NAME : **V. GOPIKA**

PURPOSE : **PROJECT DOCUMENTATION**

PROJECT TITLE : **GARBAGE CLASSIFICATION**

1. INTRODUCTION

1.1 OVERVIEW

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. 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 landfilling, 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. 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.

1.2 PURPOSE

The present way of separating waste/garbage is the hand-picking method, whereby someone is employed to separate out the different objects/materials. The person, who separate waste, is prone to diseases due to the harmful substances in the garbage. With this in mind, it motivated us to develop an automated system which is able to sort the waste. and this system can take short time to sort the waste, and it will be more accurate in sorting than the manual way. With the system in place, the beneficial separated waste can still be recycled and converted to energy and fuel for the growth of the economy. The system that is developed for the separation of the accumulated waste is based on the combination of Convolutional Neural Network and Support Vector Machine (SVM), the algorithms, that is, the combination of Convolutional Neural Network and Support Vector Machine deals with recognition and classification. Due to the fact that the trash image dataset is small, we used a pre-trained ResNet-50 model which is a type of Convolutional Neural Network architecture. In this project,by using the convolutional neural network to classify an image as either cardboard, glass, metal, paper, plastic, or trash. The image dataset collected manually by Gary Thung and Mindy Yang was used here.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

The accumulation of solid waste in the urban area is becoming a great concern, and it would result in environmental pollution and may be hazardous to human health if it is not properly managed. It is important to have an advanced/intelligent waste management system to manage a variety of waste materials. One of the most important steps of waste management is the separation of the waste into the different components and this process is normally done manually by hand-picking. Convolutional Neural Network model which is used to classify the waste into different groups/types such as glass, metal, paper, and plastic etc. The proposed system is tested on the trash image dataset which was developed by Gary Thung and Mindy Yang, and is able to achieve an accuracy of 87% on the dataset. The separation process of the waste will be faster and intelligent using the proposed waste material classification system without or reducing human involvement.

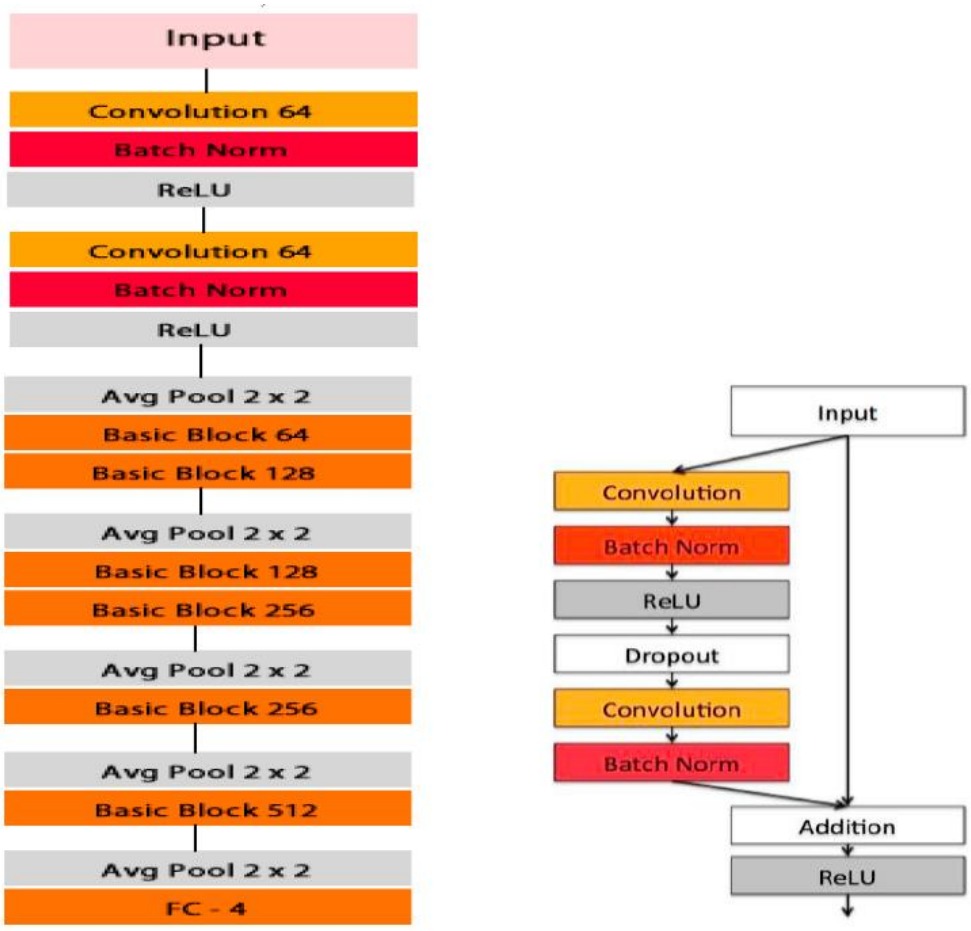
2.2 PROPOSED SOLUTION

The present way of separating waste/garbage is the hand-picking method, whereby someone is employed to separate out the different objects/materials. The person, who separate waste, is prone to diseases due to the harmful substances in the garbage. With this in mind, it motivated us to develop an automated system

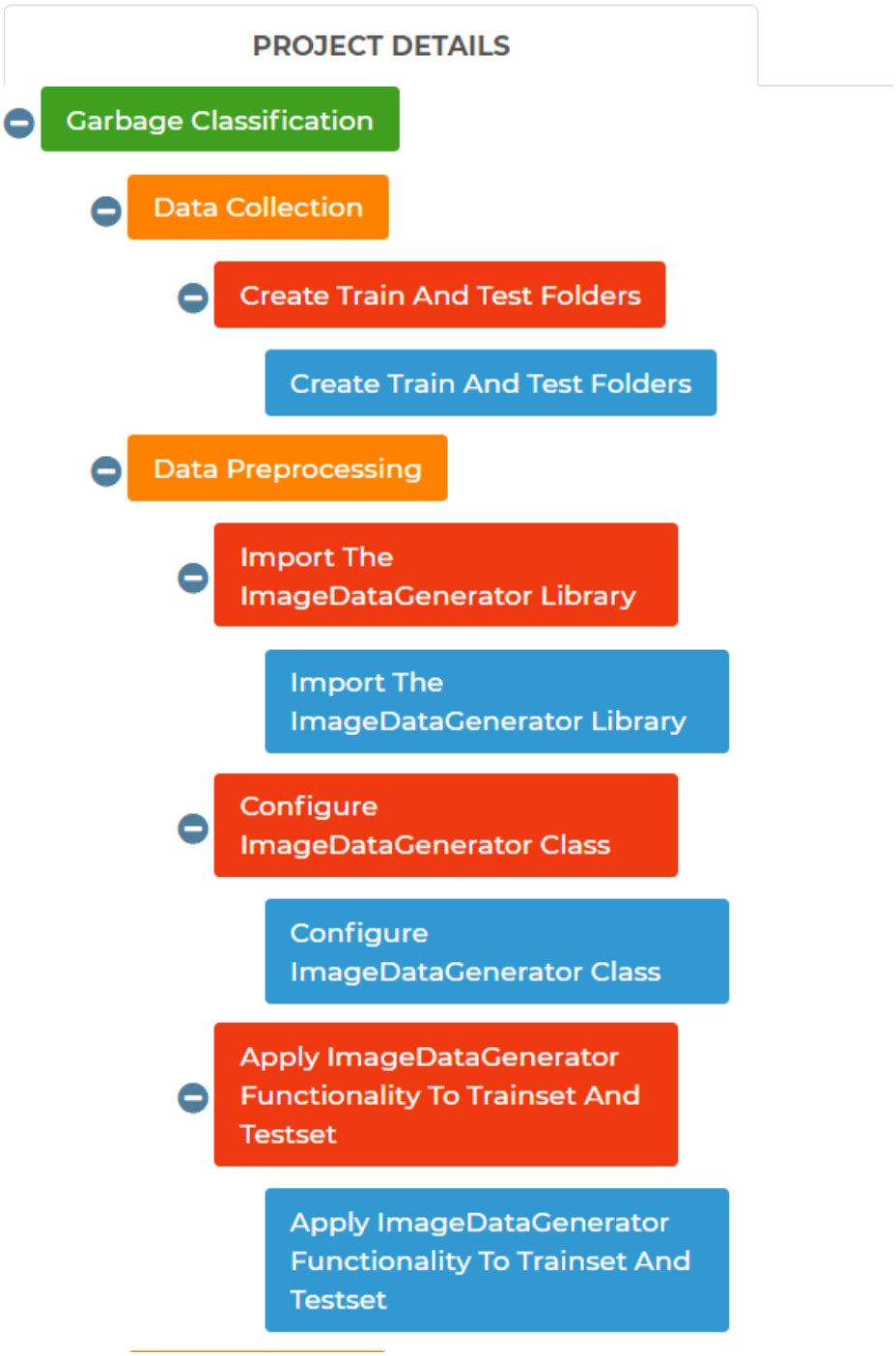
which is able to sort the waste and this system can take short time to sort the waste, and it will be more accurate in sorting than the manual way. With the system in place, the beneficial separated waste can still be recycled and converted to energy and fuel for the growth of the economy. The system that is developed for the separation of the accumulated waste is based on the combination of Convolutional Neural Network with recognition and classification.

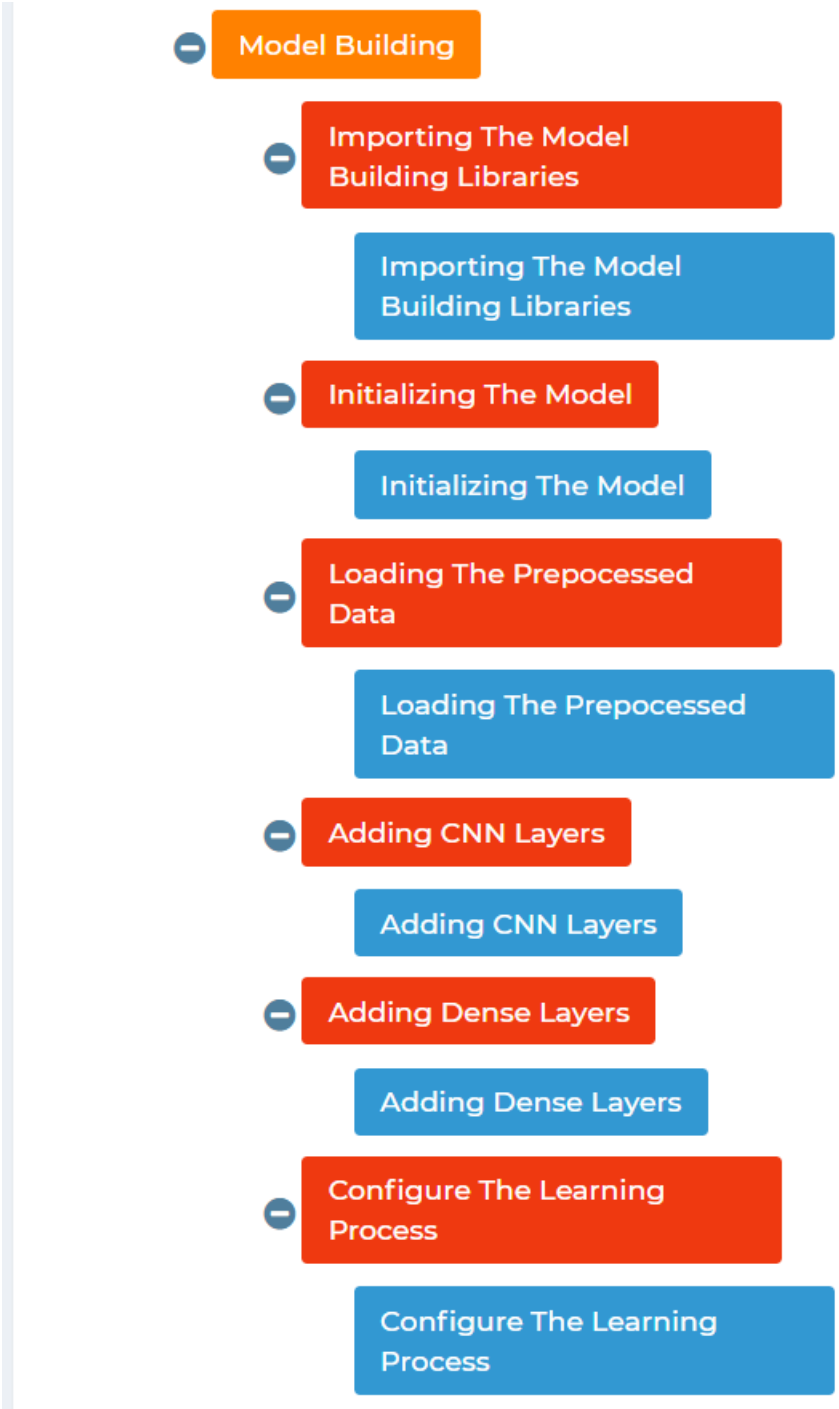
3. THEORETICAL ANALYSIS

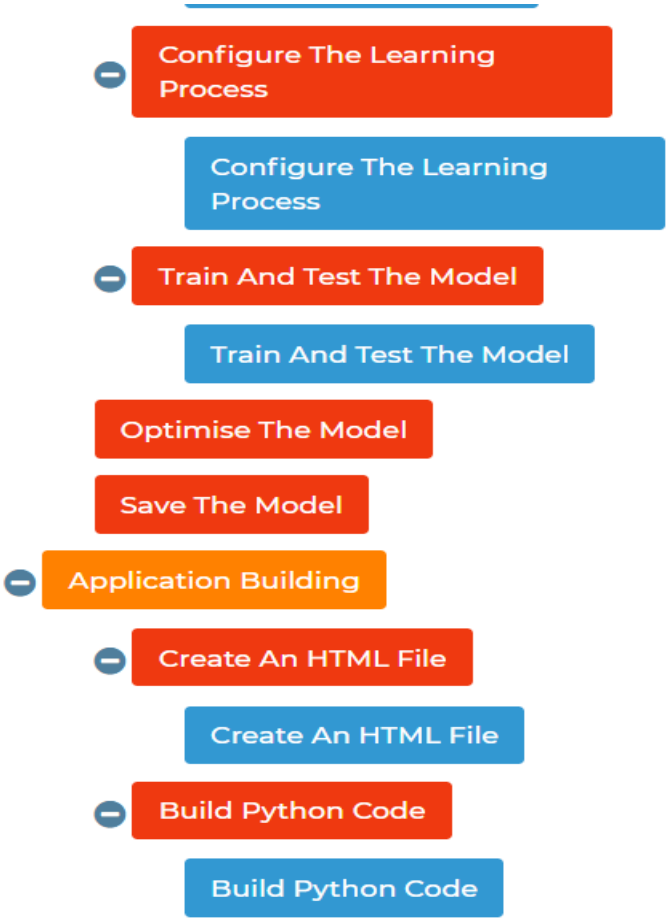
3.1 BLOCK DIAGRAM



3.2 HARDWARE OR SOFTWARE DESIGNING

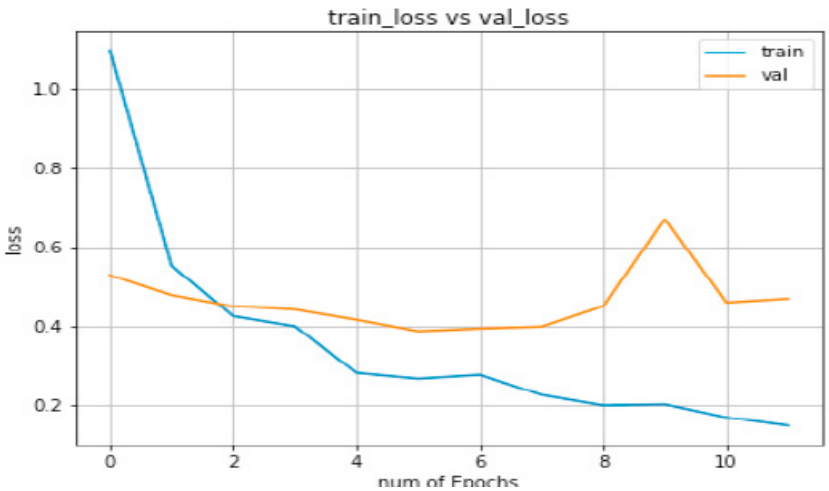



Model Building
Importing The Model Building Libraries
Importing The Model Building Libraries
Initializing The Model
Initializing The Model
Loading The Prepocessed Data
Loading The Prepocessed Data
Adding CNN Layers
Adding CNN Layers
Adding Dense Layers
Adding Dense Layers
Configure The Learning Process
Configure The Learning Process

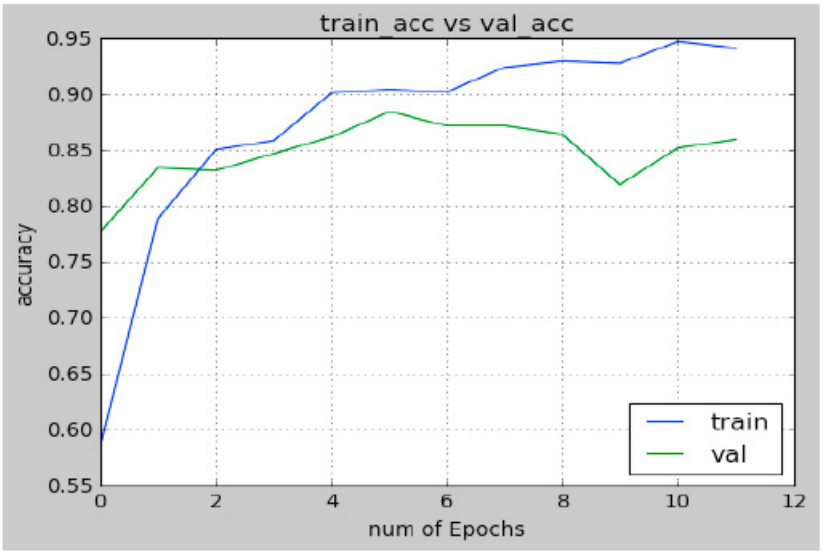


4. EXPERIMENTAL INVESTIGATIONS

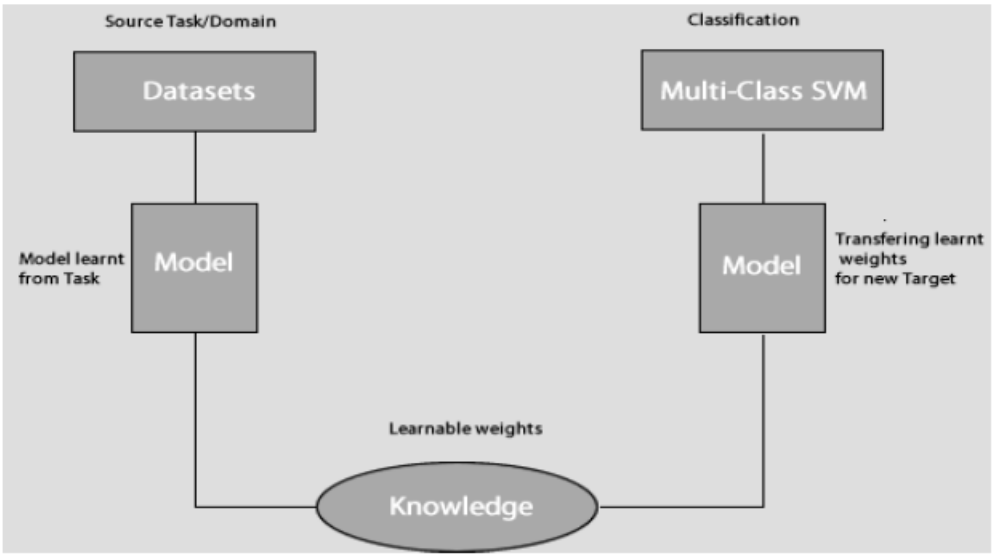
4.1 Training Loss and Validation



4.2 Training Accuracy and Validation Accuracy



5. FLOWCHART



6. RESULT

After the entire training, we got an accuracy rate of 92.1%, 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. 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. The average training accuracy was 94.5% when plotted against the epoch.

7. ADVANTAGES AND DISADVANTAGES

7.1 ADVANTAGES

- Reduced Energy Consumption
- Decreases Pollution
- Environment Friendly
- Slows the rate of resource depletion

7.2 DISADVANTAGES

- High Up-Front Costs
- Needs More Global Buy In

8. APPLICATIONS

In an automated collection system, residents are provided a standardized container into which they place their waste. Residents must place their cart at the curb on collection day. A fully automated collection program enhances worker safety and comfort, minimizes manual lifting and exposure to possible hazards in the waste such as sharp objects.

9. CONCLUSION

The Garbage classification project was successfully build using jupyter notebook which gives an accuracy of 92.1%. This system can be used to automatically classify waste and help in reducing human intervention and preventing infection and pollution. 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 dataset, the system accuracy can be improved.

10. FUTURE SCOPE

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.

11. BIBLIOGRAPHY

[1]. Adedeji, O., & Wang, Z. (2019). Intelligent waste classification system using deep learning convolutional neural network. *Procedia Manufacturing*, *35*, 607-612.

12. APPENDIX

A. SOURCE CODE

```
from fastai.vision import *
from fastai.metrics import error_rate
from pathlib import Path
from glob2 import glob
from sklearn.metrics import confusion_matrix
import pandas as pd
import numpy as np
import os
import zipfile as zf
import shutil
import re
import seaborn as sns
## splits indices for a folder into train, validation, and test indices with random sampling
    ## input: folder path
    ## output: train, valid, and test indices
def split_indices(folder,seed1,seed2):
    n = len(os.listdir(folder))
    full_set = list(range(1,n+1))
```

```
    ## train indices
    random.seed(seed1)
    train = random.sample(list(range(1,n+1)),int(.5*n))
    ## temp
    remain = list(set(full_set)-set(train))
    ## separate remaining into validation and test
    random.seed(seed2)
    valid = random.sample(remain,int(.5*len(remain)))
    test = list(set(remain)-set(valid))
        return(train,valid,test)
## gets file names for a particular type of trash, given indices
    ## input: waste category and indices
    ## output: file names
def get_names(waste_type,indices):
    file_names = [waste_type+str(i)+".jpg" for i in indices]
    return(file_names)
## moves group of source files to another folder
    ## input: list of source files and destination folder
    ## no output
def move_files(source_files,destination_folder):
    for file in source_files:
        shutil.move(file,destination_folder)
## paths will be train/cardboard, train/glass, etc...
subsets = ['train','valid']
waste_types = ['cardboard','glass','metal','paper','plastic','trash']
## create destination folders for data subset and waste type
for subset in subsets:
    for waste_type in waste_types:
        folder = os.path.join('data',subset,waste_type)
```

```
        if not os.path.exists(folder):
            os.makedirs(folder)
if not os.path.exists(os.path.join('data','test')):
    os.makedirs(os.path.join('data','test'))
## move files to destination folders for each waste type
for waste_type in waste_types:
    source_folder = os.path.join('dataset-resized',waste_type)
    train_ind, valid_ind, test_ind = split_indices(source_folder,1,1)
    ## move source files to train
    train_names = get_names(waste_type,train_ind)
    train_source_files = [os.path.join(source_folder,name) for name in train_names]
    train_dest = "data/train/"+waste_type
    move_files(train_source_files,train_dest)
    ## move source files to valid
    valid_names = get_names(waste_type,valid_ind)
    valid_source_files = [os.path.join(source_folder,name) for name in valid_names]
    valid_dest = "data/valid/"+waste_type
    move_files(valid_source_files,valid_dest)
    ## move source files to test
    test_names = get_names(waste_type,test_ind)
    test_source_files = [os.path.join(source_folder,name) for name in test_names]
    ## I use data/test here because the images can be mixed up
    move_files(test_source_files,"data/test")
```