Chapter 6
Leveraging OWL-ViT and MQTT for Real-Time Construction Safety:
An Integrated AIoT Monitoring Framework

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ABSTRACT

In Hong Kong, many construction assistants die every year in various non-fatal construction accidents because they do not wear construction site helmets. Traditional manual supervision often has problems of low efficiency, negligence, and excessive capital costs. To address these issues, this paper proposes an intelligent monitoring system based on AIoT that integrates deep learning and real-time data communication to enhance safety compliance and environmental oversight. The system uses the OWL-ViT model for automatic helmet detection and uses MQTT for seamless data transfer between the client and server. Key features include checking worker

DOI: 10.4018/979-8-3373-9245-5.ch006

helmet-wearing rationality, temperature, and humidity, and escalating decibel tracking. Experiments show that the system can provide operability opinions for site safety. This study highlights the system's problematic potential to reduce accidents on construction sites and improve the built environment.

1. INTRODUCTION

The construction industry is a key part of Hong Kong's urban growth and economic structure, but it is also one of the most dangerous fields for workers. In recent years, the city has seen a troubling number of accidents on construction sites, leading to many deaths and serious injuries. Some notable incidents that have raised public concern include the accident on November 2nd at Anderson Road Quarry, the event on October 22nd at Shek Kwu Chau, and the occurrence on October 30th in Cheung Shue Tan. These incidents are not just numbers; they highlight a failure in current safety management practices. One major reason for these accidents is the widespread disregard for safety measures by companies and workers alike.

From the company's viewpoint, there is pressure to cut costs on construction logistics and safety to boost profits. This can result in too few safety supervisors or the use of poor-quality safety gear. On the other hand, workers often feel the need to speed up construction to meet tight deadlines or earn completion bonuses. This shared focus on speed and cost over safety creates a risky environment, where standard safety procedures are often ignored. It's important to mention that accidents can still happen even when companies have comprehensive safety systems in place and workers are equipped with required safety gear, such as hard hats and safety belts. Just having safety equipment does not ensure it is used correctly or that environmental hazards are managed.

More serious, often fatal, accidents are likely if construction sites are not closely monitored. To reduce the chances and impact of such accidents, Hong Kong laws require all workers to wear safety helmets on construction sites (Occupational Safety and Health Branch, 2018). This regulation aims to protect against the leading cause of fatal injuries: head trauma from falling objects or falls from heights. However, enforcing this rule often proves difficult. Workers frequently take off their helmets or wear them incorrectly for comfort or convenience. Moreover, focusing on protection from mechanical impacts often overshadows other significant environmental risks, such as working in high temperatures, high humidity, and loud noise levels.

The physical effects of these environmental factors can be severe. High temperatures can lead to heat stroke and rapid dehydration. When body temperature rises, sweating is the main way to cool down. However, excessive sweating without proper replenishment causes an imbalance of electrolytes and lowers the body's ability to