



Chapter 15

Dual–CNN–Based Waste Classification System Using IoT and HDS Algorithm


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ABSTRACT

Efficient waste management is crucial in today's environmental landscape, necessitating comprehensive approaches involving recycling, landfill practices, and cutting-edge technological integration. The proposed approach introduces a sophisticated waste management system, harnessing dual or twofold convolutional neural networks (D-CNN or TF-CNN) and a histogram density segmentation (HDS) algorithm. This intelligent system equips users with the means to enact essential safety protocols while handling waste materials. Notably, this research presents groundbreaking contributions: Firstly, a geometrically designed smart trash box, incorporating ultrasonic and load measurement sensors controlled by a microcontroller, aimed at optimizing waste containment and collection. Secondly, an intelligent method leverages deep learning for the precise classification of digestible and indigestible waste through image processing. Lastly, a cutting-edge real-time waste monitoring system, employing short-range Bluetooth and long-range IoT technology through a dedicated Android application was proposed.

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INTRODUCTION

Waste management is the term used to describe the necessary tasks and operations that must be completed from the beginning to the end. Waste may be solid, liquid, or gaseous. Numerous procedures are used to handle various waste kinds, such as residential, industrial, and biological garbage. Glasses, cardboard, plastics, papers, and bio garbage are examples of household waste. No waste can be recycled or divided into materials or biological categories when it comes to home activities. As per EUROSTAT 423 million tonne, or 56 percent, of the residential garbage formed in the European Union held in the year 2016 was reprocessed and recycled. In 2016, landfills within the European Union handled 179 million tons of domestically produced waste, constituting 24 percent of the overall total. The reports underscore the importance of efficient household waste management to enhance recycling processes. Integrating modern technology into the waste management system could yield significant benefits. Globally, civic solid waste production amounts to 2.01 billion tons annually, with at least 33 percent not environmentally safely managed. Globally, people produce an average daily waste per capita ranging from 0.11 to 4.54 kg, indicating significant variability. Notably, although high-income countries account for only 16 percent of the world's population, they contribute more than 34 percent (683 million tons) to the total global waste output.

Worldwide, trash production is anticipated to reach 3.40 billion loads of tonne by 2050, outpacing population growth by more than double that amount. Generally, more incomes are associated with more garbage being produced. The quantity of waste formed by a person in a single day is anticipated to climb by 19% in high-income nations by 2050, compared to at least 40% in low-income and middle-income nations. Waste generation is lower at lower income levels, but as income levels increase, it rises more rapidly in low-income communities than in high-income groups. By 2050, the projected total amount of waste generated in low-income nations is expected to be over three times greater than the quantity illustrated in Figure 1 (World Bank, 2012). The Middle East and North Africa region, responsible for 6% of the global waste, ranks second to last, with Eastern Asia and the Pacific leading at 23%. Middle East of Africa, Sub-Saharan region of Africa, North of Africa, and South of Asia are projected to have the quickest rates of rise in trash creation. By 2050, the total amount of rubbish produced in these parts of the world is expected to more than triple, double, and quadruple, respectively. Currently, almost 50% of these areas' trash is discarded outside. Urgent action is necessary due to the high rate of waste increase, which will significantly affect public health, economic development, and the environment.

Waste collection shows a key part in waste management, and the associated charges vary considerably depends on income levels. In high-income and upper-middle-class countries, there is often nearly universal garbage collection coverage. Waste is collected to the amount of 48% in cities in low-income countries; outside of urban areas, the rate drops to 26%. Over 44% of the world's waste is poised in Sub-Saharan region of Africa, whereas at least 90% is poised together in Europe, North America as well as South America and Central Asia. Currently, the most dangerous problem is waste streamline, regardless of its source—domestic or industrial. The length of the consumer product's life cycle, from the opinion of manufacture to the point of clearance, determines the size of the waste streamline. Furthermore, in a few years, the garbage streamlining, consumption, and disposal practices of our society will result in a “waste tsunami.” We dispose of an enormous 2 billion tons of trash annually (Kaza et al., n.d.). The World Bank reports that trash creation has been increasing annually and is predicted to reach 3.40 billion loads of tonne, or 70% more, by the year 2050—more than twice than the pace of evolution in population (World Bank, 2012). This is primarily caused by a number of variables, including population expansion, the spread of urbanization, economic expansion, and changing consumer purchasing and lifestyle patterns.

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