INTELLIGENCE GARGABE CLASSIFICATION USING DEEP LEARNING

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1.Introduction

The world bank report showed that there are almost 4 billion tons of waste around the world every year and the urban alone contributes a lot to this number, the waste is predicted to increase by 70 percent in the year 2025 [1]. According to [1] in the next 25 years, the less developed countries' waste accumulation will increase drastically. With the increase in the number of industries in the urban area, the disposal of the solid waste is really becoming a big problem, and the solid waste includes paper, wood, plastic, metal, glass etc. The main method of managing the waste is land filling, which is inefficient and expensive and polluting natural environment. For example, the landfill site can affect the health of the people who stay around the landfill site. Another common way of managing waste is burning waste and this method can cause air pollution and some hazardous materials from the waste spread into the air which can cause cancer [2]. Hence it is necessary to recycle the waste to protect the environment and human beings' health, and we need to separate the waste into the different components which can be recycled using different ways.

Waste management is now becoming a challenging issue for many garbage management organizations. As per the current scenario, the amount of city waste is increasing but its disposal and management capacity is declining. Therefore, it becomes difficult to dispose of this waste in an efficient and timely manner [1]. The population is also increasing astoundingly in big cities, which leads to an increase in the production of goods, which ends in the generation of a huge amount of solid waste. The collection, management and storage of this waste requires great effort as it has an adverse effect on the environment as well as public health. Solid waste in cities can choke the water drainage systems leading to floods and other disastrous concerns. Thus, waste detection and management mechanisms are required nowadays to evade such crises. At present, there has not been any public record regarding process of waste detection and management. Therefore, accurately detecting and classifying several types of garbage is important to improve quality of life and the environment. In recent years, due to expansion of deep learning, convolution neural networks have been applied in garbage detection. The government and waste management organizations can use UAV technology for managing waste efficiently. UAV scan simplify many operations in waste management such as garbage collection or landfill monitoring [2].

In recent years, UAVs are becoming effective low-cost image-capturing platforms for monitoring environments with high accuracy [3]. The UAV can identify litterbugs and collect litter garbage at public areas like parks and beaches. A CNN-based model is used to train several images captured from clean and polluted areas. Deep CNN has recently been used in image classification tasks such as automatic classification, object detection and semantic segmentation [4]. The process of validating and testing the preprocessed images have been explored to hills and coastal tourism applications through probabilities of classifying images and predicting clean shores and hill areas [5]. The images of the sampled materials are taken at different time intervals between dusk and dawn in ambient light including visible light, ultraviolet light, and mixed visible and ultraviolet light. The best classification result was obtained on the sample material images shot under mixed visible and ultraviolet light [6]. In the image processing technique, the waste identification and classification must be based upon the transfer learning and convolution neural network [7], whereas the Support Vector Machine (SVM) is used to identify many types of garbage [8]. There is a long-felt need to have an automated analysis technique to make the right decisions. These automated techniques can help waste management organizations handle the garbage efficiently based on the application of symmetry. Symmetry creates balance that is required in all spheres of life. In this contemporary period, deep learning is used for image retrieval and it is a significant issue to retrieve appropriate pictures with preciseness, which nonetheless neglects the symmetry for feature extraction.

1.1. Dataset

For this work, we are using a trash image dataset which was created by Gary Thung and Mindy Yang [17]. This is a small dataset and consist of 1989 images, which is divided into four different classes glass, paper, plastic, metal, all the pictures of the images have been resized down to 512 x 384. Few samples of the images are shown in Fig. 2

(a) glass (b) metal

(c) paper (d) plastic

Fig. 2 images from trash dataset (a) glass (b) metal (c) paper (d) plasti

2.Methodology

For the pre-processing stage, data augmentation method was performed on the images, because of the small size. This technique was chosen because of the different orientations of the waste materials. Some of the technique includes, random of the image, translating the image, randomly scaling the image, image shearing, randomly scaling of the image. With this technique it maximizes the dataset size. The proposed method was developed based on the ResNet-50 pre-trained model, and the procedure is shown in Fig. 3.

2.1Res Net

In CNN, several layers makes-up the network [18][19]. The layers in CNN implement some actions, which allow it to classify input images. The convolutional layer convolves the image that is inputted using a sequence of filters window sizes of 3 x3, this was used because what differentiates the objects are small and local features. The essential features are extracted

from the input images. The primitive features are extracted with the help of the first few layers. Has the training will go down the layers more and more complex and detailed features are extracted, with the help of the loss function probability, that is, Soft max function [20].
Our model was developed based on the ResNet-50 pre-trained model, this model was pre-trained on ImageNet images with a size of 256 x 256 and classified into 1000 classes. As shown in Fig. 3 the ResNet-50 pre-trained model has already trained on the image Net dataset and a set of weights has been acquired, but we removed the top classification layer by setting the include top = False, only the feature comes out of the network. The features are passed to the Multi-Class-SVM model where the classification takes place, based on the features extracted.

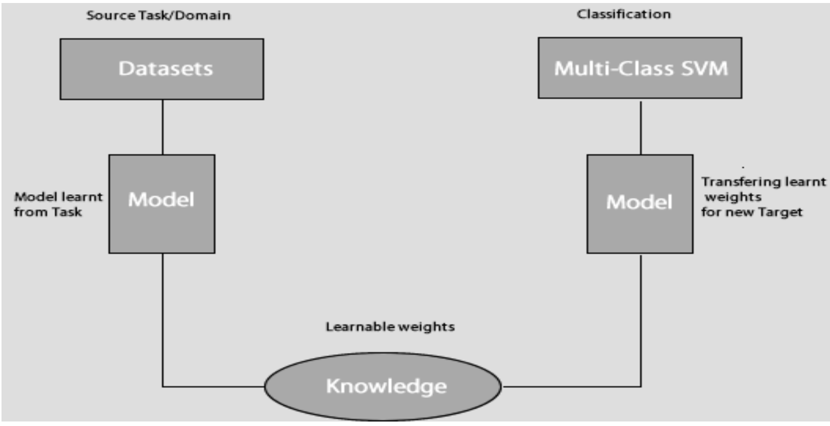

Fig.3 Flowchart of the proposed

3.Experiment and Result

The weight of the network is fixed, and the fully connected layer is removed and replaced by SVM which is trained and used for the classification. We used the following parameter for SVM optimization, the radial basis kernel was used, the SVM C- parameter was set to 1000 and the gamma was set to a value of 0.5. The pre-train ResNet-50 used was implemented on ImageNet dataset with an image size of 224 X 224. Standard colour augmentation and batch normalization were used after the convolution and before activation. The momentum and weight decay are 0.9 and 0.0001 respectively. The training was done on a core i5 Intel CPU with 12 epochs. The ResNet-50 CNN was used as the extractor for the features using Kera python with the trash dataset with 1989 images. Stochastic Gradient Descent with Momentum (SGDM) was used during the training. With the help of SGDM, the weights and biases were updated. The sample was selected at random, with a mini-batch of 12. The whole dataset was divided into two parts with a ratio of 8:2, which are used for training and testing samples, respectively. The feature extracted is then classified using Multi-Class-SVM [21][22]. After the entire training, we got an accuracy rate of 87%, after the 12th epochs the accuracy was not increasing anymore. The criteria for stopping after the 12th epoch is the test loss stopped decreasing and it was on the same value. Figures 4 and 5 show the training loss vs the validation loss and training accuracy and validation accuracy respectively. For the each of the epoch of the training, the dataset is feed into the network and backpropagation is run against each sample. The losses are stored after each epoch and the mean is calculated. The loss is plotted against the epoch which gives us the training and validation loss and it is shown in Fig. 4. The average training accuracy was 94.5% when plotted against the epoch and it is shown in Fig. 5 which was almost perfect.

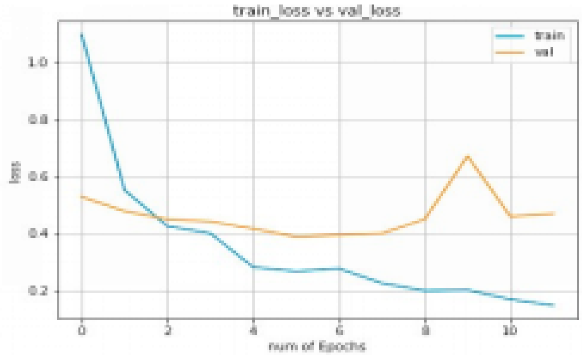

Fig. 4. Training loss and validation loss

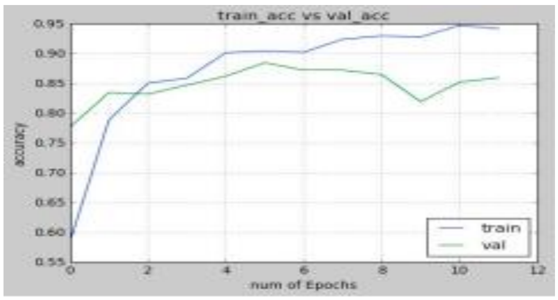

Fig. 5. Training accuracy and Validation accuracy

4.Conclusion

In conclusion, we proposed a waste classification system that is able to separate different components of waste using the Machine learning tools. This system can be used to automatically cl**assify** waste and help in reducing human intervention and preventing infection and pollution. From the result, when tested against the trash dataset, we got an accuracy of 87%. The separation process of the waste will be faster and intelligent using our system without or reducing human involvement. If more image is added to the data set, the system accuracy can be improved in the future, we will tend to improve our system to be able to categories more waste item, by turning some of the parameters used.