Chapter 17
Leveraging Fog Computing and Deep Learning for Building a Secure Individual Health-Based Decision Support System to Evade Air Pollution

Chitra P.
Thiagarajar College of Engineering, India

Abirami S.
Thiagarajar College of Engineering, India

ABSTRACT

Globalization has led to critical influence of air pollution on individual health status. Insights to the menace of air pollution on individual's health can be achieved through a decision support system, built based on air pollution status and individual's health status. The wearable internet of things (wIoT) devices along with the air pollution monitoring sensors can gather a wide range of data to understand the effect of air pollution on individual's health. The high-level feature extraction capability of deep learning can extract productive patterns from these data to predict the future air quality index (AQI) values along with their amount of risks in every individual. The chapter aims to develop a secure decision support system that analyzes the events adversity by calculating the temporal health index (THI) of the individual and the effective air quality index (AQI) of the location. The proposed architecture utilizes fog paradigm to offload security functions by adopting deep learning algorithms to detect the malicious network traffic patterns from the benign ones.

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INTRODUCTION

According to 2016 edition of World health statistics, air pollution is considered to be the world's largest single environmental health risk as it is considered to have caused nearly 7 million deaths in the year 2012 globally and around 1.5 million deaths in India. Also, according to WHO's global urban air quality database about 98% of cities in the underdeveloped and developing countries do not meet norms set out in the World Health Organization's (WHO) air quality guidelines. Harmful pollutants from vehicles, industrial exhaust, indoor cook stoves, harmful gases and smokes released during catastrophes such as volcanic eruptions, forest fires etc, are some of the common sources of air pollution. Increased exposure to air pollution causes increased risk of an individual to threats such as heart diseases, stroke, chronic obstructive pulmonary disease, lung cancer, and acute respiratory infections and asthma. Some common harmful health impacts of air pollution on human beings are discussed in Fotopoulou et al. (2016), Khreis, de Hoogh & Nieuwenhuijsen (2018), and Chen et al. (2018). The exploration of the relation between harmful health impacts and exposure of human beings to air pollution can be beneficial only when its assessments are made available to the common people through a decision support system (DSS). This heath impacts assessment through air quality evaluation can bring significant impact on the health status of the enormous urban residents. There are many researches done related to building such a DSS (Kang et al., 2018; Chen et al., 2017; Chen et al., 2018). But, most of them produce only produce general health advisories upon the predicted future values. In this, we propose a DSS which produces individual specific advisories upon the predicted future values and also produce the crucial instantaneous alerts based on the relation evaluated using individual health status and air quality status.

Air quality index (AQI) is an internationally used numerical value used to evaluate the level of air pollution. High AQI values indicate poor air quality and hence adverse health effects. Each country has its own air quality index, corresponding to the national air quality standards. At present, AQI computation are usually done with air pollutant concentration values measured over a specified averaging period by the air quality monitoring sites. Due to the high construction cost these monitoring stations are sparsely placed and hence could give only a limited coverage over the vast urban area. Therefore, the air quality data collected by these monitoring stations is not self-sufficient to portray the real severity of air pollution.

Internet of Things (IoT) is the inter-networking of a collection of physical devices such as sensors and other electronics with software and network connectivity. With recent technology advances in IoT, smart buildings can be equipped with gas sensors to monitor and evaluate the air pollution wrapped with them. The research works has addressed such designs regarding the evaluation of a metropolitan air pollution sensing system (Zheng et al., 2016; Penza et al., 2017; Hu et al., 2016). The AQI values estimated through the analytics of integrating the values obtained from monitoring stations and IoT devices can give clear insights to the air quality of any location than the one obtained from monitoring stations. Min Chen et. al (2018) in his proposed work has utilized this, to predict air quality, through the computation of the multidimensional air quality indicator (M-AQI) based on the air quality values collected through meteorological sites, mobile crowd sourcing and IoT sensing devices. In this proposed work, the same analytics is deployed with additional parameters to calculate a location's effective AQI, using the data from the monitoring stations, IoT devices, meteorological sites and the location's points of interests (POI). A location's effective AQI gives a more precise exploration of air quality in that location