



Chapter 13

Innovative Energy Harvesting Techniques for Robotics: Enhancing Autonomous Systems With IoT


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ABSTRACT

Apart from powering robots with innovative energy harvesting, the domain of robotics relies on such integration to bring about autonomy and efficiency into systems. This chapter describes state-of-the-art energy harvesting techniques designed for

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use in robotics, focusing particularly on the aspects of sustainability and lifetime of operation. Some of the techniques considered in this work are kinetic energy recovery, thermoelectric generators, and solar cells, which are analyzed with regard to their potential applications for autonomous power supply. Such synergy between energy harvesting and the Internet of Things is also discussed, showing how IoT connectivity can make its contribution to the optimality of energy management and distribution within robotic networks. The chapter covers technical and practical aspects of how advancements such as this can drive the future of robotics toward more self-sufficient and intelligent systems.

INTRODUCTION

One of the paradigm shifts in this area is energy harvesting in robotics, which will enhance the autonomy and efficiency of any robotic system by capturing and utilizing ambient energy sources. This is considered a very fundamental concept for having self-sustaining robots that could operate independently for long periods without frequent recharging or maintenance. At the heart of energy harvesting is the conversion of ambient energy into electrical power, which can be used to drive robotic components and systems—this could be from mechanical vibrations, thermal gradients, solar radiation, and even electromagnetic fields(Liu et al., 2021).

Energy harvesting technologies are of particular interest to robotic systems, especially when deployed in remote or challenging environments. Traditional sources of power, such as batteries, are normally quite restrictive either in terms of lifetime, environmental impact, or operational efficiency. In contrast, energy harvesting provides an avenue for elongating the time of operation and reducing reliance on an external supply of power. For example, in robots used in industry or other applications requiring exploration, kinetic energy from vibrations or movement can be used to power and extend their lives while reducing downtime (Loukatos et al., 2021).

Several new techniques of energy harvesting have been developed that best fit the requirements of robotics. Systems for recovering kinetic energy, like piezoelectric devices, convert mechanical stress or vibrations into electrical energy. Such systems are especially appropriate in an environment where the robots have been under continuous motion or vibration, for example, in industrial machinery or vehicular applications. Temperature differences are used by thermoelectric generators to produce power; therefore, they are quite fitting for robots working in environments with large temperature variations. On the other hand, solar cells make use of sunlight for the generation of electricity, hence providing a renewable energy source that could be fitted into robots deployed outdoors or in highly lit environments (Z. Liang et al., 2023).

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