Chapter 6
Realizing the Benefits of Energy Harvesting for IoT

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ABSTRACT

Different types of energy which generally fulfill the requirements of computing are mostly from thermal, mechanical, solar, wind, acoustic, and wave. Typically, IoT devices are powered by batteries that have limited lifetime, and thus these IoT devices need to be self-powered or require supportive energy sources that uninterruptedly power IoT devices. Energy harvesting is one of the techniques that can be applied to power these devices, which is a procedure of apprehending energy from lone or more energy from renewable sources in the proximate atmosphere known as environmental energy which can be renovated into usable electrical energy. Numerous researches are being carried out to harvest energy. This chapter is the extended version of the previous work carried out and analyses the present works on the application of IoT in energy harvesting systems and extant different research works carried out by the investigators to classify them.

1. INTRODUCTION

Internet of Things (IoT) sometimes referred to as Internet of objects are inter-connection of commonly used networked objects (Humayun et al., 2020). IoT are physical devices or virtual devices connected over the internet using 4G/5G supported phones wirelessly. These devices have inimitable ID which enables them to be inimitably identified. These devices are not only connecting devices but are also used for direct or indirect communications with one another by sending or receiving data. These devices excerpt information via applying the process of filtering followed by processing and data condensing based on which the information or knowledge can be inferred for performing the respective operations.

IoT devices are dynamic in nature, they are self-adoptable and self-configurable devices. Vermesan et al. (Vermesan et al., 2011) define the Internet of Things as simply an interaction between the physical and digital worlds. These IoT devices are power-driven by batteries which is a main constraint on

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such devices as the batteries capacity is finite. Also, a vast amount of energy is spent when IoT devices connect and communicate with one another, owing to this devices function for partial period, as long as battery persists. One of the feasible options to this energy issue can be solved by using the replaceable batteries which may be operative for smaller IoT systems whereas for huge IoT systems it's not operative and also the price of upholding and substituting billions of batteries is pretty more. In IoT devices consuming Batteries are not continuously helpful as they require human contribution to interchange the batteries. Henceforth, the main concern is for the procurement of electrical power which is preferred to function these devices.

To overwhelm this alternative kind of energy source to traditional batteries are needed to be elegantly devise. Utilization of Energy increase on a day-by-day basis rapidly and henceforth innovative, capable energy resources are required to ascertain. Investigators are realizing novel methods of exploiting profuse renewable energies from varied variety of sources which is a continuing research focus. A favorable answer for such kinds of problematic is energy harvesting which is defined as the process in which energies are captivated from one or more additional ecological sources which include from Solar, Radio frequency, Wind, etc. (Jiao et al., 2017) additional energy sources from heated bodies, foot strikes and finger strokes, etc., collecting and translating them into electrical energy which is operational. The energy harvested powers electrical energy of these devices and surge lifespan of IoT system. Two such energy harvester edifices are presented below:

2. ENERGY HARVESTING ARCHITECTURES

There are two classifications of energy harvesting and they differ from each other in their architectures: (Sudevalayam & Kulkarni, 2011) (a) Harvest-Use: Which is defined as the Energy harvested just-in-time and are directly used (b) Harvest-Store-Use: The Energy which is harvested every time possible and which is stowed for later usage.

2.1. Harvest-Use Architecture

The harvesting system right away powers the sensor node and the sensor node is operational; the power output produced from the harvesting systems need to be uninterruptedly beyond the least operating point. If passable energy is not obtainable, the node gets deactivated Figure 1(a) below depicts the Harvest-Use architecture. Unexpected variations in harvesting capacity near to the least power point caused the sensor nodes to fluctuate in ON/OFF conditions. This kind of system uses mechanical energy bases like pedaling, walking and pushing keys/buttons, etc. For instance, impulse of a keys/buttons deforms piezoelectric material, thus producing electrical energy to direct short wireless messages. Likewise, while walking and running the piezoelectric materials tactically placed in the shoes may deform to different extents which transmits or communicate using RFID signals and to keep track of the shoe-wearer.

2.2. Harvest-Store-Use Architecture

Harvest-Store-Use architecture which comprises of storage components to store the harvested energy and power the sensor nodes as illustrated in Figure 1(b) (Sudevalayam & Kulkarni, 2011). Energy storage is valuable when harvested energy is existing and surplus than to the current usage. Excess energy is