near future, it is expected to contribute significantly to various fields, including space communication, broadband wireless links, wireless optical communication, mobile communication (5G), radar detection, and higher-order frequency applications. Nano antennas can be fabricated using different techniques such as electron beam lithography, focused ion beam, and nanoimprinting lithography. This paper focuses on the nanoimprinting lithography technique, as it is a cost-effective and high-throughput method. Additionally, the issue of material selection for nano antennas is a significant challenge, and the paper will discuss strategies for overcoming it. The work done & presented in this paper is the result of the mini-project work that has been done by the first sem engineering students of the college and as such there is little novelty in it and the references are being taken from various sources from the internet, the paper is being written by the students to test their writing skills in the starting of their engineering career and also to test the presentation skills during their mini-project presentation. The work done & presented in this paper is the report of the assignment / alternate assessment tool as a part and parcel of the academic assignment of the first year subject on nanotechnology & IoT.

Keywords
Nanotechnology, Antenna, Transmitter, Receiver

Introduction

The proliferation of wirelessly interconnected, untethered devices is on the rise in modern society, giving rise to the Internet of Things. These autonomous devices are rapidly decreasing in size, reaching the millimeter scale and below, posing significant challenges to how we can power these devices [1]. This article provides a survey of current approaches to extract energy from ambient or externally supplied sources, such as radio-frequency, optical, mechanical, thermal, nuclear, chemical, and biological sources, to generate electrical power for micro- and nano-systems. The article also discusses the potential for scaling these energy conversion methods to smaller dimensions, considering both current technologies and potential future developments in nanoscience [2].

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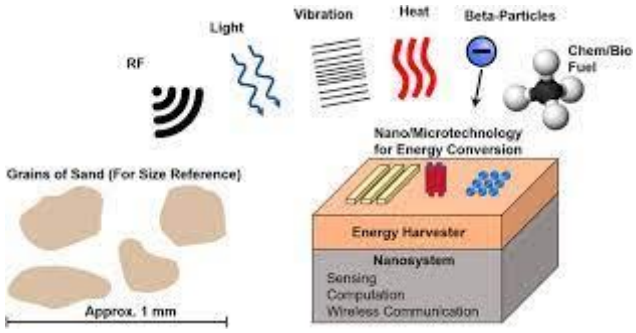

Fig. 1 : Nano energy harvesting concepts

Design concepts of the antenna

The rise of self-powered systems at the microscale and nanoscale is enabling transformative networks for health, safety, and quality of life [3]. The Internet of Things (IoT) has already brought about significant changes in areas such as smart homes, medical devices, infrastructure, and transportation, with billions of connected devices and approximately 127 new devices connecting to the web every second in 2020. However, the continued progression of IoT involves scaling down the dimensions of cyber-physical systems to the millimeter scale and below, creating a completely new landscape with new functionalities and applications [4]. This is termed the Internet of Tiny Things (IoT2) or the Internet of Nano Things (IoNT). In this work, the term IoT2 is used inclusively for all sub-millimeter systems at both the nanoscale and microscale. The Fig. 1 gives the nano energy harvesting concepts, where as the Fig. 2 gives the antennas design concepts [5].

Advances in power gain antenna

Advancements in low-power circuits and heterogeneous integration have enabled the development of small autonomous devices, often called motes, as part of a vision of "smart dust" [6]. However, delivery of sufficient power and energy to these autonomous systems is a key requirement for their success [15]. Traditional power solutions, such as battery-powered systems, direct wired connections, and wireless power delivery, are readily available for systems at approximately the centimeter scale and larger. [7] However, scaling dimensions below a centimeter presents new challenges due to rapidly decreasing efficiency of wireless power transfer at millimeter and smaller dimensions, and IoT2 devices cannot utilize conventional integration technologies involving printed circuit boards, current battery technologies, or physically accessible ports for wired connections, such as the universal serial bus [8].

Fig. 2 : Model setup & the ddeflection on the Multi meter with the antenna design concepts

The approximate power density required for these systems is on the order of 100 nW/mm2 based on recent mm-scale systems [9]. Therefore, this article will summarize power and energy sources and considerations as systems are reduced to the micro- and nano-scale, with attention specifically focused on the outlook for IoT2 systems [10]. To address the challenges of power delivery at the micro- and nano-scale, this article will survey existing approaches to harvest energy from ambient or externally supplied sources, including radio-frequency, optical, mechanical, thermal, nuclear, chemical, and biological modalities [11]. The outlook for scaling these energy conversion approaches

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to small dimensions will be discussed in the context of both existing technologies and possible future nanoscience developments. As devices become increasingly smaller, the ability to generate sufficient power and energy becomes even more crucial [12]. This article aims to provide a comprehensive overview of power and energy sources available for IoT2 devices and will aid researchers and engineers in developing novel approaches for powering these devices. The continued advancement of IoT2 technology will enable new applications and improved functionality, ultimately enriching our lives in new and exciting ways [13]. The Fig. 3 gives the concept of incoming & outgoing waves, whereas the Fig. 4 gives the nano antenna for energy harvesting [14].

Diagrams of the design process

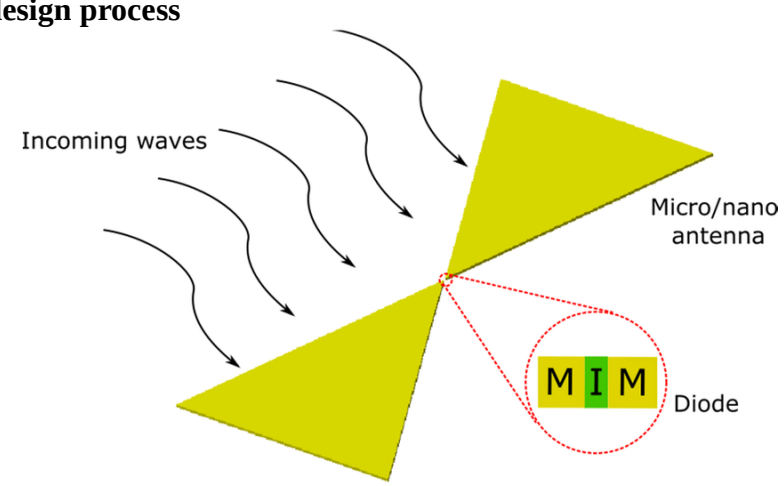

Fig. 3 : Concept of incoming & outgoing waves

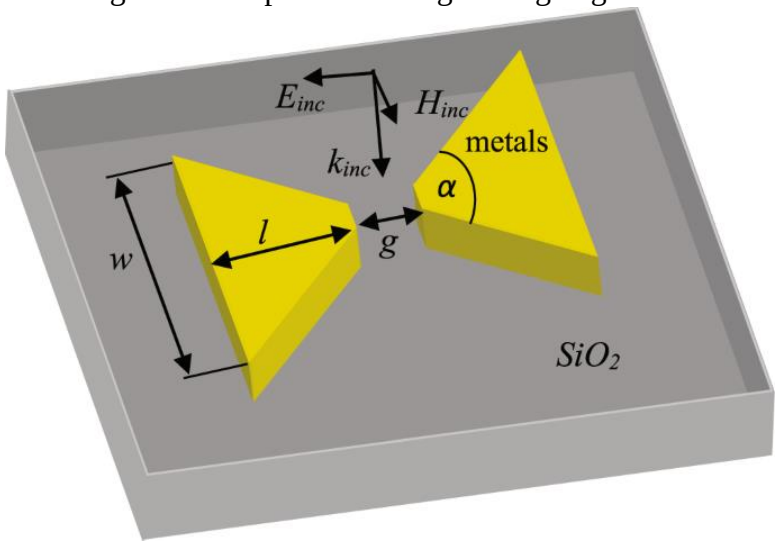

Fig. 4 : Nano antenna for energy harvesting

Conclusions

This article provides a comprehensive review of the current state-of-the-art in RF power harvesting technology. RF power harvesting is a promising technology that is expected to replace batteries in the near future. Several applications of RF power harvesting have already been realized, and a basic RF power-harvesting unit consists of three modules: the antenna, impedance matching network (IMN), and voltage multiplier. The system's overall efficiency depends on the proper integration of all three modules.

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