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Smart Bin: Biomedical Waste Segregation and Management

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ABSTRACT

The idea of this project is to study the application of Image processing and Internet of Things (IoT) in developing an efficient automated mechanical sorting system for biomedical waste at its source, which would reduce the physical efforts. This project is designed to segregate biomedical waste into bins through color coding method. Segregating waste into bins would be the pioneer step for recycling and efficient treatment of hazardous waste. The IoT based smart bin checks the waste level over the dustbins by using ultrasonic sensor and stores information about thebins.

I. INTRODUCTION

As per the World Health Organisation, most of the overallquantityofwastegeneratedisnon-hazardous however, about 15% is considered hazardous. In India, apart from some large hospitals, most of the smaller hospitals lack effective system to securely dump waste. The standard method of collecting the waste in health care department can expose staff to infections and injuries. Wastes generated in hospitals are dumped in the open bins on the roadsides or into the water bodies which contains used bandages, syringes, humantissues, used culture media containing microorganisms. This irresponsible dumping may lead to an illegal reuse of medical wastes and spread of many diseases. The primary and the most significant step of waste management is segregation. It is also necessary to make sure the segregated waste is managed properly.

NEED OF PROJECT

Hospital is the place for cure but also the place where the waste is the most contaminated. Safetyof hospital employees and patients ought to be given priority. Specially after the effects of COVID-19 a safe and automated management of waste has to be implemented. A lot of diseases spread because of direct contact. Avoidingitcan help break the chains of many contagious diseases. Wastesegregation and management is now the need of the hour and it is necessary to separate the waste materials at its source.Segregationofwasteatthepointofsourceis important because then it becomes treatment of those waste materials becomes easy for further reusing and recycling. Along with segregation a proper track of waste is also necessary. Implementation of smart bins to detect level of bins and to store data of waste collected is important for better management of wastes inhospitals.

OBJECTIVE AND SCOPE OF THE PROJECT

Our goal in this project is to capture images of a single waste material and further identify and Segregateitin to four classes, metal, glass, paper and plastic using Convolutional Neural Network(CNN). To get high test accuracy for image segregationand to build automated waste management that would speed up the process of segregation without any human requirement. Build a prototype of safe and automatic waste management in hospitals, to track data and to ensure proper transportation of specific bins to its rightlocation.

II. METHODOLOGY

We have attached Raspberry Pi to the Smart Bin model and it is used for controlling the Smart Bin. The process includes:

1. We are using IR sensor to detect the waste onceit falls on the lid. Capture the image of thewaste.
2. Send the image to the classifier using Raspberry Pi.
3. Servomotorsareusedtoredirectthewastetofall intoitsrespectivebin.Thewasteisdetectedwiththe help of image processing. The detected waste is dropped into its dedicated bin. As this process runs continuously,

the bins start to fill up. To detect the levelofthebin,ultrasonicsensorsisattachedtoeach bin which is monitored in real time on ThingSpeak. As soon as the level threshold is crossed, an alert is sent indicating that the bin is full and needs to be emptied or replaced. A database has been maintained using this which keeps a track of all waste which has been segregated by thebin.

BLOCK DIAGRAM

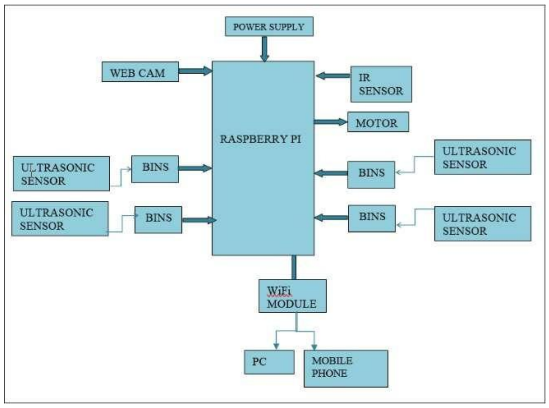

Fig. 1 Block Diagram

Using sensors and image processing waste will be classified as plastic, paper, metal and glass wastes. For this, we will partition our bin into 4 sub bins. The above figure is the basic block diagram for waste segregation using Image processing. It is proposed for faster working which involves getting images from camera with detection, object recognition, prediction and classification into categories according to color code method. The waste segregation is achieved using image processing. The bin is fitted with sensors like IR sensor, to detect the object on bin and each bin is fittedwithultrasonicsensorontoptodetectthelevel of the bin. The lid tilts accordingly and drops the waste into its respective compartment. When a certain level is reached, an alert in from of message is sent to inform that the bin is full and needs to be emptied orreplaced.

Thing Speak helps us in achieving real time monitoring of garbage bins. An administrator is notified during monitoring when the smart binlevel threshold is achieved, the staff can then do the necessay procedures.

DESIGN OF OUR SYSTEM:

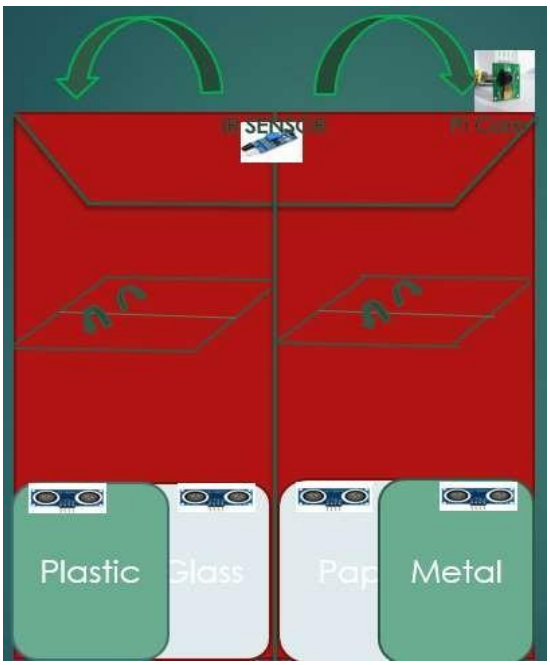

Fig. 2 Bin Design

III. HARDWARE REQUIREMENTS:

1. Raspberry PiBoard:
The Raspberry Pi board is a series of single-board computers having a System On Chip (SoC). It is a QuadCore1.2GhzBroadcomBCM283764bitCPU. With 1GB RAM, full size HDMI, I/O Peripherals, Ethernet port and USB host on it. The Raspberry Pi board is extremely economical as it can help in various automation projects. We will be using Raspberry Pi 3 Model B for ourproject.

2. UltrasonicSensor:
Ultrasonic sensors is divided into 3 broad categories: transmitters, receivers and transceivers. Thefeatureoftheultrasonicsensoristodetectlevel of the dustbin. This will, in turn, send alert to the administratorandthetrashcanbediscarded.Weare using the HC-SR04module

3. IR Sensor:
IR sensor consists of each IR transmitter and a receiver.It'susedforobjectdetectioninourproject.

An IR sensor can detect the motion within the surrounding. It detects object by transmitting IR waves. These waves reflect back if an object is present and is received by the receiver. The object detection range is 5 cms for this module.

Raspberry Pi Camera:
The Pi camera module is a portable light-weight camera that supports Raspberry Pi. This Raspberry Pi camera module V2 is that the apt camera module for this purpose of waste segregation. It has a fixed focus lens on board with an 8 megapixel resolution sensor-capable of 3280 x 2464 pixel static images. These images will be used as input for CNN model which will determine the type of waste.

4. ServoMotors:
These motors are small devices with the shaft attached and controlled by the raspberry pi board.It receives a certain amount of pulse, with which it turns clockwise or anticlockwise. It can turn from 0 to 180 degrees. We might as well use the stepper motor for efficientoutput.

SOFTWARE COMPONENTS:

1. Anaconda:

Fig. 3 Anaconda with packages installed

Anaconda comes with preinstalled python libraries which are very useful. It helps in creating an environment specific to our project requirements to isolate libraries.
The libraries used are:

Keras Tensor flow Pillow Opencv
WeareusingCNN(ConvolutionalNeuralNetwork) to segregate waste. The algorithm helps in image classification by extracting features from the image to observe patterns withindataset.

2. Thing Speak:
ThingSpeak is an open-source platform which is used to store and retrieve data. Here we are interfacing ultrasonic sensor to thingspeak to monitor the real time data of bin and to send alert when the bin is full.

HARDWARE TESTING:

Pi Cam:

Fig.4 Interfacing PiCam and Raspberry Pi

Pi Cam is needed for capturing images of object for the further segregation process in our project. Raspberry Pi has a feature for connecting the Camera Module. We have successfully installed Raspbian os in our Raspberry Pi and connected the pi cam.

Ultrasonic Sensor:

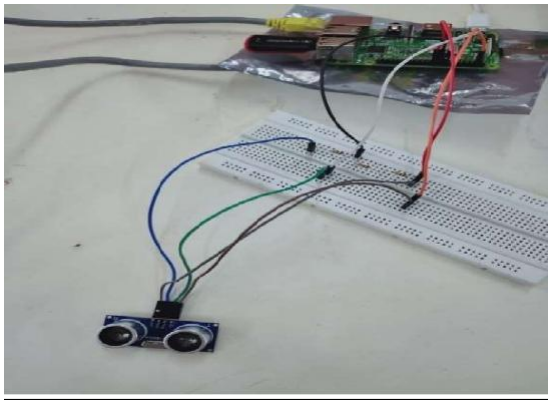

Fig.5 Interfacing Ultrasonic sensor with Raspberry Pi

IR Sensor:

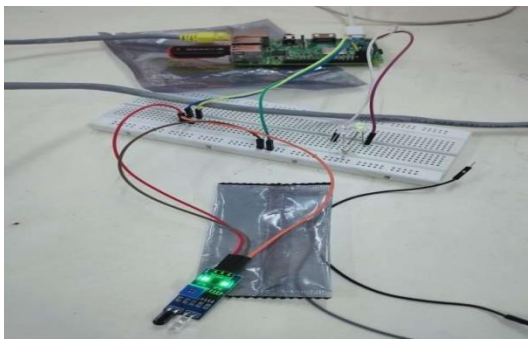

Fig.6 Interfacing IR sensor and Raspberry Pi

SOFTWARE IMPLENTATION:

GUI screens of smart bin:

Fig 6. GUI of image segregation

The GUI consists of 4 buttons:

1. Select Image: It is used to choose the image from folder to perform image segregation.
2. Image preprocessor: It is used to convert image to grayscale as input to CNNshould be grayscaleimage.
3. CNN Prediction: It is used to classify image as Metal, Plastic, Paper,Glass.
4. Exit: It is used to exit the userinterface.

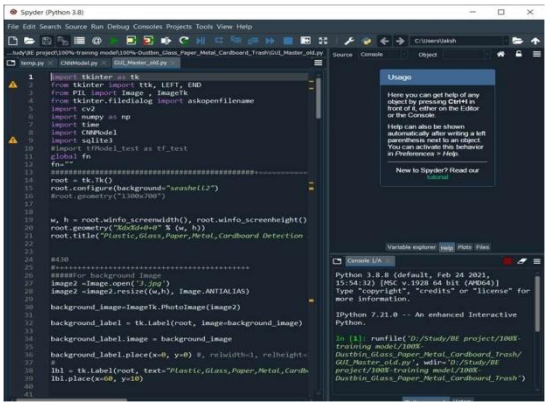

Fig 7. Image training in spyder IDE

Detecting that an input object was metal:

Fig 8. Grayscale Conversion

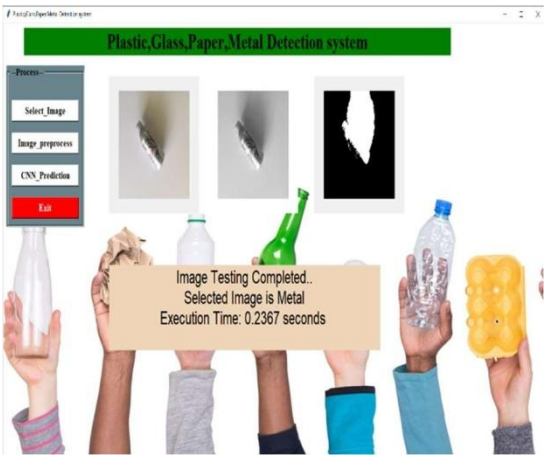

Fig 9. CNN Prediction

Accuracy and Loss of Model:

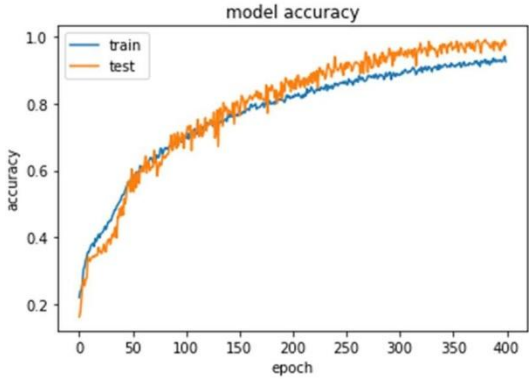

Fig.10 ModelAccuracy

The accuracy of testing Model is observed to be around 90%

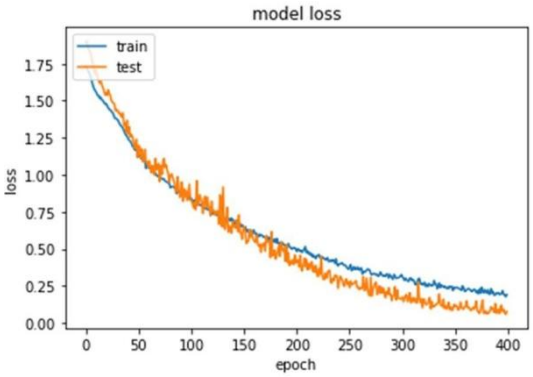

Fig.11 Model Loss

IV. CONCLUSION

Maintaining hygiene within the hospitals is crucial for a healthy society. We propose a system that segregates the waste into its dedicated bins and provides real time information concerning the bin status, i.e., if the waste in bin has reached the maximum level or not. If a particular dustbin has reached the brink of the bin then the employees can be informed and they can immediately take certain actions to empty it as soon as possible. We have achieved a testing accuracy of around 90%. Ultrasonic sensor is being used in this system to check the level of the dustbins.

FUTURE SCOPE

The system can be used as a benchmark by those who are willing to improve the cleanliness in their areas.

1 Observation of bio-medical waste produced over a period of time will helpin making necessary amends for better efficiency and management infuture.

2 Aftertheanalysesofwaste,newinnovative solutionscanbethoughtoftoreuse,recycle or reduce the waste beingproduced.

3 Further, the bincanbeconnectedtoanIoT cloudwhichwouldthensendandstoredata of wasteusage that canthenbeshared with a waste disposal department. The system can be improved by developing a mobile application and using GPS to show the routeandsendmessagetotheclosestwaste vehicle to the filledbin.

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