Chapter 2
Dual-Dimension Monitoring and Data Management via MQTT: Temperature-Humidity and Helmet Safety

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ABSTRACT

In the building industry, occupational accidents often occur due to failure to wear safety hats, causing injuries and economic losses. Traditional safety monitoring mainly relies on manual checks and basic methods, which have problems like lim-

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ited coverage, slow response, and biased judgments, lacking real-time protection. This paper introduces an integrated construction safety and environmental monitoring system. It combines computer vision, IoT sensors, and data analytics within a PyQt5 framework. The system uses image processing to detect safety helmets in real time and sensors to monitor environmental parameters like temperature and humidity. Data is transmitted via MQTT protocol, with multi-layer visualization for simultaneous monitoring of helmet compliance, temperature, and humidity. It also conducts intelligent analysis based on predefined thresholds, including automatic report generation, temporal pattern analysis, and predictive risk assessment. Tests show the system runs well, providing a foundation for future expansion.

1.INTRODUCTION

1.1 Research Background and Problems of Existing Systems

With the rapid development of smart buildings, the demand for real-time and precise safety and environmental management is growing. Traditional manual inspection methods can no longer meet the needs of today's fast and intelligent building management.

For example, existing warehouse monitoring systems mainly rely on manual inspections, simple fire detection equipment, and single temperature or humidity sensors. These methods are slow and inefficient, and problems may only be detected after a delay (Sambasiva Rao et al., 2024). Manual inspections are usually periodic—if a problem occurs between inspections, it will not be found in time, which poses safety risks. Besides, these systems have isolated data and lack multi-level integration, making it difficult to share information and collaborate effectively.

In recent years, as smart buildings develop rapidly, requirements for integrated monitoring systems have become stricter. Effective system integration can turn previously separate equipment management systems into information subsystems, realizing unified autonomous management and linkage of all subsystems to promote the sustainable development of buildings (Intel Corporation, 2024). However, Sharma (2024) points out that many automation systems lack advanced capabilities—they cannot perform real-time monitoring or predict faults and performance degradation in advance. These problems highlight the importance of integrated monitoring solutions.

Environmental monitoring is a key task in smart buildings, but current systems still have flaws in intelligent complex environment judgment, data storage, and analysis. This limits their wide application in industrial settings. For instance, some systems cannot conduct in-depth analysis of multi-source data, nor can they issue

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