Integration of AI, Sensors, and Smart Devices for Monitoring Plastic-Induced Health Hazards

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Abstract
Extensive importation of plastic containers to store water, milk, groceries among other consumables expose people to toxic chemicals that penetrate food and beverages, which cause serious long-term health problems. Regardless of growing consciousness, it is one of the biggest obstacles to decrease plastic addiction in everyday life because it is convenient and ubiquitous. This paper will offer a new technology-driven product **Sacha Sathi** that aims at tracking and curbing the health risks of consumables stored in plastics. The system, installed on the smartphones and smartwatches, constantly monitors the user interaction with the plastic container, determines the cumulative exposure, and delivers real-time risky analysis. A set safety limit allows providing early warning, alerting users about the possible risk of developing cancer, ulcers, endocrine interference, and liver malfunction as a result of the long-term consumption of the chemicals. The system also keeps the records of the past usage to study the behavioral trends and encourage the long-term lifestyle changes.
Keyword: Plastic Consumption, Food Safety, Health Monitoring, Machine Learning, Big Data, Cloud Technology, Sensors, Real-Time Alerts, AI-Driven System, Consumer Health.

1.1 Introduction

The low cost, convenience, and versatility of plastic have brought about the inseparability of the material in modern life because it is utilized to store consumable items such as water, milk, groceries, and ready-to-eat foods. Nevertheless, the scientific evidence is increasing to point out that the continuous exposure to plastic has severe health and environmental effects on humans. Food and beverage packaging plastics are known to fade harmful chemicals into the foods and beverages they come in contact with, especially when subjected to heat, sunlight, or prolonged storage and as a result the use of plastics on daily basis is a stealthy but serious health issue.

Plastic containers that store water are susceptible to chemical leaching principally Bisphenol A (BPA) and phthalates. BPA is a recognized endocrine disrupter mimicking estrogen and has been attributed to hormonal imbalance, reproductive problems, and cancer. Phthalates are linked to liver toxicity, respiratory, and developmental disorders. The constant consumption of such polluted water can result in severe health challenges in the long term. Stored milk provided in plastic containers is even more dangerous since milk fat is more effective in carrying these toxic substances, thus exposing the milk to even greater levels of them. Frequent use might be a cause of developmental problems among children, endocrine disruptions, and even cancer.

In the same way, fruits, vegetables, and dry foods that are packed in plastic are subject to contamination in the long-run. The migration of chemicals in packaging may lead to a decline in the nutritional value and cause chronic diseases such as diabetes, cardiovascular diseases and reproductive complications. The results are the leaching of chemicals like antimony and phthalates in cold drinks kept in plastic bottles resulting in gastrointestinal distress and imbalance of hormones and polluting the environment considerably.

Considering such dangers, it is necessary to minimize the use of plastics. The convenience of plastic is short lived but the long-term health and environmental expenses are much higher. The change to safer materials such as glass and metal containers, the reduction of single-use plastics, and encouraging good disposal is the steps that need to be taken in order to secure the health of people and environmental sustainability.

Environmental Impact of Plastic

1. Marine Pollution & Terrestrial Pollution

Marine pollution is mostly caused by plastic garbage, which has terrible effects on marine life. Plastic things that people throw away, such bags and microplastics, get up in the ocean via rivers, sewage systems, and direct dumping. The below fig [1] shows the marine pollution [13]. Plastic trash hurts ecosystems on land as much as in water. People don't throw away their plastic waste correctly or take care of their trash effectively, thus it accumulates up in soils and landscapes. Plastics may leak toxic chemicals into the ground, which can make it less fertile and contaminate groundwater. The below fig [2] shows the terrestrial pollution [14].

Figure 1: Marine Pollution

Figure 2: Terrestrial Pollution

3. Air Pollution

Plastic waste also contaminates the air with very dangerous gas emissions, including dioxins, furans, and fine particulate matter, which endangers health risks including cancer, heart disease, and respiratory health-related illnesses (World Health Organization, p. 15). Tiny or small plastic pieces less than 5 mm in diameter are called microplastics, which are produced by manufactured products or as a result of degradation of larger objects, hence they pose a hazard to both the environment and human health. It has been found that microplastics have the potential to enter the food web with heavy metals and other persistent organic pollutants, which are toxic and inflammatory when inhaled or ingested, causing cellular damage and oxidative stress [16].

Figure 3: Air pollution

Figure 4. Microplastic in water

5. Long-term Environmental Persistence:

Plastics take hundreds to thousands of years to decompose in the environment and undergo degradation into harmful micro-fragments that persistently pollute the ecosystems and even the biodegradable plastics may not decompose under specific conditions (Thompson et al., 2009). Extensive poor disposal of plastics is very harmful to the land and water wnvironments, and thus there is an urgent call to act at the global level, better management of waste and alternative environmental ways, as seen in Figure 5.

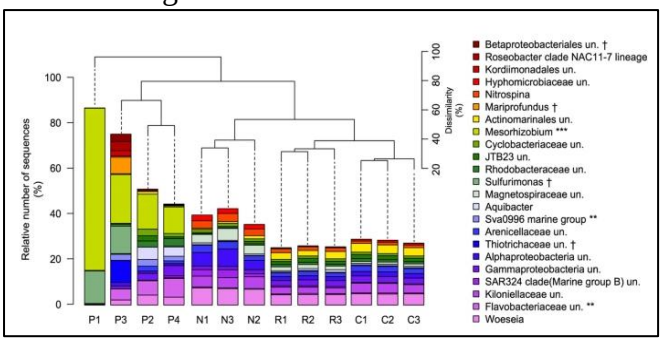

Fig 5: Long-term Environmental Persistence of plastic up-to two decades and colonization of bacteria causing disease.

Research Gap: There are no practical and consumer friendly tools that can be used to translate scientific evidence into personalized real time risks alerts by bringing together consumption behavior, health factors, and sensor data to be used globally.

2.Literature Review

The available literature has made it quite clear that plastic pollution is bringing severe threats to environmental sustainability, as well as human health, but the level of effective interventions on a consumer level is still underdeveloped. Recent review and policy focused research highlight the environmental harm, disease burden and the long-time health effect of plastic waste and microplastic exposure. Scientific studies have associated plastics with endocrine interference, heart attack, food chain bio-accumulation and decline in biodiversity in both land and sea habitats. Although such studies have been able to capture the extent and international character of the issue, majority of them are descriptive or policy-oriented and fail to project the results into practical advice that can be used by the subjects. The state-of-the-art approaches that have been investigated in parallel studies include the use of artificial intelligence, machine learning, toxicological modeling, and molecular analysis to solve the problems of plastic degradation and environmental complexity. Despite the high technical potential of these approaches, they are not much related to the daily consumer behavior, and do not offer real-time awareness, exposure tracking, and risk communication at a personal level. Health-related reviews also outline the new medical-related concerns and lack data-oriented frameworks that can combine the consumption behavior, the environmental factors, and the vulnerability of the individual. Comprehensively, a research gap can be identified in all of the literature: the lack of unified, consumer-focused systems of translating scientific and medical findings into real-time, customized alerts and recommendations. To fill this gap, interdisciplinary solutions that will be based on AI, sensor data, and behavioral analytics are necessary to empower people, minimize the impact of plastics, and facilitate informed and health-conscious decisions.

3.Proposed Novel Methodology

The proposed strategy will undoubtedly assist humanity in minimizing plastic use in the future and will also contribute to reducing illnesses caused by consuming food preserved in plastic containers or bags. The graphic below [6] depicts how we think our Problem should be set out.

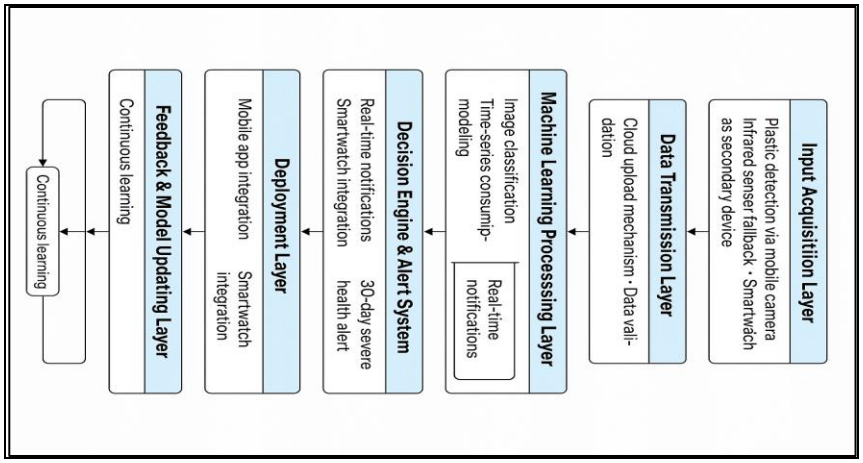

Figure 6. Proposed Architecture

Experiment Result & Discussion

The below Fig [7] shows the impact of plastic on human health and environment. It also causes cancer.

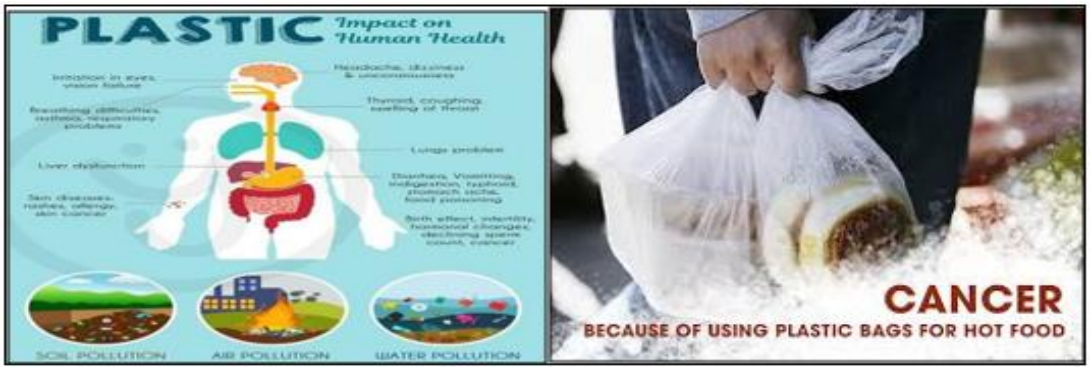

Figure 7. The impact of plastic on humans and environment

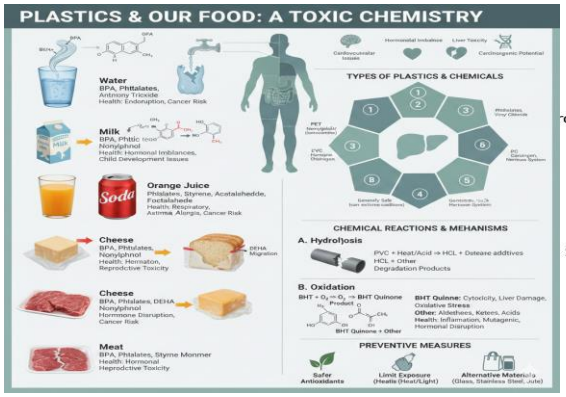

Figure 8. Impact of different product

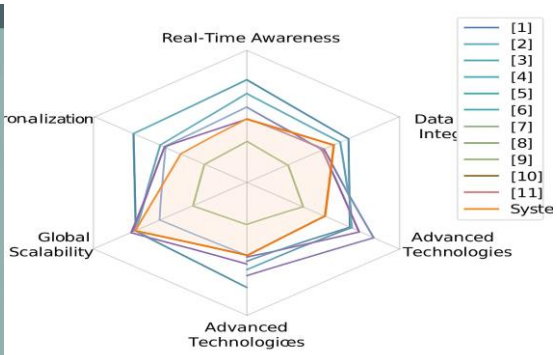

Figure 9. Real Time Awareness comparative analysis

Conclusion

The research reveals that oxidation of antioxidants and chemical reaction in plastic containers may produce toxic byproducts that percolate into food and beverages exposing them to the effects of endocrine disruption, reproductive toxicity, respiratory effects, and cancer. Heat, light, storage time, type of food and composition of plastic affect these reactions; hence safer materials such as glass and stainless steel should be used to enhance food safety.

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so in an unnumbered Acknowledgments section immediately following the last numbered section of the paper.

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