Chapter 3
Data Collection and Preprocessing for Environmental Monitoring Using Wireless Sensor Networks

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ABSTRACT

Wireless Sensor Networks (WSNs) play a pivotal role in environmental monitoring, providing real-time data for assessing and managing natural resources. However, the data collected from these networks often need careful handling due to challenges such as noise, calibration issues, and missing data. Techniques for data acquisition in WSNs, methods for preprocessing to reduce noise and calibrate readings, and strategies to treat missing data and to ensure the quality of environmental monitoring data analysis. Missing data presents a prevalent challenge in datasets. Data generation gaps can arise due to sensor damage, power loss etc. Logical imputation of data representing a crucial pre-processing step for sequential data-driven modeling endeavors. We scrutinize methodologies aimed at enhancing the precision

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of data imputation models tailored for variate time-series sensor data afflicted by significant data gaps

INTRODUCTION

Wireless Sensor Networks (WSNs) rely on effective data acquisition techniques to ensure comprehensive and accurate monitoring of environmental parameters. The architecture of a WSN is designed to enable efficient, reliable, and scalable monitoring and control of physical environments in various applications such as environmental monitoring, smart irrigation and agriculture, innovative industrial automation, advanced healthcare, and optimized surveillance as shown in fig 1. The specific design choices within the architecture depend on factors such as application requirements, resource constraints, and environmental conditions. It typically consists of several key components that work together to enable the collection, processing, and transmission of data from sensor nodes to a central location. The sensor nodes are the fundamental building blocks of a WSN. Sensor nodes consist of sensing units (such as temperature, humidity, light, or motion sensors), a processing unit (microcontroller or microprocessor), memory (for data storage and processing), a transceiver (for wireless communication), and a power source (battery or energy harvesting device). Sensor nodes are typically deployed densely in the field to monitor the physical environment. The base station or sink node, serves as the central point of communication in the WSN. It collects data from sensor nodes, aggregates or processes the data if necessary, and forwards it to the destination (e.g., a data center or monitoring station). The base station is often equipped with more powerful hardware compared to sensor nodes to handle data processing and communication tasks efficiently (Rao et al., 2019). The success of these networks depends on factors such as sensor placement, network topology, and energy-efficient data transmission. The choice of topology affects factors such as energy consumption, network scalability, and data routing efficiency (Adu-Manu et al., 2022). In section 1, we delve deeper into the key techniques employed for efficient data acquisition in WSNs. In section 2, describe the data preprocessing methods for noise reduction and calibrations. Section 3 is the handling of missing data and ensuring data quality in environmental monitoring. In the last of this chapter a case study is added for sensory data analysis.

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