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WASTE SEGREGATION AND MANAGEMENT USING DEEP LEARNING AND IOT

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Abstract:

In solid waste management, segregation at the source is essential, particularly when financial resources are scarce. We divide solid waste into three categories Wet, Dry and hazardous waste. According to solid waste management rule, 2016 it is responsibility of generators to segregate waste into these three categories. Lack of awareness, loosely implementation of laws and various other reasons are obstacles in achieving appropriate results. After segregation we can choose Reduce, Reuse and Recycle for appropriate solid wastes. Solid waste management should be sustainable ecologically as well as economically. In a developing country like India it's very important to have a cast effective solid management plan. We have to deal with poverty, population growth and high urbanization rate combines with ineffective and under-funded solid waste management technique. *Keywords* — **Deep learning, IOT, YOLOV5, Waste segregation**

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I. INTRODUCTION

This paper presents an innovative approach utilizing YOLOv5, a state-of-the-art object detection model, for waste segregation specifically targeting biodegradable and non- biodegradable waste. Waste management is a critical global issue, and efficient segregation is pivotal for sustainable and eco-friendly waste disposal practices. The proposed system leverages the YOLOv5 model to accurately detect and classify various types of waste items in real time. By focusing on biodegradable, non- biodegradable and metallic waste, the system identifies and sorts these categories with high precision. The implementation of YOLOv5 for waste segregation demonstrates promising results in automating the sorting process, enhancing waste management practices, and contributing to a cleaner and more sustainable environment.

II. LITERATURE SURVEY

A. Smart approaches to waste management for post covid- 19 smart cities in Japan-2020:

A stereo camera recognizes the images and the robotic arm sorts them , the operators are controlling the robotic arm with the help of the tablet. In the field of waste management the robotic arm have not performed adequately due to wide variety of input shapes and types.

B. Waste management technique to detect and separate non- biodegradable using machine learning and yolo algorithm- 2021:

This research paper proposes the application of image processing that works on the principle of machine learning and yolo. The proposed application is a method of detecting non-biodegradable waste from the bin so that non-biodegradable waste can be separated from the bins.

C. A survey on waste detection and classification using deep learning -2022:

Here the segregation in done based on biodegradable and non- biodegradable waste using deep learning technique.

III. PROPOSED SYSTEM

The proposed system has made use of YOLOV5 algorithm which can accurately detect the waste items for the segregation process during its real time implementation. The YOLOV5 is a part of CNN (convolutional neural network) model. YOLOv4 introduced new methods of data augmentation Mosaic and Self-Adversarial. Training (SAT). Mosaic mixes four training images. Self-Adversarial Training operates in two forward and backward stages. In the 1st stage, the network alters the only image instead of the weights. In the second stage, the network is trained to detect an object on the modified image. Apart from the above-mentioned modules, some existing methods (Spatial Attention Module[SAM]), PAN, CBN) have been modified to improve the performance.Yolov5 almost resembles Yolov4 with some of the following differences:

- YOLOV4 is released in the Darknet Framework and written in C, YOLOV5 is based on the PyTorch Framework.
- YOLOV4 uses .cfg for configuration, where as YOLOV5 uses .yaml for its configuration.

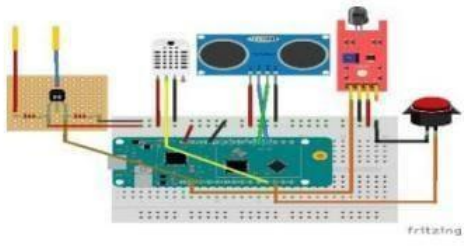

Fig1.Waste segregation using arduino

A. Proposed model

In addressing the challenge of accurately predicting the most suitable crop for a given set of conditions, our proposed system aims to deliver a robust solution, ensuring farmers maximize their profit.

The system utilizes a blend of classification models. For segregating the waste items and estimate the percentage of accuracy. The above fig represents the proposed model where Arduino is hardware implementation, LCD display is used to display the title of the project, waste categories and percentage of waste items filled in each compartment. Pick and place assembly is used to pick the waste items and put it into the respective compartment. Two H-Bridge and dc motors is used for the rotation of pick and place assembly in clock wise and anti-clock wise direction. Interfacing Arduino with deep learning can be achieved using a combination of techniques. However, due to the limited processing power and memory of Arduino boards, direct execution of deep learning models on Arduino itself is not practical. Instead, you can use Arduino in conjunction with more powerful devices like a Raspberry Pi or a laptop/desktop computer to create an interface between sensors and actuators controlled by Arduino and the deep learning model running on the more capable device. Here's a general approach:

1. **Collect and preprocess data with Arduino:**

- Use Arduino to collect data from sensors such accelerometers,gyroscopes,temperature sensors, etc.
- Preprocess the data is needed, for example scaling or normalization.

2. **Transfer data to a more powerful device:**

- Transfer the preprocessed data from ,Arduino to a more capable device, such laptop, desktop or computer.
- This can be done using serial or wireless communication.

3. **Train or load the deep learning model:**

- Train your deep learning model using PyTorch, Tensor Flow or keras.
- If the model is already trained, then load it into the device.

4. **Inference:**

- Perform inference on the data received from the Arduino using the deep learning model.
- Process the inference results as needed.

5. Send commands back to Arduino:

- Based on the results of the deep learning model send the commands back to Arduino.
- These commands may control the actuators, LED, motors or any output device connected to the Arduino.

6. Implement the interface:

- Write the required code on both Arduino and more powerful devices to establish communication and exchange data.
- Utilize the libraries or communication protocols like Serial, MQTT, WebSocket etc depending on the project requiremnets.

IV. IMPLEMENTATION

Within IOT system development, we outline the tools employed and algorithms integrated.

A. Tools Utilized

"IDLE" stands for "Integrated Development and Learning Environment." It's a software suite for Python programming language, often used by beginners as it provides an easy-to-use interface for writing, editing, and running Python code. Here's a breakdown of its features:

- Code Editor: IDLE provides a simple code editor where you can write Python code. It supports features like syntax highlighting, indentation, and code completion, making it easier to write code.
- Interactive Shell: One of the prominent features of IDLE is its interactive Python shell. You can execute Python code line by line and see the output immediately. This is very helpful for practicing with Python syntax and testing brief code segments.
- Debugger: IDLE comes with a basic debugger that allows you to step through your code, set breakpoints, and inspect variables. While not as feature-rich as some standalone Python debuggers, it's useful for debugging simple scripts.
- File Browser: IDLE includes a file browser that allows you to navigate through your file system and open Python files for editing. This makes it easy to work on multiple Python files within the same environment.

V. CONCLUSION

Implementing IoT presents a promising solution for addressing environmental challenges and improving waste management practices. By combining the power of deep learning algorithms with IoT devices, such as sensors and actuators, waste segregation can be automated, efficient, and environmentally sustainable. Here's a conclusion highlighting the key points:

1. Deep learning algorithms can analyze images or sensor data to accurately classify different types of waste, such as recyclables, organic waste, and non- recyclables. This automation reduces the reliance on manual sorting processes, improving efficiency and reducing human error.
2. IoT devices equipped with sensors enable real-time monitoring of waste bins and collection points. This allows for timely intervention, such as scheduling pickups when bins are full or detecting contamination in recycling streams.
3. By collecting and analyzing data on waste composition and generation patterns, municipalities and waste management companies can optimize resource allocation. This includes optimizing collection routes, reducing fuel consumption, and minimizing greenhouse gas emissions associated with waste transportation.
4. Implementing waste segregation using deep learning and IoT contributes to reducing landfill waste and promoting recycling and composting. This, in turn, helps conserve natural resources, reduce pollution, and mitigate the environmental impact of improper waste disposal.
5. The modular nature of IoT systems and deep learning models allows for scalability and adaptability to different environments and waste management scenarios. Solutions can be tailored to specific communities, urban areas, or industrial facilities, accommodating varying waste compositions and infrastructure setups.

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