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Automatic Waste Segregation using Image Processing and Machine Learning

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Abstract: The exponential growth of waste materials due to rapid urbanization has put immense pressure on our environment. Improper handling and disposal of waste materials has polluted our ground water and land resources. Therefore, it is imperative that we examine the process of waste collection, segregation and automation for better management of the waste materials. This paper provides a solution that can detect, identify and segregate waste items into biodegradable and non-biodegradable categories without any human assistance. The waste segregator is a centrally partitioned movable bin that travels in the area of interest and picks up any waste item in its path. This work is an integration of machine learning concept, Image processing and embedded application using Raspberry Pi. The robotic arm places the object on a rotating flap attached over the two compartments. Machine Learning is used to identify the category of the waste item. The proposed system does not use any sensors and is totally based on training hardware using artificial intelligence. The waste item is then dropped into its respective compartment by the rotating flap. The system continues to travel in its path until the end of the area is reached. The designed segregation of bio-degradable and non-biodegradable items is carried out with 92% accuracy in short time.
Keywords: Machine Learning, Image processing, Robotic arm, Automation, Waste segregation.

I. INTRODUCTION

In today's world, garbage disposal has become a cause of major concern. An astounding amount of 0.1 million tons of waste is generated each day in our country. Unfortunately, only 5% of this colossal amount of waste is recycled [1]. The huge amount of waste that is generated gets disposed by means which have an adverse effect on the environment due to improper waste management. Several advancements in technology has made it possible to convert waste items into useful sources of energy. But, to enable the waste items to be used as sources of energy, they need to be carefully processed and any non-biodegradable waste item needs to be removed.

The numbers of ways have been proposed to solve this challenge; in [2] a new concept uses inductive proximity sensor and capacitive sensing module that can sort wastes at the initial stage of segregation. Segregating module-DC geared motors sorts these wastes into three different categories, namely metal, dry and the wet waste. The waste segregation is carried out largely with the help of manual workers. The efficiency of manual segregation is low. The chances of a waste material being incorrectly classified are high due to human error. Along with that, the workers are subjected to the risk of infection and diseases which are very common in such working conditions [3].

In [4], waste segregation using deep learning is proposed for faster and cleaner working. It involves acquiring images from camera with detection, object recognition, prediction and classification into categories as biodegradable and non-biodegradable.

The waste segregation using sensors has been proposed in [5] and [6]. The bin is fitted with metal sensor and an IR sensor to determine the type of waste. The response from the metal sensor indicates non-biodegradable waste and the response from IR sensor indicates biodegradable waste. The lid tilts accordingly and drops the waste item into either compartment. This problem is addressed in [6] by using metallic sensor placed in a container. The waste is further processed by capacitive sensing module which distinguishes between wet and dry waste. The waste is then subjected to LDR+LASER to determine plastic components. The waste is identified with the help of the above sensors and then segregated by pushing them into separate containers belonging to each category. Also, [8] gives the concept of the waste is to be fed to the conveyor belt through an automatic feed system which will comprise of a hopper and other mechanism. After this, metal Sensors which are clamped below the conveyor belt, will sense the metal particles and in turn stop the conveyor belt.

This paper provides a solution to achieve automatic segregation of waste at the primary levels i.e. where the wastes are produced. If the waste items are segregated properly at their primary level, a major portion of the waste management cycle is covered. The usage of automation in segregation of waste items can greatly improve its efficiency and at the same time reduce the health hazards associated with manual segregation.

The proposed system aims to replace the need of human beings in waste segregation process by using image processing [9] for waste detection and sorting based on machine learning [10] with the bin able to navigate in a one-time path set by user. This is unique, simple and consumes less power and resources as it requires no complex hardware.

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