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"Internet of Things": An Emerging Real-Time Technology for Environmental Health Monitoring

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A R T I C L E I N F O

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With the development of human society, environmental issue has become an important manifestation of civilization and life quality. Environmental monitoring has been always related to human understanding of the nature. There are some restrictions for human using traditional methods to monitor some environmental parameters in some inaccessible places, such as desert, mountain, and jungle and so on [1]. United States Environmental Protection Agency (U.S.EPA) has imposed strict regulations on the concentration of many environmental contaminants in air and water. However, current monitoring methods are expensive and time-consuming, and create some limitations in sampling and analysis [2].

Nowadays, Wireless Sensor Networks (WSN) provide new solutions for these issues [1]. The WSN is low cost which is made up of thousands of smart sensor nodes which monitor physical or environmental conditions, such as temperature, pressure, moisture, humidity, light, or pollution in different locations [3]. A sensor is a miniature component which measures physical parameters of the environment and transmits them either by wire or wireless medium. In wireless medium the sensor and its associated components are called as 'nodes' [4]. In the biosensor devices, the target is a biological substance, and the sensing surface is composed of its specific receptor biomolecule [5]. The term ″Internet of things″ (IoT) first used by Kevin Ashton in 1999, refers to new technologies that combine all kinds of sensors with the Internet. IoT supports many devices, such as input devices and some sensors such as a camera, microphone, keyboard, speaker, screen, near field connectivity (NFC) and Bluetooth [6].

A recent study by Gartner reveals that; around 26 Billion devices will be connected to the network by the year of 2020. These devices will produce a lot of electronic waste and will also consume a significant amount of energy in order to execute different tasks. This will eventually pose a challenge in near future to reduce the energy consumption and will also demand for new ways of developing a green communication across the network [7]. The connectivity, durability and reliability of sensors are paramount importance for accurate and reliable results [8].

According to the research cluster of the IoT in Europe, three stimulants for the development of the IoT in countries are: achieving economic growth indicators, improving quality of life and protecting the environment [9]. This study aimed to summarize the applications of IoT in the environmental health monitoring [10].

Monitoring health of buildings

The IoT can be achieved by maintaining a distributed database of the building and structural integrity measurements that can be collected by suitable sensors located in buildings, such as vibration and deformation sensors to monitor the building stress, atmospheric agent sensors in the surrounding areas to monitor pollution levels, as well as temperature and humidity sensors to have a complete characterization of the environmental conditions [10].

Integrated waste Management

Nowadays, waste production in the world has increased due to population growth, improvement of living standards, economic conditions, and development of industries [11]. Increased solid waste quantities require improving and expanding the solid waste management options that affect various environmental issues, posing numerous threats and creating major potential problems [12]. The primary issue in many modern cities is waste management, due to cost of services and garbage storage problems. It can be solved by using an intelligent waste container that detects the level of loading. Furthermore, an embedded sensor is used in this container that optimizes the collector truck's route, reduces waste collection costs and improves the quality of recycling. The IoT can connect these end devices, i.e., intelligent waste containers, to a control center for optimal management of the collector truck [10].

Air Quality and Noise Monitoring

In crowded areas, parks or fitness trails, the IoT can provide means to monitor the quality of air. This will provide the healthiest path for outdoor activities and people can be continuously connected to their preferred personal training application[10]. Furthermore, by sensors, dust storms characteristics, toxic gases and UV Radiation in ambient air can be detected [13-15]. As a noise monitoring tool, the IoT can measure the amount of noise produced at any given hour. Besides, the sound detection algorithms enable to identify the type of noise [10].

Water Quality Monitoring

Inadequate water supplies and increasing pollution in many parts of the world have become a growing concern during the past quarter century [16]. On-line water resource information monitoring is basic and important for the water resource management [17]. Therefore, the water quality monitoring is necessary which includes several chemical parameters. Some of these are: pH, redox potential, conductivity, dissolved oxygen, ammonium and chloride ion amount [18]. Traditional water quality monitoring methods also have many problems, such as a long water quality monitoring cycle, water quality parameters sampling process consuming much manpower and resources, aging equipment and instruments, and insufficient data accuracy [19]. By using water monitoring system, water wastage and power consumption are avoided and water is easily stored for later generations [20].

CSO (Combined Sewer Overflow) and Effluent monitoring

Understanding the behavior of the CSO structures is vital for urban flooding prevention and overflow control. Several cities have employed the IoT to monitor the performance of sewer systems and to provide useful data for managers and engineers. For the CSO structures, in addition to properly monitoring, it is also imperative to construct a model to predict the CSO events by utilizing data from the realm of the IoT. The model is expected to provide sufficient response time for making decisions about the CSO control, protect downstream hydraulic infrastructures during extreme rainfall events and mitigate the impact of the CSO on receiving waters [21].

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Traditionally, the quality of treated wastewater is defined by the measurement of the global parameters such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC) and Total Suspended Solids (TSS). Real-time monitoring of wastewater quality remains an unresolved problem to the wastewater treatment industry [22]. Monitoring and control of wastewater treatment plants rely on four building blocks: insight the process as summarized in a proper process model; sensors that provide on-line data; adequate monitoring and control strategies and actuators that implement the controller output [23].

Food Safety Monitoring

Optical biosensors show greater potential for the detection of pathogens, pesticide and drug residues, hygiene monitoring, heavy metals and other toxic substances in the food to check whether it is safe for consumption or not [24].

In conclusion, in recent years, the use of environmental degradation without ecological potential of the land has led to a collapse in the balance of nature, resulting in considerable deterioration in the environment. Resource constraints on the one hand and population growth and patterns of consumption energy on the other hand have caused to raise the pressure on the environment and natural resources. Continuous monitoring of the environment can make policymakers and decision makers more informed [25].

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