Chapter 12

A Conceptual Framework for the Design and Development of Automated Online Condition Monitoring System for Elevators (AOCMSE) Using IoT

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ABSTRACT

The reliability of an elevator system in a smart city is of great importance. This chapter develops a conceptual framework for the design and development of an automated online condition monitoring system for elevators (AOCMSE) using IoT techniques to avoid failures. The elevators are powered by the traction motors. Therefore, by placing vibration sensors at various locations within the traction motor, the vibration data can be acquired and converted to 2D grayscale images. Then, maximum response-based directional texture pattern (MRDTP) can be applied to those images which are an advanced method of feature extraction. The feature vectors can also be reduced in dimension using principal component analysis (PCA) and then given to extreme learning machine (ELM) for the classification of the faults to five categories. Thus, the failure of elevators and the consequences can be prevented by sending this detected fault information to the maintenance team.

INTRODUCTION

In smart cities, the safety and privacy of people are improved by the collection and utilization of data to upgrade the lifestyle of the residents by using low-cost sensors and other wifi-enabled technologies. The IoT devices can collect and provide data at real-time so that the managers of the smart cities can

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function in an efficient manner. In smart city, the data are collected from public populated areas such as hospitals, libraries, and schools etc for overall monitoring. The information collected is communicated through the network to the other devices in the smart city via the Internet of Things (IoT). In a smart city, the authorities can monitor the day-to-day happenings of the city from the information collected from various vital locations to enhance the quality of living, traffic regulations and resource consumption. The major advantage of this system is that the responses for the critical events can be done in a real-time. Smart city concept is implemented in various developed nations such as Singapore, United States of America, China etc. and now it is proposed in India similar to cyberville, flexicity, knowledge-based city, and ubiquitous city. The objective of the smart city is to provide hassle-free, safe environment to the people and to provide high-speed internet to the common people.

Certain applications in which smart cities with IoT devices can be used are Street and traffic lights monitoring, Parking maintenance, Crime analysis, Waste management, Air quality checking, Energy usage, Transportation and Traffic flow monitoring. The automated elevator monitoring provides superior security, better safety, and smaller costs. Most multi-storied buildings have elevators but less security. This affects the security of the tenants to a hazardous degree. Elevator monitoring systems prevent illegal visitors as well as inform the faults of the elevators to the managers of smart cities for avoiding critical failures (Heather K, 2010).

The smart cities have multi-storied buildings, where the elevators are essential for the vertical transportation between different floors. The elevator (or lift) is a type of vertical transport equipment that efficiently moves people or goods between floors (levels, decks) of a building, vessel or other structure. The elevators are generally powered by electric motors that either drives cables, hoist, or pump hydraulic fluid to raise a cylindrical piston like a jack. There are four types of maintenance activities for an elevator namely corrective maintenance, preventive maintenance, predictive maintenance, and prescriptive maintenance. Corrective maintenance activities are done after failure. Preventive maintenance is based on the expected lifetime of the parts. Prescriptive maintenance is based on the farsighted prediction of the failure. Predictive maintenance is condition-based maintenance that prevents frequent visits. Predictive maintenance can be applied very effectively in case of a smart city.

Figure 1 shows the schematic diagram of machine lifts which is widely used in commercial applications. These traction elevators work on the principle of see-saw where the car is raised and lowered by traction steel ropes rather than pushed from below. The ropes are attached to the elevator car, looped around a sheave and connected to an electric motor. When the motor turns one way, the sheave raises the elevator; when the motor turns the other way, the sheave lowers the elevator. Typically, the sheave, the motor, and the control system are all housed in a machine room above the elevator shaft. The ropes that lift the car are also connected to a counterweight, which hangs on the other side of the sheave. The counterweight and the car are perfectly balanced. In gearless elevators, the motor rotates the sheaves directly. In geared elevators, the motor turns a gear train that rotates the sheave. Nowadays, some traction elevators are using flat steel belts instead of conventional steel ropes. Flat steel belts are extremely light due to its carbon fiber core and a high-friction coating and do not require any oil or lubricant.

The elevators have different capacities like 450kg - 1,150 kg, 1,150kg-1,500kg, 1,500kg-2,000kg and others. The Miconic 10 elevator by the Schindler Company has keypads that can sort and cluster the passengers for a particular elevator based upon the floor number entered by the passenger which saves much of the time needed to reach a particular floor (Nick A, 2010). A certain type of elevators can move in the vertical as well as the horizontal direction which avoids the walking across floors (Heather K, 2010). Also, the overall energy consumed by the elevators can be reduced by a regenerative braking system.