Effective TOXIN management-An IoT based approach

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ABSTRACT

A wide range of synthetic chemicals and heavy metals now pervade our oceans worldwide. These create a dangerous condition for both marine wildlife and people through their persistence, toxicity and ability to accumulate. Toxic chemicals trickle into the environment from various sources such as factories, farms, homes, automobiles, plastics, etc. These toxins become a part of the human diet, and can cause birth defects in children and toxicity in adults. Every country is in need of a global solution to reduce these chemicals. The current technology only monitors the contaminants in the environment and delivers the general real time information and data necessary to make decisions for environmental response. To make it more e-friendly, a new system has been proposed in this paper to monitor the toxins with the help of sensors that can effectively sense the toxicity from the wastes that are emitted by the industries. An application has been created and a short message service has been introduced for the registered mobile number thus reporting to the authority thereby making the eco system to survive well.

KEY WORDS: Toxin, Chemicals, Metal.

1. INTRODUCTION

Toxins are often distinguished from other chemical agents by their method of production. Based on the different standards of eco system, the toxin can be defined as a poisonous substance that are capable of causing disease or even death on absorption by body tissues of living organisms. In a day to-day life people are forced to inhale lot and lot of toxic chemicals without the knowledge what it could be. Some of the chemicals are, mercury. Petroleum, hydrogen sulfide, chlorine gas etc., The byproducts coming out from toxic chemicals May contain radiation, dangerous pathogens. These byproducts are came out as a results of industries such as manufacturing, farming, construction, laboratories and hospitals. Toxic waste can neither be reactable, ignitable nor corrosive wastes. Toxic waste has become more abundant since the industrial revolution, causing serious global health issues. Each and every second 310kgs of toxic chemicals are released into our air, land and water by industrial facilities around the world. Approximately 10 million tons of toxic chemicals are released into the environment by industries every year. Industries release these toxic chemicals by spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing chemicals into the environment.

The chemicals disposed into the environment cause multiple problems in acquatic life. The acquatic life can be spoiled in terms of processed food stuffs, contaminated water and also even due to beauty and personal care products. As an example scanerio, if these toxins, when gets mixed up into the ocean, it greatly affects the acquatic life as said earlier. In other way, if it harms an organism, it ends up destroying an entire food chain of acquatic life even it may kill sea mammals, corals and fish.

A comprehensive toxicology and environmental health has been maintained these details with US government, which includes access to toxins-related resources produced by other government agencies and organizations. This web site includes links to databases, bibliographies, tutorials, and other scientific and consumer-oriented resources. The content of the website has been pointing on the emerge towards toxin management. By having this mind a novel system has been proposed in this paper with the help of Internet of things to monitor the toxins thereby making the environment hazard free. The structure of the paper is as follows. Section II briefs about the various literatures in the field of toxin management. Section III describes the proposed system and the effectiveness of the system has been discussed. The conclusions and the future work have been presented in section

Background study:

Sea-based activities resulting in the release of contaminants into the environment:

Oil: Marine pollution caused by accidental spills is a well-known global concern. Oil tanker accidents account for 10–15% of all the oil that enters the ocean world-wide every year. Although there is evidence for decrease in number of maritime incidents, major accidental oil tanker spills still occur from time to time (EEA, 2008).

For example, Crude oil is not a single substance but it is composed of thousands of chemicals and its chemical composition changes dynamically after release into the environment. Moreover, there are thousands of different kinds of crude and refined oils. (Coppock, 2014), The polycyclic aromatic hydrocarbons (PAHs) often comprise up to 10% of the organic compounds in crude oil and can be used as tracer for the general distribution of petroleum hydrocarbons in the environment associated with a spill. Oil spills are also an importance source of Volatile Organic Compounds (VOCs) such as hexane, heptane, octane, nonane, benzene-toluene-ethylbenzene-xylene isomers (BTEX), and other lighter substituted benzene compounds. (Sammarco, 2013), In recent years, there has been an increased interest in other components of petroleum, such as compounds containing nitrogen, sulfur, and oxygen, acids, esters, ketones, phenols and metals such as iron, nickel, copper, chromium and vanadium.

Waste: Dumping of the most toxic materials is banned by a few countries, but in the past all types of wastes were ocean dumped, including contaminated dredged material, industrial wastes and sewage sludge. Although there are no complete records of the volumes and types of materials disposed in marine waters prior to 1972, some areas with decades of uncontrolled dumping became demonstrably polluted with high concentrations of PAHs, acid chemical wastes (e.g. titanium dioxide waste), heavy metals, and organic chemical wastes. Vethaak (1991), Radioactive wastes, munitions and chemical weapons were also routinely dumped into the sea worldwide previously and until the prohibition with the London Convention (OSPAR, 2010).

Heavy metals: Metals are toxic if they change the structure and function of proteins and enzymes (GESAMP 2001). Metals found in the ocean that are highly toxic on their own include mercury, cadmium, lead, arsenic, tin, copper, nickel, selenium, and zinc. Mercury, cadmium, and lead can become even more highly toxic in combination with organic compounds. Themselves but are able to react with organic materials, creating very toxic compounds (UNEP 2006). Many metals occur naturally in the environment, but anthropogenic emissions from industrial and mining activities can increase concentrations of many to toxic levels. 96% of mercury enters the ocean via atmospheric input (GESAMP 2001). While some metals are deliberately dumped in the ocean, most are found downstream from their sources, including waste dumps, industrial areas, mining operations and metal processing areas.

Proposed System:

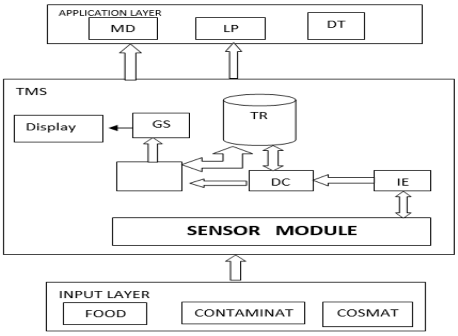

Figure.1. System Architecture

DC – Data Comparator, DT- Desktop, IE – Inference Engine, LT - Laptop, MD - Mobile Devices, TMS – Toxin Management System, TR – Toxin Repositor.

The proposed system architecture is shown in figure.1. Layer based approach has been used to design the system architecture. The layers are named as input layer, Toxin management system and an application layer. The functions of the individual layers are discussed below.

This paper mainly aims to monitor the toxin chemicals from various source of materials as shown in figure.1. Sensor is used to identify a small change in the environment or in the surroundings which is confined for living. The main nutritional support for the human body is the food consumption. The consumed food became poisonous because of the chemical compositions present in the food. In this fast food world, the composite food is something which is impure, unsafe, or noxious. The food contamination have occurred because of poor harvesting or storage of grain, use of banned veterinary products, industrial discharges, human error and deliberate adulteration. Sensors have been used to identify the toxins present in these kind of food stuff.

The second essential element to live on earth is water. Drinking water is one of the major prerequisites for a healthy life, whereas waterborne disease is still a major cause of death in many parts of the world. Natural contaminants, particularly inorganic compositions that arise from the geological strata may cause toxins even in running water. In the same way, Pesticides, herbicides and industrial solvents are some of the man-made activities that produce more toxins. The point sources for the man-made activities are discharges from industrial premises and sewage run off from agricultural land and from hard surfaces, such as roads. Specialized indicators are used to monitor the toxicity of water.

Another major role in human life is played by cosmetics. The chemicals used in the cosmetics may degrade and create a poisonous toxins. A high sensitivity sensor has been used to detect the level of toxicity in these kind of products. Hence an array of sensors have been used to detect the various level of toxicity at different level of sensitivity.

Binary signals sensed at the output of the sensor module have been given to the comparator and inference engine. The data comparator used in this proposed system make a comparison of the real time data with the existing reference levels stored in the repository. The role of the inference engine is unique here. Inference engine fix up the level of sensitivity dynamically, according to the type of substances taken up for toxin management. Option to choose the type of substance can be achieved with the help of Display. An arduino board is used to process the sensed data and send the information to the data comparator and inference engine. Pre-defined reference levels have been stored in repository. For making dynamic decisions, the inference engine make use of the pre-defined data set stored. Based on the output of the data comparator, the IoT module trigger the GSM modem to send the information about the rise in toxicity to the registered user through SMS or E-mail. The message can be viewed in any one of the human friendly electronic devices.

2. RESULTS AND DISCUSSIONS

The results in figure.2, have shown that, the system is capable of detecting toxins well compared to existing system. The existing system doesn't have the dynamic decision making. The same can be achieved through the inference engine which has predefined rule sets for making intelligent and dynamic decisions.

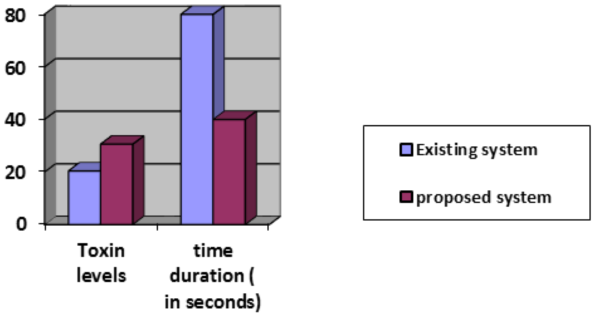

Figure.2. Comparative analysis

3. CONCLUSIONS AND FUTURE WORK

The toxic management has been achieved using Internet of things as discussed in the paper. Rule set derived for identifying toxicity levels of the chemicals made the proposed system to identify higher level of toxic detection when compared to the prior work. The time duration for detecting the toxin levels are reasonable lower. This made the system more responsive. The results have been shared with the end users through SMS or E-mail makes the system e-friendly. The limitation of proposed system is it only detects a predefined toxic levels. It is planned to enhance the system with dynamic toxic management in future.

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