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Waste Segregation Using Image Detection and IOT

Rizwana S, Abinaya J, Harshada G,
Sampada S and Shreya M
SIES Graduate School of
Technology, Nerul, Navi Mumbai.

Abstract: ***This project presents a garbage classification system that uses Python, YOLOv8, and OpenCV to detect whether garbage is wet, dry, metal, or plastic through a webcam. The model is trained on a dataset of labeled images and uses transfer learning to improve its accuracy. Additionally, the system includes a feature that allows users to take images of garbage and classify them using the model. The system also includes an Arduino Uno microcontroller and a servo motor that opens the appropriate bin based on the classification output. The level of garbage can also be detected, and the data is stored in a firebase. Flask App would give the option as to garbage should be classified via image or webcam. This project could be used in waste management systems and smart cities to improve garbage sorting and reduce environmental impact.***

Keyword: Waste Segregation, Yolo-v8, Firebase, Trained model

I. INTRODUCTION

The world is facing a serious challenge of waste management, with the increasing amount of waste produced every day. Proper sorting and disposal of waste can significantly reduce the negative impact of waste on the environment. To address this issue, we have developed a garbage classification system that can classify waste into wet, dry, metal, or plastic through a webcam. The system uses Python, YOLOv8, and OpenCV for image processing and classification. Additionally, the system includes a feature that allows users to take images of garbage and classify them using the model. The system also includes an Arduino Uno microcontroller and a servo motor that opens the appropriate bin based on the classification output. This project can be useful in waste management systems and smart cities to improve garbage sorting and reduce environmental impact.

Literature Review

There are various systems available that are used for learning web application development. Some of the systems are studied as follows.

1.Segregation System using IoT:

Smart bins are a popular solution for waste segregation using IoT. These bins are equipped with sensors that can detect the type of waste that is being deposited, such as plastic, paper, or organic waste. The data collected by these sensors is then transmitted to a cloud-based platform where it can be analyzed and used to optimize waste collection and disposal. [1]

2. Automatic Segregation System using IoT.:

It is a smart waste management system that uses IoT sensors to monitor the fill level of waste bins in real-time. The system uses machine learning algorithms to predict when a bin will be full and sends alerts to waste collection teams to empty the bin before it overflows. [2]

3.Smart Waste Management System using IoT:

This study proposes a smart waste management system that uses IoT devices to monitor and segregate waste in real-time. The system includes sensors that can detect the type of waste and a machine learning algorithm that can classify the waste into recyclable and non-recyclable categories.[3]

4.IoT-based Waste Management System:

This study proposes an IoT-based waste management system that uses ultrasonic sensors and a microcontroller to monitor the fill level of waste bins in real-time. The system also includes a mobile application that allows users to report any issues with the waste bins. [4]

5. Dry and Wet Waste Segregation and Management System:

It is a smart waste management system that uses IoT sensors to monitor the fill level of waste bins and provide real-time data on waste generation patterns. The system uses this data to optimize waste collection and disposal, reducing costs and improving efficiency.[5]

II. PROPOSED SYSTEM

We have developed a garbage classification system that can classify waste into wet, dry, metal, or plastic through a webcam. The system uses Python, YOLOv8, and OpenCV for image processing and classification. Additionally, the system includes a feature that allows users to take images of garbage and classify them using the model. The system also includes an Arduino Uno microcontroller and a servo motor that opens the appropriate bin based on the classification output.

Dataset:

To train our garbage classification model, we used a dataset of images labeled with the correct class of garbage. The dataset contains images of wet and dry garbage, as well as images of metal and plastic waste. We used approximately 3000 images for training and 750 images for validation.

Model Architecture:

We used the YOLOv8 architecture for garbage classification. YOLOv8 is a deep learning model that uses a convolutional neural network (CNN) to detect objects in an image. It is an improvement over previous versions of YOLO, with a higher accuracy rate and faster processing speed.

We used the custom Dataset to train our YOLOv8 model. We used transfer learning to train our model, starting from a pre-trained YOLOv8 model on the COCO dataset.

Hardware device: - Hardware devices which are used in this project are Arduino UNO,servo motor,ultrasonic sensor,breadboard,jumper wires. After the object is being detected, the respected dustbin opens with the help of a servo motor.

Software used:- VS studio is used to make webpage,Pycharm is use to integrate the hardware components with the website ,Flask is used for the classification of the image and sending the distance of ultrasonic ,Firebase is used to fetch the data and display the level of distance on the CleanCube

III. SYSTEM IMPLEMENTATION

We implemented our garbage classification model using Python and OpenCV. We used the OpenCV library to preprocess the webcam output as well as image output and extract features for the YOLOv8 model. We also used the library to detect the location and class of the garbage in each image/webcam frame.

We then sent the classification output to an Arduino Uno microcontroller. The Arduino Uno controlled a servo motor that opened the appropriate bin based on the classification output. For example, if the garbage was classified as wet, the servo motor opened the wet garbage bin. The level of the bin would be sent to firebase and would be displayed in website.

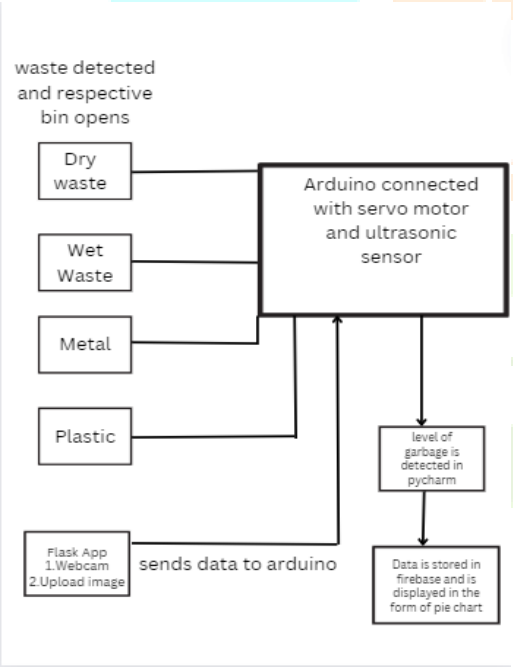

Fig 1: Block diagram

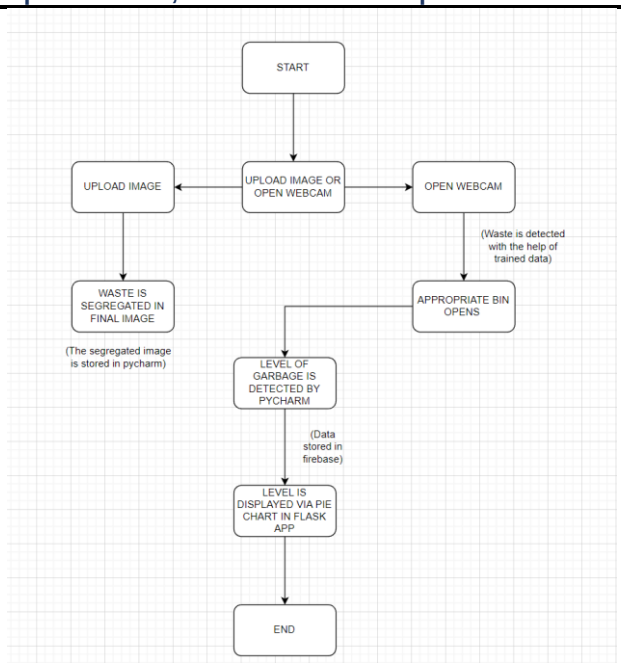

Fig 2: Architecture

IV. ANALYSIS AND RESULTS

Proposed system is implemented with the various technologies, the screen shots exhibit the layouts of its components.

Fig 3: Snapshots of code in Pycharm

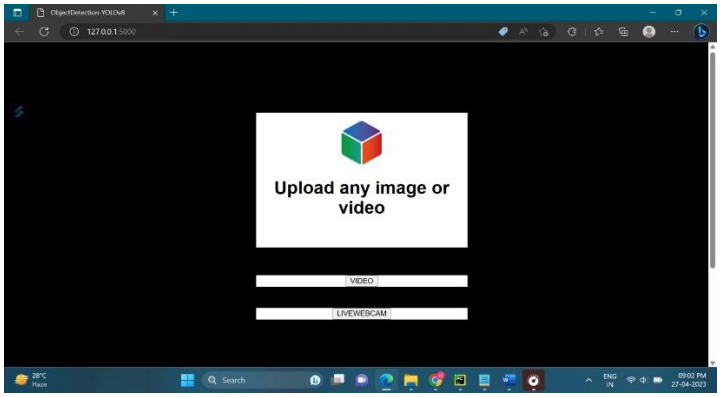

Fig 4: Software

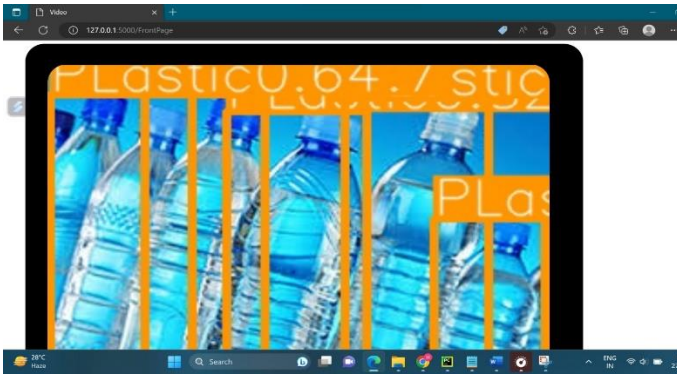

Fig 5: Uploading multiple images.

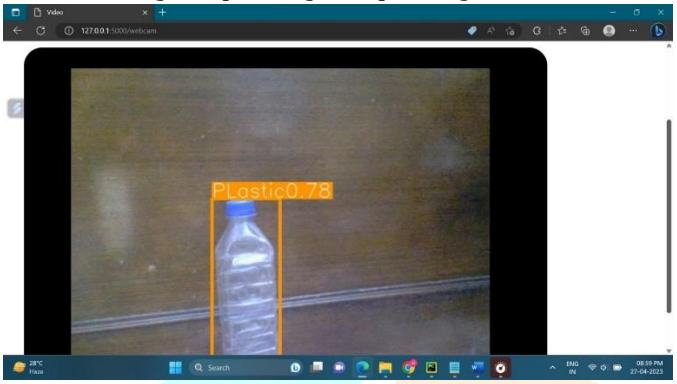

Fig 6: Uploading single image

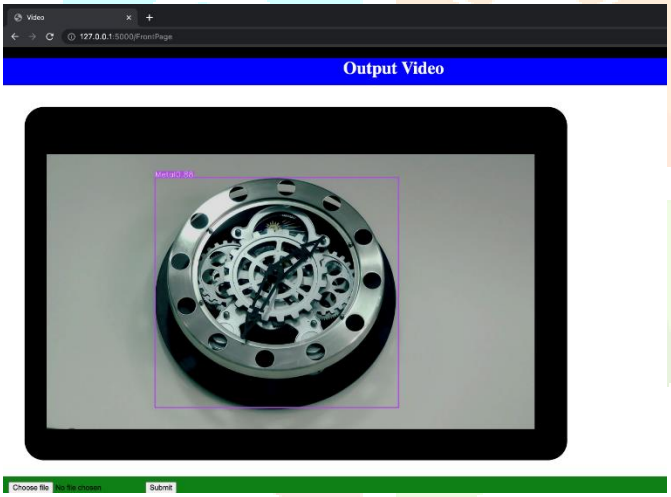

Fig 7: Uploading Video

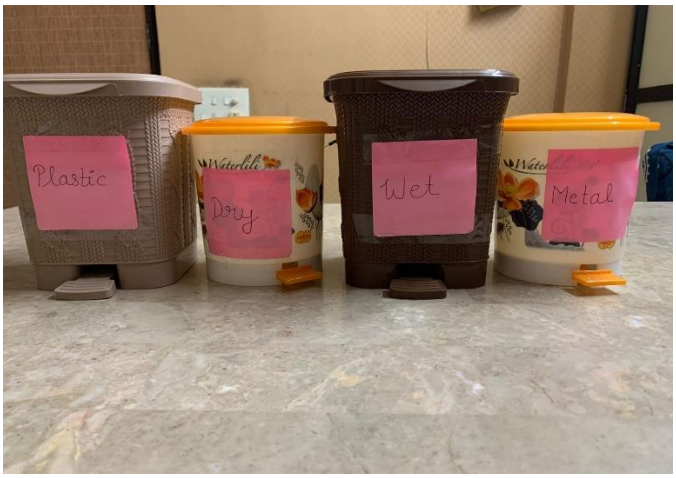

Fig 8: Bins which would open on detection.

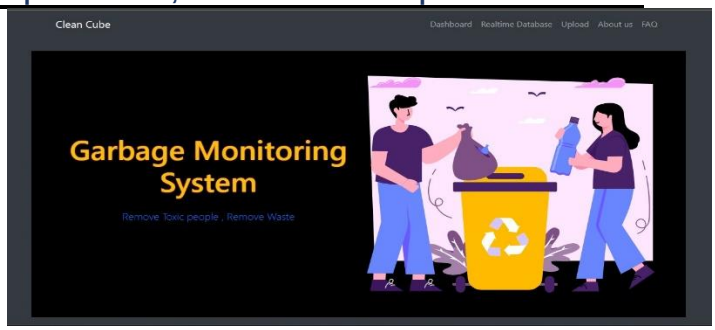

Fig 9: Level of garbage can be detected through software

Fig 10: Dashboard which shows the percentage of wet, dry, metal, plastic in the form of pie chart.

Fig 11: Page which shows the percentage of wet, dry, metal, plastic in the form of bar graph.

V.CONCLUSION AND FUTURE WORK

In this project, we have developed a garbage classification system that uses computer vision and machine learning techniques to classify waste into different categories. The system provides an efficient and user-friendly solution to the problem of waste sorting, which can help reduce the negative impact of waste on the environment. We have successfully trained and tested the model on a dataset of labeled images and integrated it with an Arduino Uno microcontroller and a servo motor to open the appropriate bin based on the classification output. The system can also classify waste in images provided by users.

Our project has several strengths, including its accuracy, efficiency, and ease of use. However, there are also some limitations, such as the need for a large dataset and the potential for errors in the classification process. Nonetheless, we believe that our project can contribute significantly to the field of waste management and the environment.

There is scope for further development and improvement of the garbage classification system. Future work could include the following:

Enhancing the accuracy of the model by incorporating more data and exploring other machine learning techniques.

Expanding the classification categories to include other types of waste, such as hazardous waste or electronic waste.

Integrating the system with other smart city solutions, such as waste collection and transportation systems.

Exploring the potential for mobile applications that allow users to classify waste and track their waste disposal activities.

Conducting a comprehensive analysis of the system's environmental impact and evaluating its effectiveness in improving waste management practices.

Overall, we believe that our project can contribute to a cleaner and healthier environment, and we hope that it can inspire further research and development in the field of waste management.

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