



Smart Waste Management Using Deep Learning with IoT

Jobin Joseph¹, Aswin R², Allen James³, Alwin Johny⁴ and Prince V Jose⁵

¹St. Joseph's College of Engineering and Technology, jobin.joseph1305@gmail.com

²St. Joseph's College of Engineering and Technology, rahulnpr18@gmail.com

³St. Joseph's College of Engineering and Technology, allen.jamesvaranam@gmail.com

⁴St. Joseph's College of Engineering and Technology, alwinjohny57@gmail.com

⁵St. Joseph's College of Engineering and Technology, prince.v.jose@sjcetpalai.ac.in

ABSTRACT

The emerging rise in the population and urbanisation alarms the nation for its environment safety. The incorrect handling and waste disposal will cause immense threat to these growing cities. Therefore, it has raised the need for proper waste collection and classification of wastes with proper disposal. The current waste disposal system in India consists of unclassified and unorganized wastes collected and then segregated at different stations[7]. This segregation done by manual labour forces can bring health related issues to the waste sorters and also being less efficient, time consuming and not completely feasible due to their large amount. This paper proposes a solution that can identify and classify the waste and organize it into the particular waste bin (recyclable, organic and harmful wastes) without any human hand. The system uses deep learning algorithms to identify and classify the wastes into particular category; the categorized recycled and organic wastes can be used for future better purposes. This process will help the environment in making more valuable and ecologically safe and help us to make rich green ecosystem and a promising better future.

Key words: Deep Learning, Segregation, Waste Management

1.INTRODUCTION

In this growing world, waste management has become a severe issue. The country produces about a 68.8 million tonnes of mixed waste (recyclable, organic and harmful wastes). According to the reports, by 2025 there would be an increase in the world population by 20% making. The population mark reach to its highest peak. Such an increase in population will increase in its demand and consumption of utilities and such will increase the generation of waste at the similar rate.

The waste generated can be of three types –recyclable, organic and harmful wastes. The improper disposal and collection of these wastes have very harmful effects in all forms of life leading contamination of air, water, soil a can cause dangerous diseases to human life. The proper an organized collection of these wastes can help us to exploit these wastes into resources.

The number of ways has been proposed to overcome these challenges, but the importance to classify and segregate the waste at its initial stage is important to organize the waste into different compartments[4]. The human hand in classifying and segregating the waste is less efficient. To overcome this challenge we use deep learning algorithm for waste classification for better and efficient results[1]. The waste is identified with the algorithm trained to a machine and it identifies the type of waste and categorizes it into its particular waste bin.

2.OBJECTIVE

The current implementation of the system in India which has a population of 1.37 billion still relies on human labor for segregation of its waste, with this population the process is not healthy but also time consuming and also brings many hazards for workers. The unorganized collection of wastes also leads to disuse of many recyclable and organic wastes which can be used as source of resource after their treatment.

Our objective is to replace this human labor way of segregating waste through automated waste management process through which the waste will be classified by deep learning algorithms which will produce cleaner and green eco-environment. The segregated wastes can also be used as future resources.

3.EXISTING SYSTEM

The garbage collection in India still relies on collection of unorganized wastes and then segregated at a station. The segregation still depends on human labor which has many health mishaps, less efficient, time consuming and requires financial share to the workers.

Uncontrolled dumping of waste on outskirts of towns and cities has created overflowing landfills which are not only impossible to reclaim because of the disorder manner of dumping but also has acute environmental implication in terms of ground water pollution and contribution to Global warming. This has been found to reduce the average life span of the manual segregators.

A new concept uses a hardware component that can sort waste at the initial stage thus making waste management more powerful and fruitful[2]. The designed system sorts wastes into three different categories, namely metal, dry and the wet waste. [3]A simple 8051 microcontroller forms the heart of the system. It controls the working and timing of all the sub sections so as to sort the waste into the three primary categories.

The main disadvantage in the existing system is that, segregation of the waste consumes time. Size of the waste must be less than or equal to the dimension of the funnel i.e. 20cm X 20cm. E-waste, Sanitary waste and medical waste cannot be segregated by this system as there are certain rules and regulations specified by government to be followed for their segregation. It also uses complex hardware components for segregating the garbage.

4.PROBLEM DEFINITION

The increasing urbanization of India poses so much threats as with increase in population land consumption increases, utilities increases, consumption of food increases, use of resources increases and more than these the amount of waste generated by 1.37 billion people increases.

Solid waste management is a big challenge in urban areas for most of the countries throughout the world. A huge tone of waste is generated each day in India. But only 5% of this large amount of waste is recycled. One possible solution for this problem could be identifying and classifying the waste at the starting stage itself. The segregation of the waste is to be properly managed so as to minimize the risks to the health and safety of the eco-system.

The economic value of waste is best known when we segregate the waste products. Currently there is no effective system for segregation of various types of wastes. The purpose of our project is to make a simple, low cost and user-friendly segregation system for urban cities to process waste management more effectively in India.

5.DEEP LEARNING

Deep learning is an arising field of Machine learning which is still in its research and mainly aims in bringing machine learning even more nearer to one of its focuses: Artificial Intelligence. Machine learning concentrates on tasks such as recognizing the images, converting speech to text, recognition of speech and visual object, drug discovery, face detection and recognition, weather forecast etc. Deep learning techniques are used more in these applications where adaptive learning is done. Deep learning can do cognitive learning such as learning the features, characteristics and attributes with the help of good algorithms which can learn by itself and deep architecture. The family of deep learning has been increasing which includes neural networks, various unsupervised and supervised learning algorithms for recognizing feature such as Deep Belief Network, Deep convolution Neural Network and Recurrent Neural Network and models which represent the probability of the hierarchy.

It has the capacity to process complex data given as input and results in giving the predicted output through effective recognition. [6]Deep learning allows processing of multiple layers through the computational models in order to learn data representations with abstraction of many layers. Deep learning uses the back propagation algorithm to discover complex structures in huge data sets and represents how a machine should vary its inner parameters that are used to

determine the representation of each layer from the depiction of previous layer. Deep architecture has networks with multiple layers and the adjacent layers are in some way connected with each other. It is mainly used in solving the problems of representation and classification through constant learning. Perceptron which has some weight combines all the known features for recognizing the objects.

A. DEEP LEARNING IN OBJECT RECOGNITION:

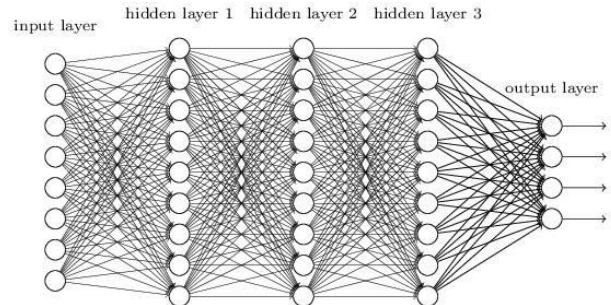


Figure 1: Training deep neural networks

For each pixel in the input image, the intensity of the pixel is encoded is the value for a corresponding neuron in the input layer as shown in figure2. For the 28x28pixel images, there are 784 neurons which are given as the inputs. The output of the network can be an input image based on the trained network’s weights and biases.

Each neuron in the first hidden layer will be connected to a small region of the input neurons as shown in figure 1. The region in the input image is called the local receptive field for the hidden neuron which acts as a window for the input neuron which acts as a window for the input pixels. Each connection learns a weight by itself when trained and the hidden neuron learns an overall bias too.

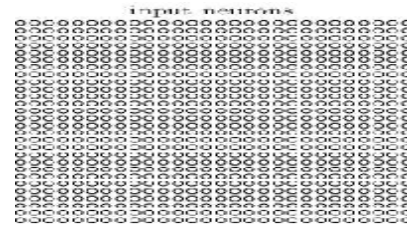


Figure 2: Input neurons

6.PROPOSED IDEA

The proposed idea mainly focuses on the identification and classification of the waste that is on the verge of dumping in waste bin.

Usually, unsegregated waste is dumped in a landfill and made to decay which however takes hundreds of years in the case of non-biodegradable waste and the mixing of toxic

harmful wastes will degrade the land resources and water resources.

This project proposes an idea where the machine on its own is able to identify the waste without human intervention based on the set of datasets, irrespective of its shape and size, easily and classify them[8]. Our proposed system can learn by itself and thus can constantly update itself in case of new materials. The advantages to the proposed system would include easy decomposition, lesser health hazards and faster process that requires only an initial investment and is automatic.

A. Use Case Diagram

Use case diagram as shown in figure 3 is a platform that can provide a common understanding for the end-users, developers and domain experts. The system have four modules such as analyze, identifies, bin selection and open then alerting the user in completion of waste. When the user is approached with the waste the system starts the process.

- Analyzing the waste and making assumptions about the waste.
- Identifier analyzes the waste with the help of analyzer.
- Identifier identifies the waste and gives the information into the bin selection mode.
- Classify the waste and decide which bin to open.
- The bin contains sensors which indicates the users about the completion of bin.

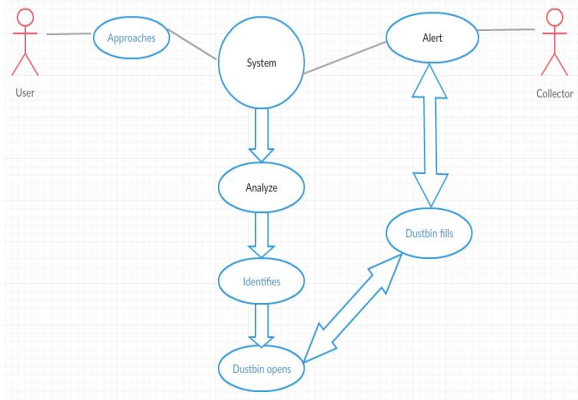


Figure 3: Use-case diagram

B. Activity Diagram

Activity diagram in figure 4 shows the flow of the sequence of activities to implement the application in the system.

- The user approaches the idle system with the waste.
- The bin analyzes the waste and identifies the type of waste.
- The bin then opens the box for the particular waste and collects the waste.
- The bin then checks the amount of waste,

- If the bin is completely filled, it will send the authorities an alert about the completion of bin.
- The authorities will collect the waste.
- The collected waste will be used for recycling and can be treated as resources.

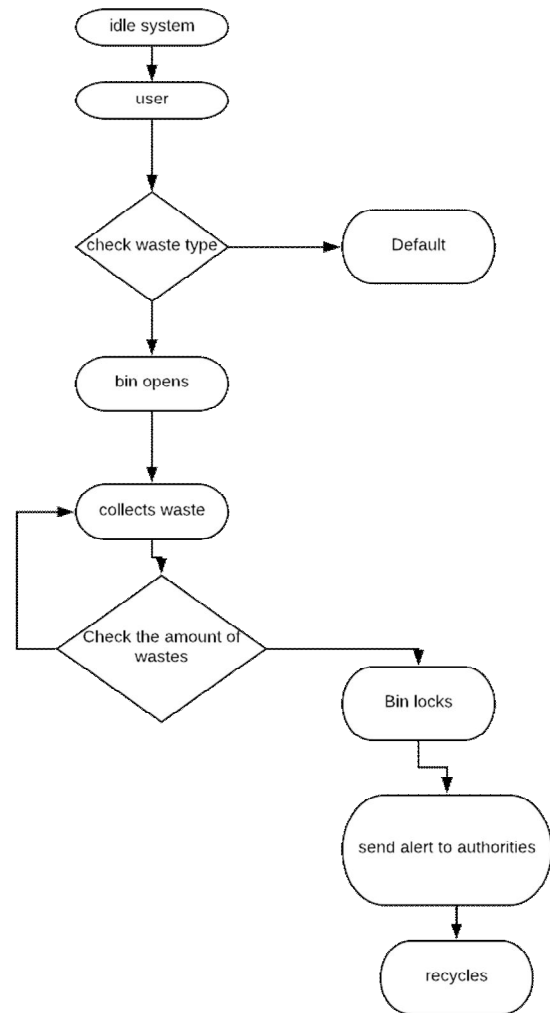


Figure 4: Activity diagram

7.WORKING WITH TENSORFLOW

The implementation part is done using Tensorflow which is a deep learning framework as software. Deep learning, which is becoming more popular every day, can be regarded as a learning technique on artificial neural networks. While classification methods in classical machine learning approaches are considered to be 0 or 1, deep learning can provide numerical results between 0 and 1 as well. Thus, more accurate answers can be obtained for the current problem, and faster and higher accuracy values can be achieved in classification approaches.

The reasons for choosing this software includes its comparatively:

- ❖ High speed
- ❖ Open source

- ❖ Flexibility in all operating systems
- ❖ Reliable results
- ❖ Updated coding
- ❖ Parallel neural networking as depicted in figure 5.

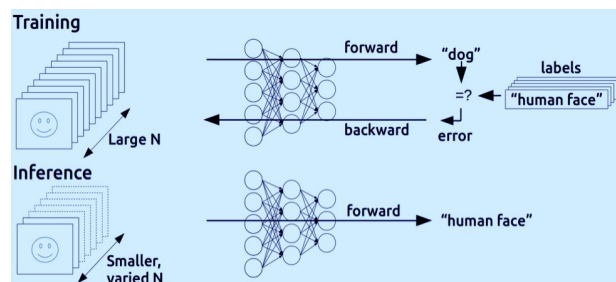


Figure 5 : Parallel neural networking

Tensorflow software is practical and can be run on different operating systems as in Ubuntu, Windows and Mac. It is developed by the Google for numerical computation, which is now widely used by many large companies. Tensorflow provides an interface for expressing machine learning algorithms and an application for executing these algorithms. It provides a framework which can be modified for working with machine learning algorithms with a set of reference models. It has a library of python in which the convolutional neural networks can be trained. It needs Cuda and Gpu along which it can process around 40 million images for various tasks such as detection and recognition. It has platforms that make developing and deploying of prototypes to cloud environment easy. It has also provisions for supporting research projects, applications in industry and various applications in speech, vision and multimedia through clear modules of code and bindings to Python. A calculation expressed using TensorFlow can be carried out with little or no modification in a wide range of heterogeneous systems, from mobile devices such as phones and tablets, to large scale distributed systems of hundreds of machines, and to various computing devices such as GPU cards.

The classification of image in TensorFlow can be done by using inception v3 model, QuocNet, AlexNet, ImageNet and recognizes image using python API, and C++ API[5]. It can prove to be very useful in training a dataset provided a high processing computer is available to process these images.

8.CONCLUSION

An effective waste management system was proposed, designed and successfully implemented. The system is designed to be used in every household to every public community by for proper waste management and a healthy eco-environment. The deep learning in system will make the users easily identify the type of waste and objectifies the particular bin to dispose. [4]IOT application will look for proper disposal and monitor the filling of waste bins and alerts the user providing proper hygienity. Overall system

quality is good with a smooth experience for the users as well as for the organizations for further treatment of waste for many useful purposes. The system is easy to maintain. The primary objective allows creating a green environment for the growing and developing cities. The proper waste management and proper treatment of the waste will allow us to use our waste as energy resources[7].

The system gives the users to dispose the wastes in an organized way of in order to carry useful purpose of the waste and take care of the environment. It also decreases the man effort in separating the waste for recycling process. The users can also keep track of them of waste bins and will help the user by notifying it when the bins are completely filled, The smart waste management system helps to provide the environment a better and green eco-system in this rapidly growing population.

REFERENCES

- [1] M. Bihis, S. Roychowdhury, A generalized flow for multi-class and binary classification tasks: An Azure ML approach, Proc. — 2015 IEEE Int. Conf. Big Data IEEE Big Data 2015, pp. 1728-1737, 2015. <https://doi.org/10.1109/BigData.2015.7363944>
- [2] Shubham Thakker, R. Narayanamoorthi, “Smart and wireless waste management.” International conference on Innovations in information embedded and communication systems (ICIIECS) (2015) <https://doi.org/10.1109/ICIIECS.2015.7193141>
- [3] VikrantBhor, PankajMorajkar, Amol Deshpandey, Smart garbage management system. International conference of engineering research and technology (IJERT), vol. 4, Issue 03, March- <https://doi.org/10.17577/IJERTV4IS031175>
- [4] K. A. Monika, N. Rao, S. B. Prapulla, and G. Shobha, Smart dustbin-An efficient garbage monitoring system, vol. 6, no. 6, pp. 7113–7116,2016.
- [5] M. Rastegari, V. Ordonez, J. Redmon, A. Farhadi, Xnor-net: Image Net classification using binary convolutional neural networks, European Conference on Computer Vision, pp. 525-542, 2016. https://doi.org/10.1007/978-3-319-46493-0_32
- [6] M. Bihis and S. Roy Chowdhury, A generalized flow for multi-class and binary classification tasks: An Azure ML approach, in Proc. - 2015 IEEE Int. Conf. Big Data, IEEE Big Data 2015, 2015, pp. 1728–1737. <https://doi.org/10.1109/BigData.2015.7363944>
- [7] S. Dugdhe, P. Shelar, S. Jire, and A. Apte, Efficient waste collection system, in 2016 Int. Conf. Internet Things Appl. IOTA 2016, 2016, pp. 143–147. <https://doi.org/10.1109/IOTA.2016.7562711>
- [8] Glouche and Couderc 2013] Glouche, Y. and Couderc, P. (2013). A smart waste management with self-describing objects. In The Second International Conference on Smart Systems