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# Automatic Garbage Segregation and Management System

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**Abstract:- The increasing population, rapid growth of industries and urbanization have led to the daily generation of a humongous amount of waste, which may cause fatal diseases in living beings and also cause pollution. Hence the collection and segregation of garbage is a major issue faced by the cities. The segregation of waste at junk yards is mundane and laborious which consumes a lot of time and labor. To prevent this, we propose a system to segregate garbage at the domestic level based on the nature of the waste. The proposed model is a microprocessor-based IoT device where the bins are embedded with sensors that help in identifying the type of waste. The garbage is segregated using a robotic arm that uses object detection through Image processing to pick and place the garbage into their respective dust bins, then using the ultrasonic sensors the garbage level is monitored and updates the data in the cloud using Blynk IoT application. The main objective of our model is to provide an efficient and cost-effective solution for the current problem in waste management i.e., proper segregation of the garbage.**

***Keywords:*** *Pollution; Segregation; Microprocessor; Iot; Sensors; Robotic Arm.*

## I. INTRODUCTION

The metropolitan cities of India are littered with garbage, leading to many problems like servingas a breeding ground for many infectious diseases, pollution, etc. Often the waste is collected only from significant locations of the cities or towns, leaving the other places unattended and choking with the waste collected over time. However, waste management has been ineffective, dumping them into unattended landfills.

According to the statistics, the world generates about 2.24 billion tons of solid waste per day, which amounts to a footprint of 0.79 kilograms per person per day. At this rate, by 2050, waste generation is expected to increase by 73%, which levels to 3.35 billion tons of waste per day. In India, the waste generation amounts to 0.1 million tons per day. Solid waste is disposed of by several methods, the most prominent among them is the incineration of the solid waste. Incineration of waste leads to the generation of a large amount of greenhouse gas like carbon- di-oxide. The other method followed widely is dumping solid waste into landfills, which pollutes the land and the underground water by percolating through the layers.[1]

Proper management of waste is necessary to build sustainable cities. But it remains a challenge for many underdeveloped and developing countries as effective waste management requires an integrated system that is effective, efficient, and sustainable. According to the 'Zero Landfill' policy, 100% of the recyclable waste must be recycled. There is a need to develop a time-targeted action plan for waste management to prevent the impending environmental crisis.

## II. LITERATURE SURVEY

As shown in Table 1, from paper 1 and 4 image processing technique is referred, from paper 2 MQTT is referred, from paper 3 CNN and Deep Learning is referred and from paper 2 and 5 IoT techniques are referred. From various papers it is observed that, the limitations of the papers are waste must be thrown separately and one at a time and also limited data sets of components images lead to inaccuracy. Future scope is to develop an automated waste segregation and it can be done by robotic arm and to train the image processing model with large data sets.

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Table 1 Comparative Study of IEEE Papers

| Comparing Factor | Paper 1 | Paper 2 | Paper 3 | Paper 4 | Paper 5 |
|---|---|---|---|---|---|
| Technologies Used | LoRa, TensorFlow (Image processing) Deep Learning & IoT | MQTT (Message Queuing Telemetry Transport) & IoT | CNN, Deep Learning | Machine Learning for Image Processing (SURF,KNN) &IoT | IoT |
| Hardware Used | Raspberry Pi, Arduino Uno, RFID module, Sensors | Node MCU, Sensors | | Arduino Mega , Sensors | Sensors, Microcontroller |
| Applications | Object Detection for waste segregation using TensorFlow and Updates the status of bins using low power consuming LoRa | Segregates dry waste from wet waste and updates the levels of bin and sends a message to the authority. | Identifies wastes into several categories like cardboard, metals, plastic and paper | Segregates dry and wet waste. Further the dry waste is segregated into metals, plastics and paper | Segregates dry and wet waste, Displays the status of bins on an Android app |
| Limitations | Waste must be thrown one at a time . | Does not categorize the dry waste further. It is a primary model | Limited Data set leads to inaccuracy | Only one waste can be thrown once at a time. | Primary Segrgation |
| Further Scope | May develop an automatic Self training model to increase the data set. | May develop to categorize dry waste . | Develop an recommended verification system for further addition to dataset when a new object is detected | Develop an robotic arm for segregation of waste. | Develop for further segregation |

➢ *Problems Identified*

From the Literature Survey carried out, several problems were identified in the existing process of waste segregation and management. They are:

- Manual segregation is tedious and time-consuming.
- Human interaction with garbage leads to many infectious diseases,deteriorating the health of humans.
- The garbage from the dust bins in public places is not collected at the appropriate time leading to an overflow of bins.
- In many places, separate bins are not maintained for wet and dry waste making the segregation process difficult.

✓ *Proposed Solution*

Following the problems identified in the existing system, the solutions proposed are:

- To build a model which can segregate the waste automatically into several categories.
- To reduce the human interaction in garbage segregation to the minimum level possible.
- To ensure the timely collection of garbage from the bins by notifying the authorities.

By following the above methods, it can be made sure to promote a healthy and cleanenvironment, and it reduces the risk of spreading infectious diseases due to human interaction at the dump yards and landfills.

➢ *Software and Hardware Requirements*

Hardware and Software requirements are shown in Component Diagram of Fig.1.

- *The Hardware Requirements for the Project are:*
  - ✓ *Raspberry Pi 3*
  - ✓ *Camera Module*
  - ✓ *Robotic Arm*
  - ✓ *Ultrasonic Sensor SR04*
  - ✓ *Gas Sensor MQ2*
  - ✓ *Arduino UNO*
  - ✓ *Breadboard*
- *The Software Requirements for the Project are:*
  - ✓ *Raspberry Pi OS*
  - ✓ *Open CV*
  - ✓ *TensorFlow*
  - ✓ *Python*
  - ✓ *Blynk IoT Application*
  - ✓ *Arduino UNO*

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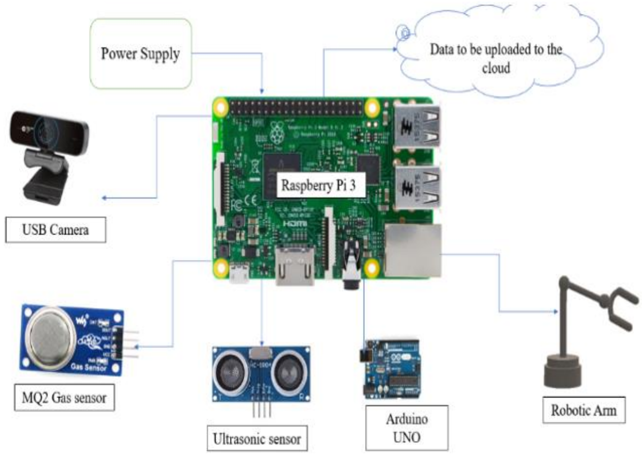

Fig 1 Component Diagram

## III. METHODOLOGY

➢ *Proposed Methodology*

The main objective of the project is the segregation and disposal of waste. The garbage dropped into the bin is segregated (bio-degradable, plastic, metal etc.) at the panel with the data acquired from the results of image processing and the garbage is dropped into the respective bins.

- The garbage is thrown into the compartment allotted for the mixed waste.
- The robotic arm incorporated identifies the dry waste from the wet waste using Image Processing and picks and place the waste into the respective bins [5].
- The garbage that is identified as dry waste, is further identified as paper, plastic, metal, glass and E-waste accordingly robotic arm picks up and places the waste into the respective bins [6].
- Gas sensors are used in the bio-degradable segment to sense the level of methane gas. Ultrasonic sensors are used to determine the level of the trash collected and is updated in the database. The trash can be then collected to be recycled.
- The type of garbage collected and the level of the dust bins are updated onto Blynk IoT application through Wi Fi [7].

➢ *Image Processing*

The image processing part of this project is divided into four steps.

- Collection of dataset: The dataset required for training the image processing model is collected from various internet sources. The majority of these images are collected from an existing dataset known as trashnet available over the internet. The dataset consists of 2527 images as shown in Fig. 2, that are used to train the model.

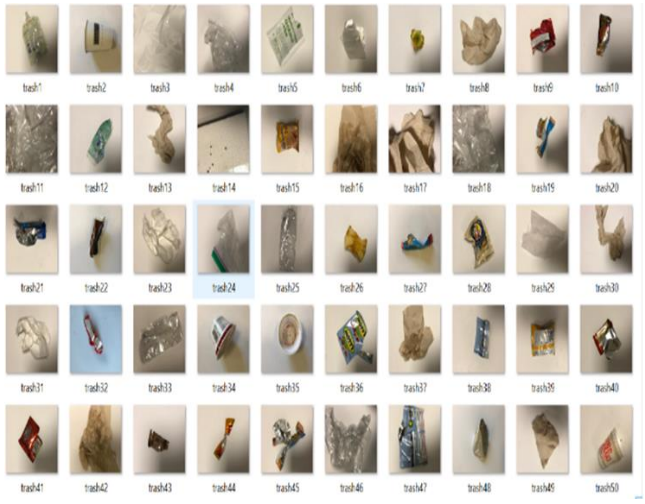
Fig 2 Sample of Waste Images Dataset

- Labelling the images: The images obtained must be labeled to train the object detection model. We use the LabelImg software to label the images. The images are annotated by drawing a bounding box around the interested area of the image as shown in Fig. 3 and the same dimension of the image is converted into a.xml file which is supported by algorithms like YOLO.

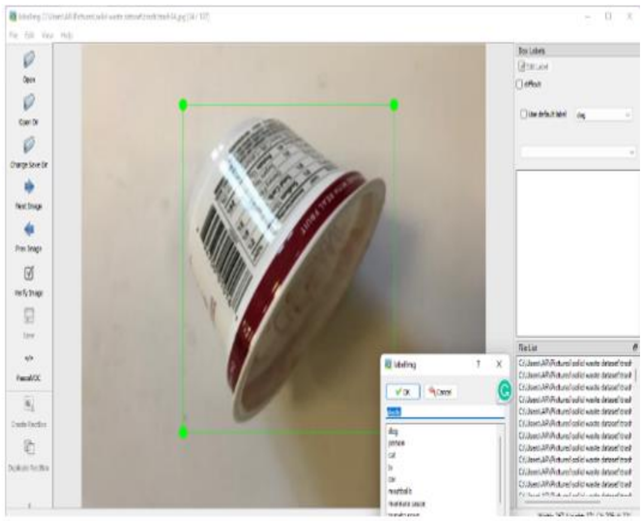
Fig 3 LabelImg Interface

- Training the TensorFlow model: To train the TensorFlow model, the transfer learning process is used, where a pre-trained model is fine-tuned for the intended purpose. The dataset is loaded and the model is trained, and tested for the images classified as test images. The accuracy of the model is measured using mean average precision (mAP) as shown in Fig. 4.

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```
%cd /content/mAP
!python calculate_map_cartucho.py --labels=/content/labelmap.txt

94.38% = cardboard AP
66.72% = glass AP
67.81% = metal AP
51.86% = paper AP
57.41% = plastic AP
mAP = 67.64%
Calculating mAP at 0.75 IoU threshold...
90.52% = cardboard AP
66.72% = glass AP
67.81% = metal AP
51.86% = paper AP
56.02% = plastic AP
mAP = 66.59%
Calculating mAP at 0.80 IoU threshold...
90.52% = cardboard AP
66.72% = glass AP
67.81% = metal AP
51.86% = paper AP
56.02% = plastic AP
mAP = 66.59%
Calculating mAP at 0.85 IoU threshold...
90.52% = cardboard AP
60.10% = glass AP
59.55% = metal AP
50.19% = paper AP
```

Fig 4 Calculation of mAP of the Model

- Deploying the model: The custom-trained TFlite model is deployed onto the raspberry pi and the program is run for object detection, the result is shown in the Fig. 5.

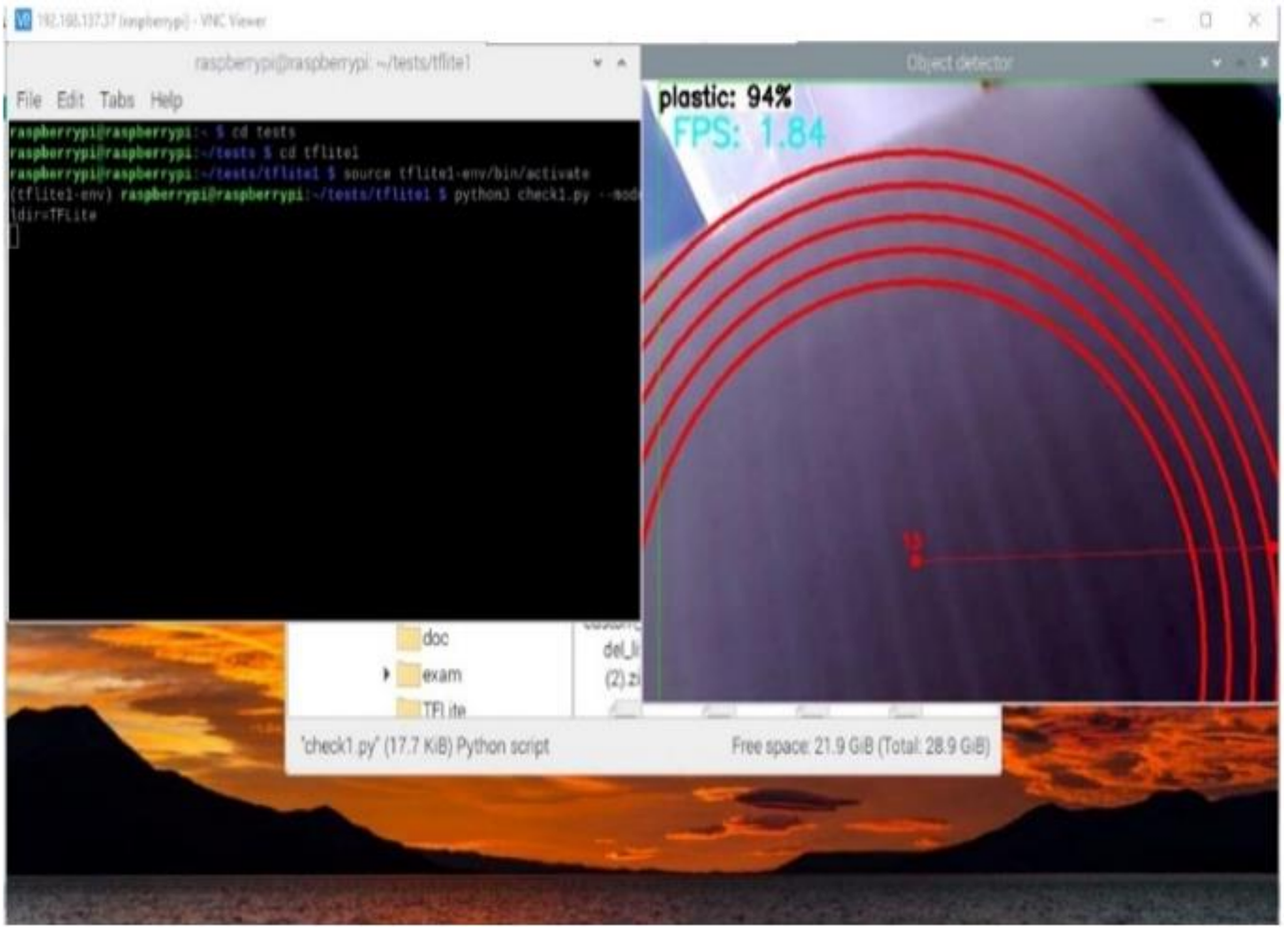


Fig 5 Object Detection Result

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- *Flow Chart*

The steps involved in Image Processing can be depicted in a flow chart as shown in Fig. 6.

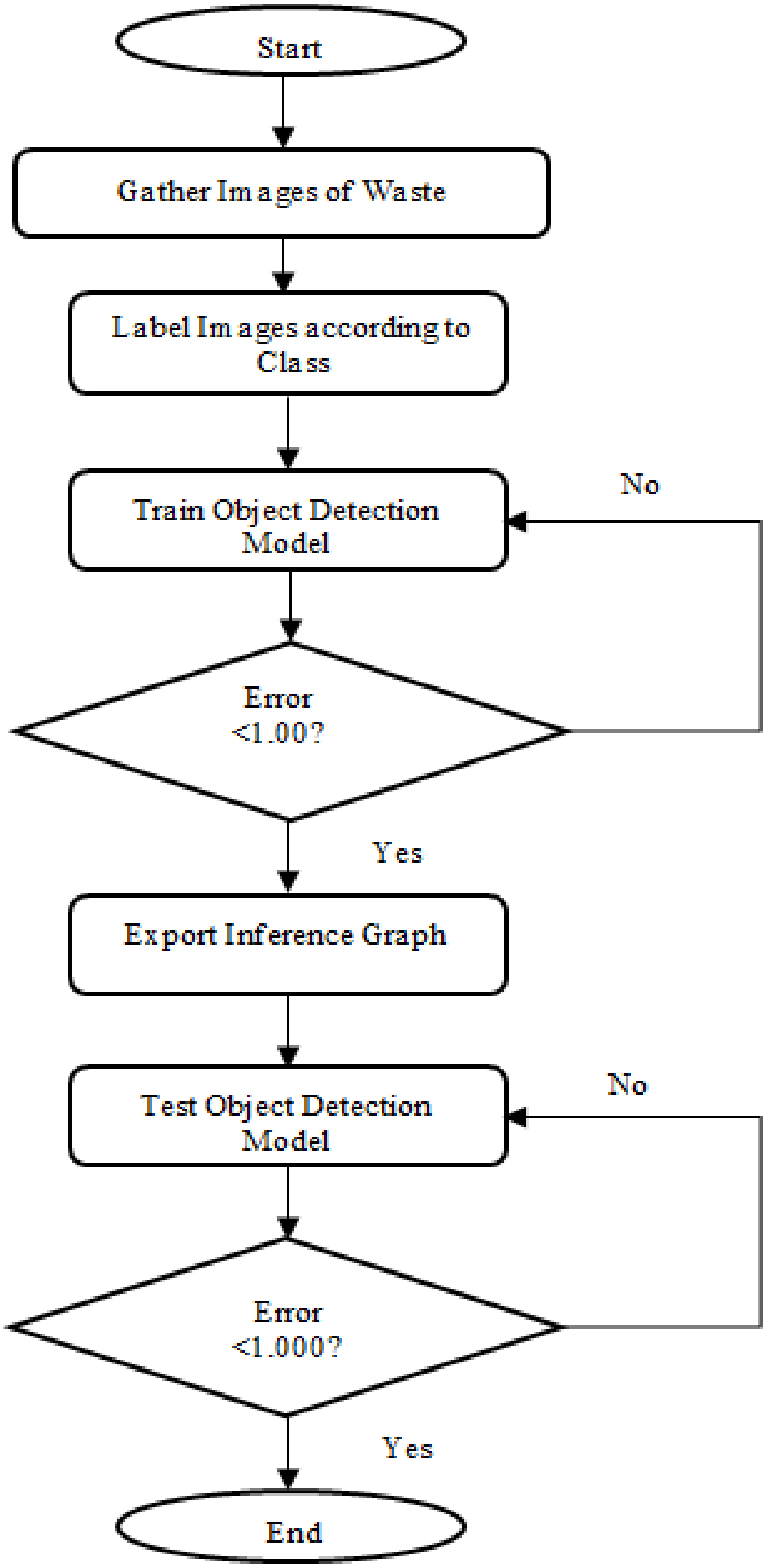


Fig 6 Flow Chart Depicting the Process in Image Processing

## IV. RESULTS

The project model is shown in Fig. 7(a). The camera gives the input video to Raspberry Pi, the object detection model detects the type of waste and displays the result on the Raspberry Pi window The robotic arm then picks up the waste and places it into the corresponding bin as shown in Fig. 7(b), (c), (d) and (e).

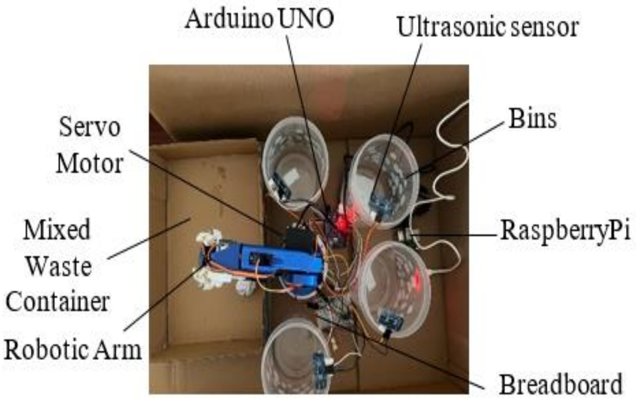

Fig 7 (a) Project Model


Fig 7 (b) Camera Detected the Object


Fig 7 (c) Robotic Arm Picking Up Paper


Fig 7 (d) Robotic Arm Dropping Paper


Fig 7 (e) Robotic Arm Dropped Paper

In this model waste management is done by using Blynk IoT application. The level of the waste in the bins is stored in cloud and updated to Blynk IoT. In the Fig. 8, it is shown that level of the waste inside the bin on hourly, daily and weekly basis where wet and glass bins are almost full.

Fig 8 Wet and Glass Waste Bins is almost Full

## V. CONCLUSION

The proposed system is an innovative solution to the challenges faced in waste management. The use of sensors, image processing, and IoT technology makes the process of garbage segregation at the domestic level more efficient and cost-effective. By separating the waste based on its nature, the system facilitates recycling, reduces the amount of waste sent to landfills, and helps in preventing environmental pollution. The system also provides real-time monitoring of the garbage levels in the bins, enabling timely collection and disposal. Overall, this model can contribute significantly to creating a cleaner and healthier environment, making it a valuable addition to waste management systems in cities and other urban areas.

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## REFERENCES

[1]. C. KAYMAK and A. UCAR, "Implementation of Object Detection and Recognition Algorithms on a Robotic Arm Platform Using Raspberry Pi," 2018 International Conference on Artificial Intelligence and Data Processing (IDAP), 2018, pp. 1-8, doi: 10.1109/IDAP.2018.8620916.

[2]. T. J. Sheng et al., "An Internet of Things Based Smart Waste Management System Using LoRa and Tensorflow Deep Learning Model," in IEEE Access, vol. 8, pp. 148793-148811, 2020, doi: 10.1109/ACCESS.2020.3016255.

[3]. S. N., P. M. Fathimal, R. R. and K. Prakash, "Smart Garbage Segregation & Management System Using Internet of Things(IoT) & Machine Learning(ML)," 2019 1st International Conference on Innovations in Information and Communication Technology (ICIICT), 2019, pp. 1-6, doi: 10.1109/ICIICT1.2019.8741443.

[4]. Jaikumar, K., Brindha, T., Deepalakshmi, T. K., & Gomathi, S. (2020). IOT Assisted MQTT for Segregation and Monitoring of Waste for Smart Cities. 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS). doi:10.1109/icaccs48705.2020.9074399.

[5]. D. K. Tripathi, S. Dubey and S. K. Agrawal, "Survey on IOT Based Smart Waste Bin," 2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT), 2020, pp. 140-144, doi: 10.1109/CSNT48778.2020.9115793.