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AUTOMATED E-WASTE DISPOSAL USING MACHINE LEARNING

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Abstract: *E-waste is a huge problem in India. In my surroundings we have always noticed that people dispose their non-working or damaged tube lights, batteries, lamps, filament bulbs, electronic toys, routers, earphones etc. in general waste which is an incorrect method of disposal because it contains extremely hazardous and toxic metals and we also need to minimize the number of people getting exposed to damaged electronic equipment's so to overcome this problem we wanted to ensure that the e-waste generated in household of India gets into the proper hands which can dispose, recycle and reuse effectively for this it became mandatory to make an e-waste vending machine where people will gather all the unused, damage equipment and dispose it into our machine for which they will be rewarded but because of rewards people should not dump any unwanted things like plastic, papers, stones so for that we have used the camera module which will take the image of an object which further will be predicted by ML model that the waste is electronic equipment and worth storing or no. We wanted to ensure that the system built by us will effectively collect the E-waste generated and we can reuse most of them for further process and it will also reduce the pressure on non-renewable resources which are used in production of various products as recycling can significantly decrease the demand for mining heavy metals and reduce the greenhouse gas emissions from manufacturing virgin materials.*

Keywords – *Disposal, E-waste, hazardous, mining, ML Model*

I. INTRODUCTION

The hazardous nature of e-waste is the rapidly growing environmental problems of the world. The problem is deepened by the ever-increasing amount of e-waste associated with the absence of knowledge and sufficient capacity. Increased use of electrical and electronic equipment is generating waste at an alarming pace in India, coupled with a huge population and evolving consumption patterns. This is attributable to the improvement or growth of technology. In modern times, these drastic advances have undeniably increased the quality of our lives. At the same time, these have led to several issues, including the issue of large quantities of toxic waste and other waste from electric product. These dangerous and other wastes pose a significant danger to the environment and human health. Land-filling of these waste results in extensive soil and groundwater pollution, while waste incineration contributes to the release of harmful gases such as dioxins and furans. Obsolete PCs are appealing to informal recyclers because of the high precious metal content and high demand for used machines in developing countries such as India. Computer recycling includes sophisticated applications and procedures, which are not only very costly, but also require special abilities and preparation for the operation. The majority of recyclers

actually involved in recycling operations do not have this costly waste management equipment. Recycling, and with all contaminants removed, would have an impact on pollution when removing useful materials. Since there is no separate e-waste collection in India, there is no clear data on the quantity of e-waste produced and disposed of each year and the degree of environmental risk resulting from it.

Direct interaction with hazardous materials such as lead, cadmium, chromium, flame retardants brominated or polychlorinated biphenyls (PCBS) and exposure to toxic fumes causes serious health hazards and environmental degradation."
This happens due to: Selling of electronic goods to scrapper as he dismantles it in unorganized way and disposing of electronic waste with general waste
Here are some specific steps that you should not take while disposing your electronic goods:
1.1 Do not mix the e-waste with normal waste, like remote control batteries.
1.2 Never disassemble your electronic devices on your own.
1.3 Never sell or distribute your e-waste to the local scrap dealer (bhangarwala) who operates in the informal and unorganized market.
India is 3rd largest e-waste generator in the world after China and USA.
India generates about 3 million tons of e-waste annually and ranks third among e-waste producing countries, after china and the United States. Reports state that it might rise to 5 million tons by 2021. There has been 150 official recycling centers created but there is no intermediate formed yet which will make our e-waste reach there.

II. COMPONENTS REQUIRED

Fig. 2.1 Raspberry Pi 3

Main Component of the Project is **'Raspberry pi'**. It is also known as the brain of the project. It works as CPU in this project. It is Micro-processor, it has 512 MB ram, 40 pins header, camera connector. We are not using Arduino in this, because memory of raspberry pi is larger than Arduino, raspberry pi has many USB port to connect many components, we can save many coding in this for multiple actions but we can't do it in Arduino as it is only efficient for repetitive tasks and not for multiple tasks. Therefore, we are using raspberry pi. Raspberry Pi has fully functional **operating system** called Raspbian. Pi is faster than Arduino by 40 times in clock speed. Pi has ram 128000 times more than Arduino. So Raspberry Pi is more **powerful** than Arduino.

Fig.2.2 Camera Module

'Camera Module' is used to capture or scan the images of the object. We are using OV7670 module in this project.

Fig2.3 Servo Motor

It will produce a mechanical moment to open and close the lids of collection bin and rejection bin. This work on PWM (Pulse Width Modulation) principle.

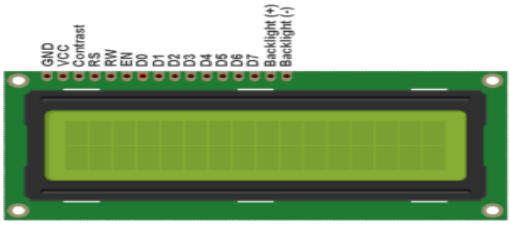


Fig.2.4 Display

To display the Instruction for using the device and lastly we are using this to display "Thank-you" that your object has been disposed successfully.

Fig.2.5 Ultrasonic Sensor

'Ultrasonic Sensor' is used to turn on the machine and detect whether the object is present or no.

Fig.2.6 Weight Sensor

To measure weight of object on surface.

III. FLOWCHART

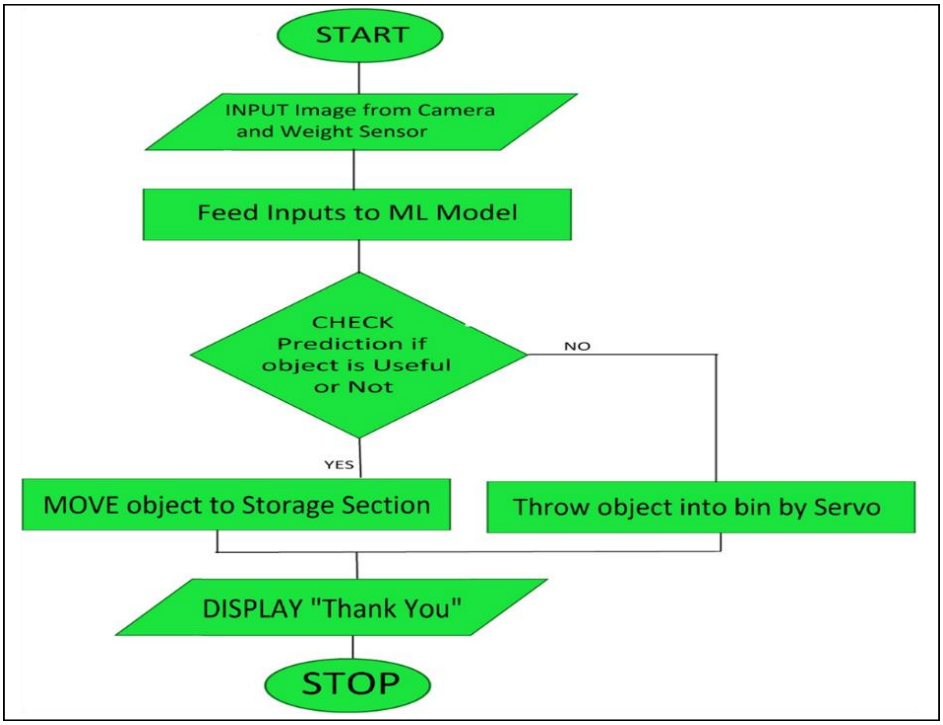
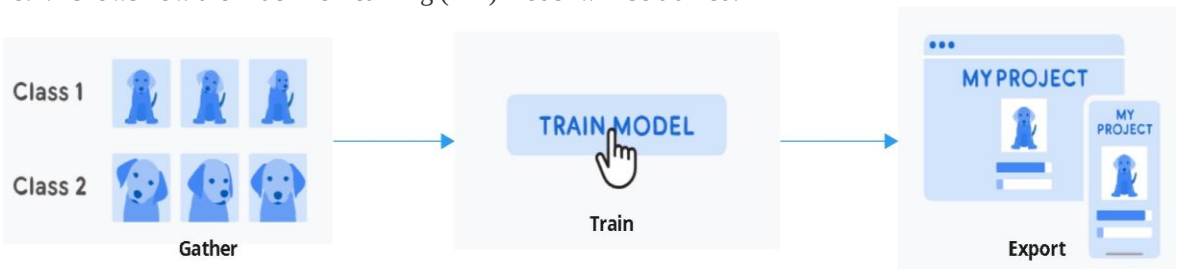


Fig No.3.1 Flow chart of Machine Learning (ML) Model

Flowchart above shows the work flow process in sequential order. It is a generic tool that can be adapted for a wide variety of a project plan. The system starts and feeds the input to ML model which will check the prediction of storage and if the prediction is correct then the object dumped will be stored and display thank you and if not the object will be thrown into the bin through servo.

IV. METHODOLOGY

This study explores a method for image recognition to recognize and classify waste electrical and electronic equipment from images. Its primary aim is to promote the sharing of information about the waste to be collected from individuals or waste collection points. In this system the main unit is raspberry pi which will process the machine learning (ML) model and detect the type of waste by using camera module which is placed in a container. Fig No.4.1 shows how the Machine Learning (ML) model will be trained.



4.1 Gather
Gather and group your examples into classes, or categories, that you want the computer to learn.

4.2 Train
Train your model, then instantly test it out to see whether it can correctly classify new examples.

4.3 Export
Export your model for your projects: sites, apps, and more. You can download your model or host it online for free.

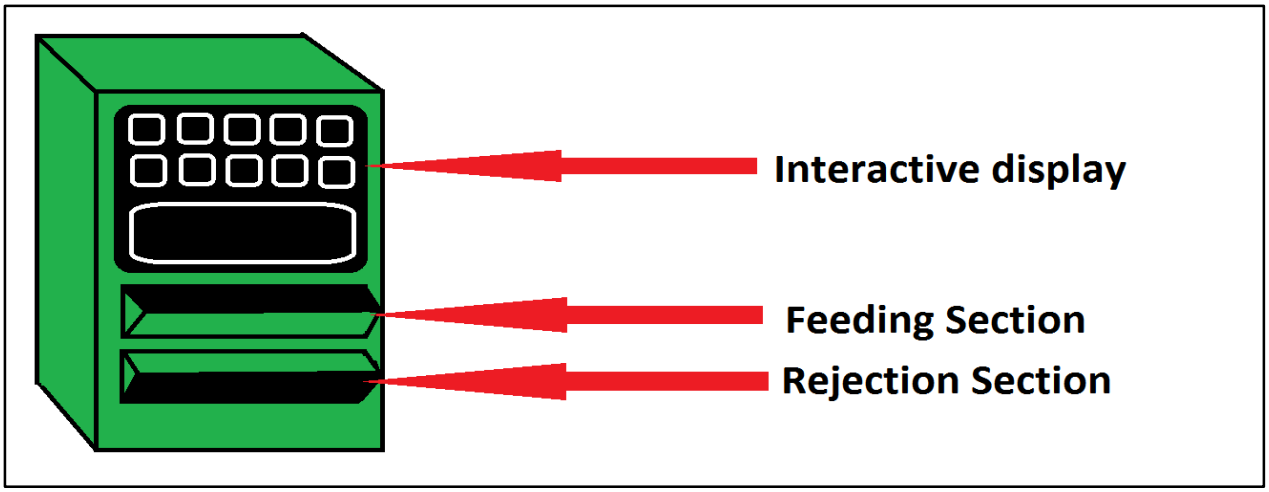


Fig No.4.2: Diagram of Proposed E-waste Disposal

4.4 Display: The display used in the project will let users interact with the machine so they can identify or choose from the dataset the type of waste they are going to dump into the machine.

4.5 Feeding section: This is the section where users will insert the objects that they want to dump into the machine.

4.6 Rejection section: If the object dumped by the users is not reusable or recyclable then it is thrown out by this section.

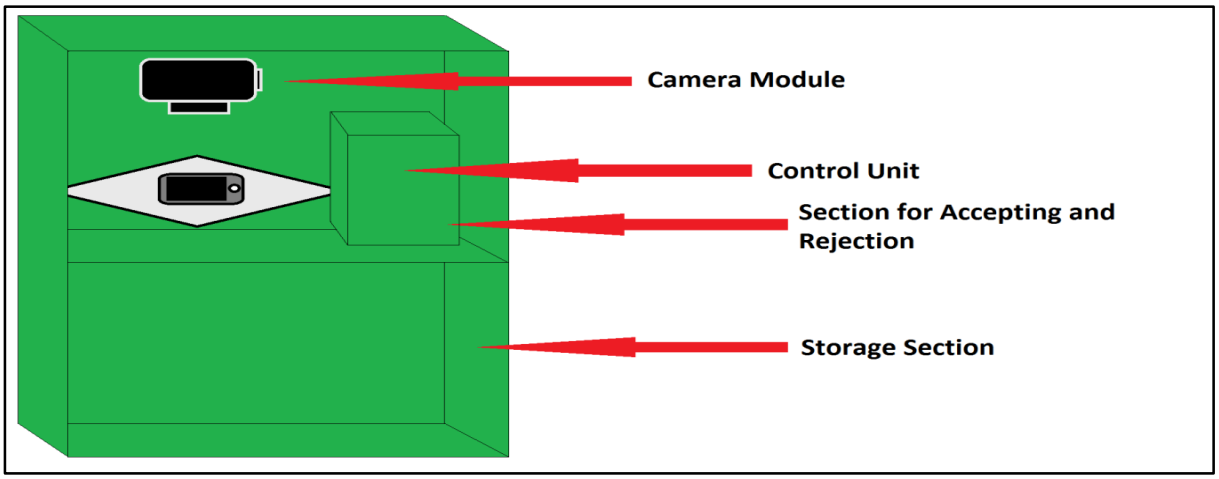


Fig No.4.3: Working Diagram of Automated E-waste Disposal

Users will insert the gadgets that they want to dump into the machine through the feeding section. The display used in the project will let users interact with the machine so they can identify or choose from the dataset the type of waste they are going to dump into the machine. The object will go in front of the camera and it will take a picture of the inserted object. Processing unit which is raspberry pi will feed that image taken by camera to pre-trained ML models. ML model will predict what the object is and will it be worth savaging as E-waste then give the result. Based on the result given by the model object is stored in the storage section or rejected and thrown out by the rejection section. The input from the weight sensor with the camera will be used to get more accurate predictions.

V. EXPECTED RESULT

```
[7]  import tensorflow.keras
     from PIL import Image, ImageOps
     import numpy as np

     # Disable scientific notation for clarity
     np.set_printoptions(suppress=True)

     # Load the model
     model = tensorflow.keras.models.load_model('keras_model.h5')

     WARNING:tensorflow:No training configuration found in the save file, so the model was *not* compiled. Compile it manually.

[8]  labels = ['batteries', 'coffee_maker', 'electric_toaster',
               'hair_dryer', 'calculators', 'computer_mouse', 'digital_Clock_watches', 'Earphones_headphones'
               , 'electronic_toys', 'keyboard', 'old_cables', 'old_CD_DVD_players', 'old_circuit_boards', 'old_routers',
               'old_cameras', 'phone_chargers', 'phones', 'waste']

[9]  # Create the array of the right shape to feed into the keras model
     # The 'length' or number of images you can put into the array is
     # determined by the first position in the shape tuple, in this case 1.
     data = np.ndarray(shape=(1, 224, 224, 3), dtype=np.float32)

     # Replace this with the path to your image
     image = Image.open('/content/download.jpg')

     #resize the image to a 224x224 with the same strategy as in TM2:
     #resizing the image to be at least 224x224 and then cropping from the center
     size = (224, 224)
     image = ImageOps.fit(image, size, Image.ANTIALIAS)

     #turn the image into a numpy array
     image_array = np.asarray(image)

     # display the resized image
     image.show()

     # Normalize the image
     normalized_image_array = (image_array.astype(np.float32) / 127.0) - 1

     # Load the image into the array
     data[0] = normalized_image_array

     # run the inference
     prediction = model.predict(data)
     [[0.00002024 0.00000001 0.00001421 0.00000371 0.0000364  0.00002972
       0.01718004 0.00000095 0.00000067 0.00026512 0.00001324 0.00000008
       0.00000067 0.00000449 0.00000031 0.00163133 0.98067194 0.00012681]]

[10] idx = np.where(prediction == np.max(prediction))
     result = labels[int(idx[1])]
     result

     'phones'

[11] from IPython.display import display, Image
     display(Image(filename='/content/download.jpg'))
```

The estimated output will be in the above form which shows the trained machine learning model in which the input image of the e-waste is given to the input of ML model which gives the output in terms of the type of waste detected.

VI. CONCLUSION

Less manual work will be required for salvaging valuable materials and electronics parts for reuse. Helps in reducing large amount of E-waste generated every year and disposed by incorrect method. This system will help us to send maximum amount of e-waste to proper recycling center's. There will be decrease in e-waste generation to recycling ratio. This system will increase social awareness due to advancement in technology, there is high generation of e-waste and limited awareness of dangers associated with its improper disposal and over 90% being recycled by unorganized sector, the environment is getting polluted very badly but this method will create awareness to greater extend and a keen interest for a proper disposal. Good governance. Builds Sustainable environment. Safety and security of citizens. Health and education. Eco-friendly: From this project we will be able to save landfills getting polluted. Efficient: In this paper a complete framework is presented about the proper and efficient way of e-waste management. Conserves natural resources: Reduces the load on natural resources because the raw material required for the production of new products is extracted from E-waste rather than mining it from earth's crust. Employment opportunities: It creates the job for professional recyclers. Hence, it is high time for us to realize our mistakes and take corrective measures to prevent irreparable damage to the environment.

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