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Trash Probe using Image Recognition and Deep Learning

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ABSTRACT: Substantial amounts of garbage are generated all around the world at alarming rates. And the quick and efficient disposal of waste is a growing problem that needs to be tackled. The proposed model will be trained over an array of images that would help recognize any kind of trash/garbage/waste by viewing from a connected media input module, using supervised learning, a convolutional neural network and directives of machine learning. The model is intended to detect and segregate various types of waste in real time. Fitted with a 21-megapixel camera, the input feed is divided into frames and image classification is done dynamically. Identification of the different types of objects will help us to develop an automated sorting machine in the future which will fully automate the process, eliminating the harms of manual segregation. Thus, the second phase will be a robotic arm system that sorts the incoming waste and disposes them into separate bins based on the identification done by our model. The project proposes a bilateral mode of working where primarily a single stage network is made to learn prediction methods. This model will give space for a double staged network like a convoluted network that can be trained to reiterate and re-learn the classification in question based on our primary model. Along with an appropriate interface and corresponding mechanical additions, the proposed project will bring diametric ease to the waste segregation effort.

KEY WORDS: Classification, Machine Learning, Predictive analysis, waste, image classification, neural network, dataset

I.INTRODUCTION

Modern problems are paving the way for smarter technologies to be designed, created and implemented to enhance our way of life. However, problems are also growing at a higher rate, and the greatest of all, is pollution. The greatest reason for this problem is unsorted, unsegregated waste which causes disposal issues and, ultimately, fills up landfill sites. Garbage and pollution and the diseases caused by it are a menacing issue and its removal is pivotal.

In India, only twenty percent of plastic waste generated is recycled, whereas developed countries, like Sweden, have a very efficient method of waste management, with some even importing garbage to fulfil their recycling needs. Unsorted garbage is the root cause of excessive trash, landfills, groundwater pollution, toxic chemical discharge and health hazards. India's urban population of forty-two crore produces sixty-two million tonnes of garbage every year, most of which ends up in landfills. A comprehensive CNN trained on various trash dataset that can sort plastics, e-wastes and various other garbage can be very helpful in garbage recycling and disposal. The objective of this model is to create an extremely smart network with capabilities of distinguishing amongst various trash and the ability to sort and dispose mechanically.

India produces millions of tonnes of urban waste annually, out of which over seventy five percent is untreated and dumped at landfill sites. According to a study [1] conducted in 2017, India is the 12th biggest polluter of plastic in the world and ranked as the 5th largest e-waste producer. Over 70% of waste generated in India is dumped directly into landfills. Despite its expanding population, India is behind many countries in terms of converting waste-to-energy. If India begins to process the waste it generates, it will be able to generate a considerable amount of energy to supply cities, reducing our dependence on other sources and reducing our carbon footprint. Besides India, the issue of pollution is a global epidemic which needs to be tackled as soon as possible. Countries have already started to

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implement steps to reduce pollution, and so, our project will serve as a tool to help bring about a change in Indian waste management techniques.

II. SIGNIFICANCE OF THE SYSTEM

A CNN trained on datasets and with an expanding learning technique will give rise to a holistic AI that can smartly sort all kinds of garbage. Concepts of image recognition and data augmentation will be used to train the network. Interface will be made for image-based learning over an API scheme. A handshake protocol and assembly coding to be done to help produce autonomous systems. The study of literature survey is presented in section III, Methodology is explained in section IV, section V discusses the future study and Conclusion.

III. LITERATURE SURVEY

Chen Zhihong et al. Proposed a robotic grasping system for automatically sorting garbage based on machine vision. This system achieves the identification and positioning of target objects in complex background before using manipulators to automatically grab the sorting objects. It uses VGG-16 architecture to identify objects. The key problem in object identification is due to the position of object, discolouration or state of the object. Optimisation techniques such as data augmentation should be used.

In Thailand due to the vast amounts of municipal solid waste was being left untreated. Chutimet Srinilta and Sivakorn Kanharattanachai wrote a paper on segregation employing CNN. A comparative analysis has been done in this study on 4 object classifiers - VGG-16, ResNet-50, MobileNet V2 and DenseNet-121. These frameworks are pre-trained on the ImageNet dataset and each provide a statistical classification. The highest waste-type classification accuracy was 94.86% achieved by the derived ResNet-50 classifier.

Mohd Anjum and M. Sarosh Umar proposed a model that is a DCNN based architecture which identifies heaps of garbage lying around using a gradient-based image processing technique. The model generates a layered mask of the given image and superimposes it to correctly identify the garbage. Boundary detection is also used. The paper was aptly named Garbage Localisation based on weakly supervised learning in DCNN.

S. Sudha et al. Indian cities face several problems related to friendly waste segregation. It explores how deep learning plays an instrumental role in helping reduce pollution. A layer by layer analysis is done by the machine using a back-propagation algorithm. The paper exhibits a flowchart depicting the basic flow of control of classification.

Rahmi Arda Aral et al. In this research study, deep learning models such as Densenet121, DenseNet169, InceptionResnetV2, MobileNet, Xception were used and trained over the TrashNet dataset. The TrashNet dataset is a collection of images of trash. Using this, it was found that DenseNet121 gave an accuracy of 95% using fine-tuning. Similarly, the InceptionResNetV2 model gave a fine-tuned accuracy of 94%.

IV. METHODOLOGY

Image classification refers to the task of extracting information classes from a dataset of multiband raster images. The resulting raster from image classification can be used to create thematic maps which will help us identify the type of waste by comparing with the dataset. The recommended way to perform classification and multivariate analysis is through the Image Classification toolbar. Classification may also be done using 2-D or 3-D pooling of layers or by using specific algorithms such as k-nearest neighbors or vector analysis.

To help with identification of objects there are a number of steps that have to be followed. Since we will be dealing with a large dataset, we have to pre-process the input image according to specific parameters. This is done to create uniformity between two different input images, so that our classifier easily recognises the significant object features and filters it according to our need.

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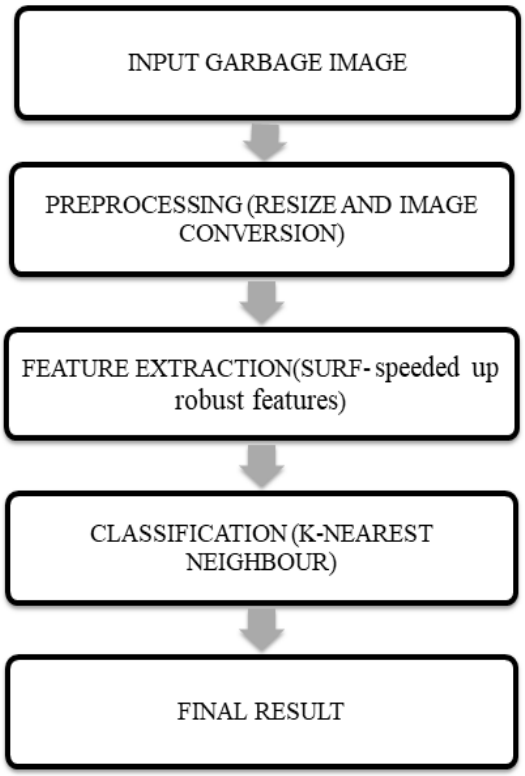
A) Dataset

A data set (or dataset) is a large group of data. A collection of data in audio, visual or textual format which is grouped together under one common attribute is called a dataset. To build our Trash Probe we will require a dataset of waste objects. Datasets such as TrashNet or Garbage Image Dataset (GIDset) may be used to train the model. However, our dataset must be constantly updated to accommodate new unidentified objects so that the next time our classifier will be able to identify the new object quickly. This collection of images will then be fed to the model to train the convolutional neural network.



B) Pre-processing

Pre-processing is a common name for operations with images at the lowest level of abstraction; both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing. Image pre-processing methods use considerable redundancy in images. Neighbouring pixels corresponding to one object in real images have essentially the same or similar brightness value. Thus, distorted pixels can often be restored as an average value of neighbouring pixels. All the input images are resized into the same dimensions. If the specified size does not produce the same aspect ratio as the input image, the output image will be distorted.

C) Feature Extraction

In supervised learning of a prediction model, feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. Feature extraction is related to dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be redundant (e.g. the same measurement in both feet and meters, or the repetitiveness of images presented as pixels), then it can be transformed into a reduced set of features (also named as feature vector). Determining a subset of the initial

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features is called feature selection. The selected features are expected to contain the relevant information from the input data, so that the desired task can be performed by using this reduced representation instead of the complete initial data. In computer vision, speeded up robust features (SURF) is a patented local feature detector and descriptor. It can be used for tasks such as object recognition, image registration, classification, or 3D reconstruction. It is partly inspired by the scale-invariant feature transform (SIFT) descriptor.
A neural network works on the same premise of feature extraction and employs a number of algorithms to accurately create the image feature set. A few of these are:

- Using SURF (Speed Up Robust Features)
- Based on SIFT (Scale Invariant Feature Transform)
- Scaling, resizing, enhancement
- K nearest neighbor techniques as a matching algorithm
- Exporting Learning arcs to define Convolutional Neural Networks
  -get Convolution layer
  -get reLu layer
  -pooling strides
- Get paradigm for recurrent learning

V. CONCLUSION AND FUTURE WORK

The most appropriate application of this project will be of total automation and collaboration with a robotics company to develop a robotic-arm-like machine to pick up identified waste from a platform. However, this is a long way down the road. Our goal is to build the best classifier model available which will be ready to take on real world problems.

This paper provides an insight to understanding image classification requirements to distinguish certain objects that can be categorised as trash or garbage. This paper aims to propose a convolutional neural network to visually identify certain imagery based on deep learning mechanisms, data review, augmentation and gradient perceptive image recognition. It builds a holistic AI to define and differentiate garbage based on imagery and vision. It has high scope in future monumental applications and can have a compounded accuracy with the union of conventional sensors and lasers.

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