Chapter 2
Internet of Things for Building a Smart and Sustainable Environment: A Survey

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ABSTRACT

In the previous decade, internet of things (IoT) has emerged as a transformative force in the quest to create smarter and more sustainable environments. By interconnecting a large array of sensors, devices, and infrastructure, IoT technology enables the real-time collection, analysis, and utilization of data to optimize resource management, improve decision-making, and reduce environmental impact. In smart cities, homes, industries, and agricultural settings, IoT plays a pivotal role in achieving resource efficiency, environmental preservation, and economic growth. However, its widespread adoption also poses several challenges related to privacy, security, and interoperability. As IoT continues to evolve, it promises to shape a future where sustainability and technological innovation go hand in hand, making a path toward more resilient, efficient, and livable environments.

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1. INTRODUCTION

1.1 IoT Fundamentals: Definition, Key Components, IoT Communication Protocols for IoT Systems

The "Internet of Things" (IoT) is a system of networked computing devices, software applications, and physical objects that may collect and share data across various communication networks, such as the internet (Atzori, L., Iera, A., & Morabito, G. 2010) (Al-Fuqaha, A., Guizani, M., et al., 2015). Connecting everyday objects online so they may exchange data, make autonomous decisions, and share their experiences with humans and other systems is what the Internet of Things (IoT) is all about. Internet of Things systems rely on the following key components:

- Physical devices that either collect data from the environment (sensors) or perform actions in the environment (actuators) are known as actuators and sensors, respectively. Sensors can also be motors, temperature sensors, or motion detectors.
- Connection: IoT devices use a wide range of communication protocols to share data with one another, with other mobile devices, and with the cloud. Some popular networking methods include Bluetooth, cellphone networks, Internet Protocol (Wi-Fi), LoRaWAN, and Zigbee.
- Data processing: Many IoT devices can process data in some way, allowing them to analyze data and perform preprocessing before sending it to a cloud service or another device. Examples of this include basic analytics, filtering, and aggregation.
- Data Storage, Processing, and Analysis on the Cloud: Most Internet of Things (IoT) systems rely on cloud computing platforms to handle massive data sets. The scalability and flexibility provided by cloud services are ideal for applications that operate on the Internet of Things.
- The Internet of Things (IoT) generates vast amounts of data, which need efficient data storage. Databases, data warehouses, or storage systems like Amazon S3 are the most common ways to achieve this purpose.
- Machine learning and advanced analytics may glean useful insights from data collected by the Internet of Things (IoT), paving the way for optimization, anomaly detection, and predictive maintenance.
- User Interface: Apps or dashboards let end-users interact with IoT systems; these provide them access to data in real-time, let them operate devices, and display insights visually.

Communication Protocols for IoT Systems

There are a number of different communication protocols that IoT devices use to share data with one another (Zanella, A., Bui, N., et al., 2014) (Gubbi, J., Buyya, R., et al., 2013). Several factors, including as the data payload, the device's power limitations, and range requirements, dictate the protocol choice. Here are a few examples of common protocols used for communication in the Internet of Things:

- Low-power devices and unreliable networks are ideal for the lightweight publish-subscribe protocol known as Message Queuing Telemetry Transport (MQTT). The Internet of Things frequently makes use of it due to its efficacy and little overhead.

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