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Current E-Waste Management Using Artificial Intelligence Techniques Is The Need Of The Hour: A Review

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Abstract

The purpose of this study is to analyse how e-waste is generated, its negative impact on the environment and the application necessities of artificial intelligence (AI) techniques based e-waste management. Our analysis throws light on volume of e- waste generated due to computer, computer related accessories and peripherals and its disposal mechanism. This can serve as a basis for the development of efficient policy approach for computer related electronic waste management in the state and in the country. One of the fastest growing waste streams in the world is computer and electronic waste or e-waste. E-waste has become a global issue in the last ten years. In this paper the environmental problems related with the discarded computer and computer related electronic accessories and appliances are reviewed. Moreover, the current and the future production of these computer related e-waste, the potential environmental problems associated with their disposal and management practices are discussed whereas the existing e-waste management schemes are also discussed. The future of smart recycling is looking brighter. Robots, guided by cameras and artificial intelligence, are helping make recycling facilities run more efficiently. Where does the waste from all computer related technological activities go? The purpose of this study is to analyse volume of e- waste generated due to computer, computer related accessories and peripherals and its disposal mechanism. This can serve as a basis for the development of efficient policy approach for computer related electronic waste management in the state and in the country and attract attention towards application of AI based E-waste management techniqes or equipments and related researches.

Keywords: computer and electronic waste, e-waste, e-waste management, environmental pollution, recycling, Solid waste segregation, deep learning, convolutional neural networks, transfer learning, robotics.

1.Introduction

Environmental deterioration and health risk [6,7,12,4] due to improper e-waste management has become a serious health hazard and environmental pollution issues across the globe. The major portion of e-waste reaches an unorganized e-waste recycling sector and is then treated by using crude methods. This review article presents a brief highlight on the need to adopt smart modern e-waste management technology based on artificial intelligence for quality e-waste management. The present e-waste management needs to be more focused on environmentally sound management, by more active support from all sides.

Manufacturers have made a complete line of recycling equipment [1,2,5,10] to ensure the highest recovery rates for virtually any material type, including commercial and industrial, e-waste, food waste and green waste recovery based on machine learning and Artificial Intelligence (AI) techniques. AI and machine learning are incorporated into the solution to enhance human insight and improve waste diversion. Employing AI in garbage sorting and disposal processes is a better method for smart recycling and waste management. Therefore AI and various sensors including RFID tags are used. Many intelligent dustbins have been developed that are equipped with AI programs and Internet of Things (IoT) sensors in the waste management sector. Electronic waste (e-waste) is one of the fastest growing waste streams in the on the globe. Growth of Information and Communication Technology sector has enhanced the usage of the electronic equipment exponentially. Faster obsolescence and subsequent up-gradation of electronics product, are forcing consumers to discard old products, which in turn accumulate huge e-waste to the solid waste stream. E-waste is growing at the high rate of besides other electronic waste items computer hardware and accessories related e-waste contributed a lot . Major recycling of e-waste is carried out in the non-formal sector using primitive and hazardous methods [1,6,7,12,4]. Adequate legislative measures and cost-effective, environmentally friendly, technological solution would be needed to address the issue.

Electronic waste or e-waste is growing at a very fast pace, posing serious challenge both nationally and globally [1,4,5,6,8,11,13]. Unlike other kinds of waste, e-waste constitutes of disparate materials, some of them highly toxic [6,7,12,14] and some very precious [1,5,10,17]. This is dangerous on a number of levels[1,2,6,7,12,14] both for the environment and for human health. Mercury, lead, and brominated flame-retardants are just a handful of the dangerous compounds found in e-waste. These compounds cause damage to practically all major bodily systems after continuous exposure during dangerous e-waste recycling activities, including neural systems, blood systems, brain development, skin problems, lung cancer, heart, liver, and spleen damage. Most of the e-waste is recycled in India in unorganized units, which engage significant number of manpower. Recovery of metals from PCBs by primitive means is a most hazardous act. Proper education, awareness and most importantly alternative cost-effective technology need to be provided so that better means can be provided to those who earn the livelihood from this. A holistic approach is needed to address the challenges faced by India in e-waste management. A suitable mechanism needs to be evolved

to include small units in unorganized sector and large units. Recycling e-waste is vital, but it must be done in a safe and consistent manner. The acceptable risk levels for hazardous, secondary e-waste chemicals in developing and industrialised countries should not be different. Given the physical distinctions and evident vulnerabilities of children, acceptance criteria should be set differently for children and adults. Our society has undergone a massive technological revolution over the past decade and electronic appliances have now become ubiquitous. The increase in production of electronic products and the growing inherent need to own the latest technology available has led to a significant increase in the amount of E-waste produced each year. So, the means to provide a viable mobile solution for E-waste collection from everywhere with minimal human intervention is need of this advance technological era. Proper management and recycling of E-wastes are critical for the sustainability of any modern city today. While industrial and commercial collection of E-wastes has been in the spotlight, solutions for collection of E-wastes from individual households are limited.

Mobile robot [1,2,14] that identifies common electronic wastes based on transfer learning and serves as an attachment to existing municipality garbage trucks. The robot moves around, identifies electronic wastes and performs segregation of the identified material via its arm-based lift and storage mechanism. A convolutional neural network–based identification system has been employed for categorising the E-wastes and yields 96% accuracy[1]. Research work on waste management has also been of great interest in the realm of robotics. Macro-sorting of municipal solid waste materials is a process that requires a huge amount of manual labour. Apart from the tiring nature of work, labourers are also subjected to a toxic and harmful environment that can cause long-term effects on their health. Optimisation of the existing configurations for macro-waste sorting robotic systems was explored and the methodology was applied to sorting mercury free bulbs to provide proof of concept [1].This ever-increasing waste is very complex in nature and is also a rich source of metals such as gold, silver, and copper, which can be recovered and brought back into the production cycle. So e-waste trade and recycling alliances provide employment to many groups of people in our country. Tonnes of e-waste is handled every year by bare hands. Improper dismantling and processing of e-waste render it perilous to human health and our ecosystem. Therefore, the need of proper e-waste management using higher technology based on human free science like AI has been realized as it is necessary to review the public health risks and strategies to combat this growing menace due e-waste. The advent of robotics for waste sorting propelled the automated waste management to the next level. Deep neural waste recognition combined with autonomous robots acts a mobile garbage pickup system. This article throws light on the hazardous impact of computer related e-waste on environment, need of such smart AI based electronic waste's management. We can expect a significant decrease in e-waste if traditional techniques are replaced with automated intelligent solutions and sorting AI-robots.

2. Application of artificial intelligence based equipment to enhance collection of E-waste is a potential solution for collection and segregation of the poisonous piles of e-garbage and home collections

The integration of the Internet of things (IOT) with ML has also gained traction for automating the garbage classification process and proven efficient in achieving automated separation of biodegradable and non-biodegradable materials [1]. Microcontroller-based convolutional neural network (CNN) smart bins have been developed with the focus of supplementing the waste segregation process in both commercial spaces and households. Smartphones connected to the bins either via Bluetooth or via the Internet provide constant updates to the owner on the status of the bin while maintaining proper management of the wastes. CNNs, for the precise purpose of waste classification in smart bins, have also proven beneficial as additions to the existing smart bin architectures. An IOT and ML integrated waste management system can reduce manual interactions. Deep learning systems for household waste monitoring with real-time feedback of data have been created to offer consumers with instant updates through smartphone apps about the wastes in their homes[1]. Hybrid deep learning methodologies for collecting wastes from public centres use high-resolution cameras and sensors to separate wastes into recyclable and non-recyclable [1]. Several pretrained networks have also been used to facilitate automation of the waste segregation process through transfer learning. Some classification characteristics are distinct for E-waste materials, and utilisation of these features proves beneficial in the garbage partitioning process. Resource recovery and recycling of electronic wastes are drastically improved by including classification of metallic fractions and non-metallic fractions from E-waste materials. Thermal imaging was employed [1] to extract feature vectors to be used as the basis for classification. Individual material thermograms were obtained from the E-waste materials. Experimental results conducted on simulated E-wastes confirmed the accuracy and efficiency of their model. Scalable classification of different E-waste materials, upon proper implementation, can benefit recycling plants immensely. Absence of strict regulations on e-waste management, lack of awareness by the masses and absence of efficient infrastructure are some factors for the widespread e-waste. Lack of proper procedures for the collection, disposal and recycling are the main reasons for the poor state of e-waste management.

For the recycling of e-waste, countries heavily depends on the unorganized sector as only a handful of organized e-waste recycling facilities are available. Recycling and treatment facilities require a high initial investment, particularly those fitted with technologically advanced equipment and processes. Despite of significant attention from the media and enactment of some national level trade bans the problem is apparently worsening when it comes to e-waste management and proper disposal of e-waste at different levels of inappropriate management of end-of-life electronic wastes. As an effort to make the users aware of the recycling of e-waste, many electronic companies such as Apple, Dell, and HP have started various recycling schemes[2].

Our lack of initiative in e-waste management has resulted in many recyclable precious items being thrown into dustbins, which have ended up in landfills. It is the need of the hour to reduce, reuse and recycle e-waste. Gold, silver and other precious metals can be obtained by recycling e-waste [1,2,14]. Non-recyclable items can either be sent to landfills or burned (incinerated) under controlled environments. We can expect a significant decrease in e-waste if traditional techniques are replaced with automated intelligent solutions and sorting AI-robots. As sensible individuals, we should reduce e-waste and make others aware of its value, in addition to the harmful effects of e-waste. This is important to save our lives and the environment using advance AI Techniques.

3. E-waste Management Using Artificial Intelligence Techniques is the Need of the Hour

Many more environmental epidemiological studies are required to assess the present status of e-waste management system to assess the e-waste quantities and exact amplitude of the problem everywhere, and to establish relationships with the informal recycling sectors and to establish relationships with the informal recycling sectors. The hazardous nature [1,2,6,7,12,14] of e-waste is one of the rapidly growing environmental problems of the world. The ever-increasing amount of e-waste associated with the lack of awareness and appropriate skill is deepening the problem [16,7,12,14]. A large number of workers are involved in crude dismantling of these electronic items for their livelihood and their health is at risk; therefore, there is an urgent need to plan a preventive strategy in relation to health hazards of e-waste handling among these workers in India. Required information should be provided to these workers regarding safe handling of e-waste and personal protection. For e-waste management many technical solutions are available, but to be adopted in the management system, prerequisite conditions such as legislation, collection system, logistics, and manpower should be prepared. This may require operational research and evaluation studies. The valuable data will be generated by these studies that would help in drafting an action plan for e-waste management. India should start a surveillance system for diseases and health consequences of e-waste. The sustainability of e-waste management systems has to be ensured by improving the collection and recycling systems. It would be desirable to establish public-private partnerships in setting up buy-back or drop-off centres. Levying advance recycling fees is another approach to ensure waste management sustainability. To identify best e-waste management technologies across the globe and adopt them successfully can be key to a sustainable futuristic growth[1]. The reduction of the hazardous substances in the electronic and electrical equipments [6,7,12,14] and the promotion of use of their safer substitutes many countries have adopted the Restriction of Hazardous Substances (RoHS) Regulations in the manufacture of these items. More and more such less hazardous substitutes should be identified which can be used in electronic equipment.Proper waste management, including e-waste, is required to prevent pollution and health issues. e-Waste management involves the following steps :Collection; Segregation;Transportation;Processing;Disposal/incineration,

Waste disposal in a landfill gives rise to land, air and water pollution. An alternative way is to burn/incinerate waste materials under controlled environments. Incineration is carried out both on small and large scales by industries using special incineration equipment under controlled conditions. A waste-to-energy plant is a waste management facility that combusts waste to produce energy.e-Waste management involves both manual and large, intensive technical processes. e-Waste is first dismantled manually and then sent for further processing. For example, in a laptop, components like capacitors, memories, LCD screen and batteries are first manually removed and separated. Then, the remaining part is sent for recycling through mechanical processing. The mechanical processing plant may include a crushing unit, shredders, and magnetic, eddy-current and air separators.Employing AI in garbage sorting and disposal processes is a better method for smart recycling and waste management. Therefore AI and various sensors including RFID tags are used. Many intelligent dustbins have been developed that are equipped with AI programs and Internet of Things (IoT) sensors in the waste management sector.Two ways to sort waste materials before recycling are either dropping the waste into separate trash bins or letting the trash bins sort themselves through an automatic system. If everything is dumped into one trash bin, sorting for recycling can be a tiresome task. To tackle this manually, different countries have different colour-coded dustbins for dumping different waste materials. But manual separation of waste materials or throwing into separate trash bin is somewhat confusing as human beings can make mistakes. People can get confused as to where to dump the waste, because they are not sure of the actual material of the packaging and devices. This is where AI comes in. AI is the new saviour of e-waste management and recycling. AI, machine learning, image processing and robotics have a bright future in the waste management sector. Multitasking sorting AI robots have been developed for waste management that can sort tons of garbage on a daily basis. RFID tags and sensors are used to collect garbage. A pneumatic garbage disposal system then reads these tags. The main computer, which stores all data, determines an appropriate method to dispose of the waste. As per a report from mirror.co.uk, Bin.E is the world's first intelligent bin that sorts waste materials. It uses a combination of sensors, image recognition and AI, and can recognise objects like glass, plastic or paper, and compress these before placing them in containers.Developed by Clean Robotics, TrashBot robot is the first ever smart trash robot that uses AI to sort recyclables from landfill waste [1].Robotic waste sorting system employs AI for smart recycling of waste materials. Using computer vision, machine learning and AI, the robot can sort and pick recycled materials from moving conveyor belts [1,2].

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4. Conclusion

Electronic waste (E-waste) generation has become a primary cause of concern in the digital era due to the sheer volume of its production and the implications it has on our ecosystem [1]. The total quantity of waste electrical and electronic equipment (WEEE) increases at the higher rate annually which is highly concerning and draws attention to the available low recycling rate. The definition of electronic wastes encapsulates various forms of electronic products that have lost value and are considered to be frivolous to their owners. From personal gadgets to home appliances, electronic wastes have now found their way into our environment. Most consumer electronic goods contain hazardous metals like lead, cadmium, nickel, mercury, beryllium and zinc. It is therefore essential to separate these wastes from the general solid waste channel. The E-waste domain is also a forum for undertaking business initiatives for precious meta [1,5,10]l recovery and a means for producing energy via biochemical processes. Hence, the identification, recovery and proper recycling of electronic wastes is an imperative step towards achieving a sustainable future. The increasing illegal export of E-wastes to developing countries to reduce recycling costs is highly concerning from a self-sustainability point of view too [1]. Current e-waste management systems are unable to efficiently deal with the massive amounts of e-waste generated every day. Automating the processes of sorting and disposal using AI and machine learning would help in handling e-waste more effectively. It is time to switch to AI and machine learning for smart recycling and e-waste management.

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