SMART DUSTBIN

Combined Report submitted

for

PRODUCT DEVELOPMENT-II[DIP004U3M]

and

PRODUCT DEVELOPMENT-II[DIP005U3M]

to

Indian Institute of Technology, Jammu

by

Group No. - 31

1. ***Manik Singh Sarmaal*** *[2021umt0181]*
2. ***Nishit Bhargava*** *[2021uch0022]*
3. ***Darsh*** *[2021ucs0093]*
4. ***Mohmad Ali*** *[2021ucs0103]*
5. ***Agam Thappa*** *[2021ume0200]*

under the supervision of

Dr. Sudhakar Modem

Department of Electrical Engineering

भारतीय प्रौद्योगिकी संस्थान जम्मू
INDIAN INSTITUTE OF TECHNOLOGY JAMMU
विद्याधनं सर्वधन प्रधानम्

INDIAN INSTITUTE OF TECHNOLOGY JAMMU

April 2024

1. Introduction

Briefly introduce your project, in terms of (i) problem identification, (ii) objective, (iii) proposed solution, and (iv) expected outcome. Write briefly in one/two pages, using upto max 1000 words

PROBLEM IDENTIFICATION:

Improper waste management and disposal have become critical environmental issues in recent years. The indiscriminate mixing of different types of waste, such as organic, inorganic, and metal, not only contributes to environmental pollution but also hinders effective recycling and waste treatment processes. Consequently, there is an urgent need for efficient waste segregation at the source to facilitate proper waste management and promote sustainability.

OBJECTIVE: Develop a smart waste segregation system.The primary objective of this project is to develop an intelligent waste segregation system that can automatically classify and sort different types of waste materials into three categories: organic, inorganic, and metal. By leveraging cutting-edge machine learning and computer vision technologies, the system aims to streamline the waste segregation process, reducing the burden on manual labor and improving the overall efficiency of waste management practices.

PROPOSED SOLUTION: SMART DUSTBIN, an intelligent waste segregator using ultrasonic sensing, image capture, and machine learning for automated sorting of recyclable and non-recyclable waste, optimizing waste management processes.

EXPECTED OUTCOME:

Proposed Solution

The proposed solution involves the integration of several key components:

1. **Image Acquisition**: A Raspberry Pi camera module will be used to capture images of waste items as they are introduced into the system.
2. **Object Detection and Classification**: A state-of-the-art object detection and classification model, such as YOLO (You Only Look Once), will be trained on a diverse dataset of waste images. This model will be capable of accurately identifying and classifying waste items into the three predefined categories: organic, inorganic, and metal.
3. **Raspberry Pi Integration**: The trained YOLO model will be deployed on a Raspberry Pi, a

low-cost and energy-efficient single-board computer. The Raspberry Pi 3B+ will process the captured images, perform inference using the trained model, and determine the appropriate waste category for each item(0-Inorganic,1-Organic,2-Metal).

4. **Mechanical Sorting Mechanism**: Based on the predicted waste category, a mechanical sorting mechanism will be activated to direct the waste item into the corresponding bin section(2 stepper motors are used to control flaps to throw waste in 3 sections of the bin). This mechanism will consist of stepper motors and flaps controlled by the Raspberry Pi, ensuring that each waste item is sorted into the correct bin compartment.
5. **Web Interface**: A user-friendly web interface will be developed to display the real-time classification results and provide insights into the waste segregation process. This interface will serve as a monitoring and control panel, allowing users to interact with the system and potentially integrate it with broader waste management systems. Server

Expected Outcome

The successful implementation of this intelligent waste segregation system is expected to yield the following outcomes:

1. Improved Waste Management Efficiency
2. Increased Recycling Rates
3. Environmental Benefits
4. Cost Savings
5. Public Awareness and Engagement

Successful implementation of hardware with software will yield an effective Smart Waste Segregation system.

2. Experiments/Simulations/Fabrication/Testing Works

(i) Include, basic concept of the Product developed

(ii) Mention equipment, device, machine, (if any) available in the institute, which you have used for this project.

(iii) Mention in detail the list of chemicals, consumable materials, (if any), components, used in this project.

(iv) Add pictures, experiment data, trials, fabrications, and describe them briefly.

(v) Additionally, summarize the results, outcome of the project (Add link to video of the working demonstration of the product)

(vi) List the learning outcome of the project

(i) **Basic Concept of the Product Developed**

The intelligent waste segregation system is designed to automate the process of sorting waste into three categories: Inorganic, Organic, and Metal. The system utilizes computer vision and machine learning techniques to analyze the captured images of waste items and classify them accordingly. The classified waste is then directed into the appropriate bin section using a mechanical sorting mechanism(stepper-motors) controlled by a Raspberry Pi.

(ii) **Equipment, Devices, and Machines Used**

- Raspberry Pi 3 Model B+
- Raspberry Pi Camera Module
- Ultrasonic Sensor
- 2 Nemo-17 Stepper Motors (on each dustbin) and A4988 Motor Drivers (1each motor)
- Mechanical Sorting Mechanism (Flaps and Bins) - used acrylic sheets for laser cutting
- 12V DC input power for motors

(iii) Chemicals, Consumable Materials, and Components Used

- Printed Circuit Boards (PCBs) for motor drivers and control circuits
- Jumper wires and Alligator connectors
- Power supply units - 12 V battery
- 5V input for raspberry as power source
- 7805 Voltage Regulator
- Enclosure materials (acrylic sheets - 12x16inch & 14x14inch)

3. Project Work-log

Duration	Work done (in short bullet points)
Semester-01	- Chose an interesting regular problem

07 Aug -18 Sep 2023	Project –Mentor-Group choice Finalization
19 Sep - 28 Nov 2023	- Made some basic machine learning models -Extensive testing/evaluation of trash images - Learnt how to integrate this with hardware - Learnt how ML works in domain of waste segregation without human intervention
29 Nov 2023	End Semester Evaluation
Semester-02	
03 Jan - 28 Feb 2024	- Had problems regarding choice of hardware, initially we were using ESP32 cam for detection and requesting a host server for trash image class. - website was created so esp32 will request image results and rotate motors respectively - But then we ran into complicated hardware problems so dropped idea of using ESP32cam
01 Mar - 08 Mar 2024	Mid Semester Presentation
09 Mar - 26 Apr 2024	- Started hardware implementation using Raspberry Pi 3b+ - delayed orders of motors and no 3D printing availability to make the whole model lead to late submissions - Therefor, Acrylic sheets laser cutted into dustbin flaps that will rotate as an alternative for #D printer we used our own bucket - Integrated YOLOv8 model and included it with stepper motors code

	for any image - **(IMAGE FORMATS SUPPORTED - ".jpg", ".jpeg", ".png")**
27 Apr 2024	Final Demonstration

Useful Links -

- **Github - Sbin-Yolov8**
  - **Website**
  - **Whole Data**

- **Model - model_weights** (please feel free to use our model weights and finetune to bigger garbage datasets)

- **Video Demonstration - Video-Demonstartion**

4. **Bibliography, (if any)**

You can include, all reference articles, websites, book-chapters, you referred for this reports

[1] Author's initials. Author's Surname, "Title of chapter in book," in Book Title, edition (if not first), Editor's initials. Editor's Surname, Ed. Place of publication: Publisher, Year, page numbers. (for Book-chapter)

[2] Author's initials. Author's Surname, "Title of article," Title of journal abbreviated in Italics, vol. number, issue number, page numbers, Abbreviated Month Year. (for Journal Article)

[3] Author's initials. Author's Surname, "Title of paper," in Name of Conference, Location, Year, pp. xxx. (for Conference Papers)

[4] Author's initials. Author's Surname, "Title of report," Abbreviated Name of Company., City of Company., State, Report number, year. (for Reports)

[5] Title of Standard, Standard number, date. (for standards)

[6] Author's initials. Author's Surname, "Title of thesis," Designation type, Abbrev. Dept., Abbrev. Univ., City of Univ., State, Year. (for Thesis/Dissertations)

[7] Author's initials. Author's Surname. (Year, Month. Day). Title of web page [Online]. Available: URL

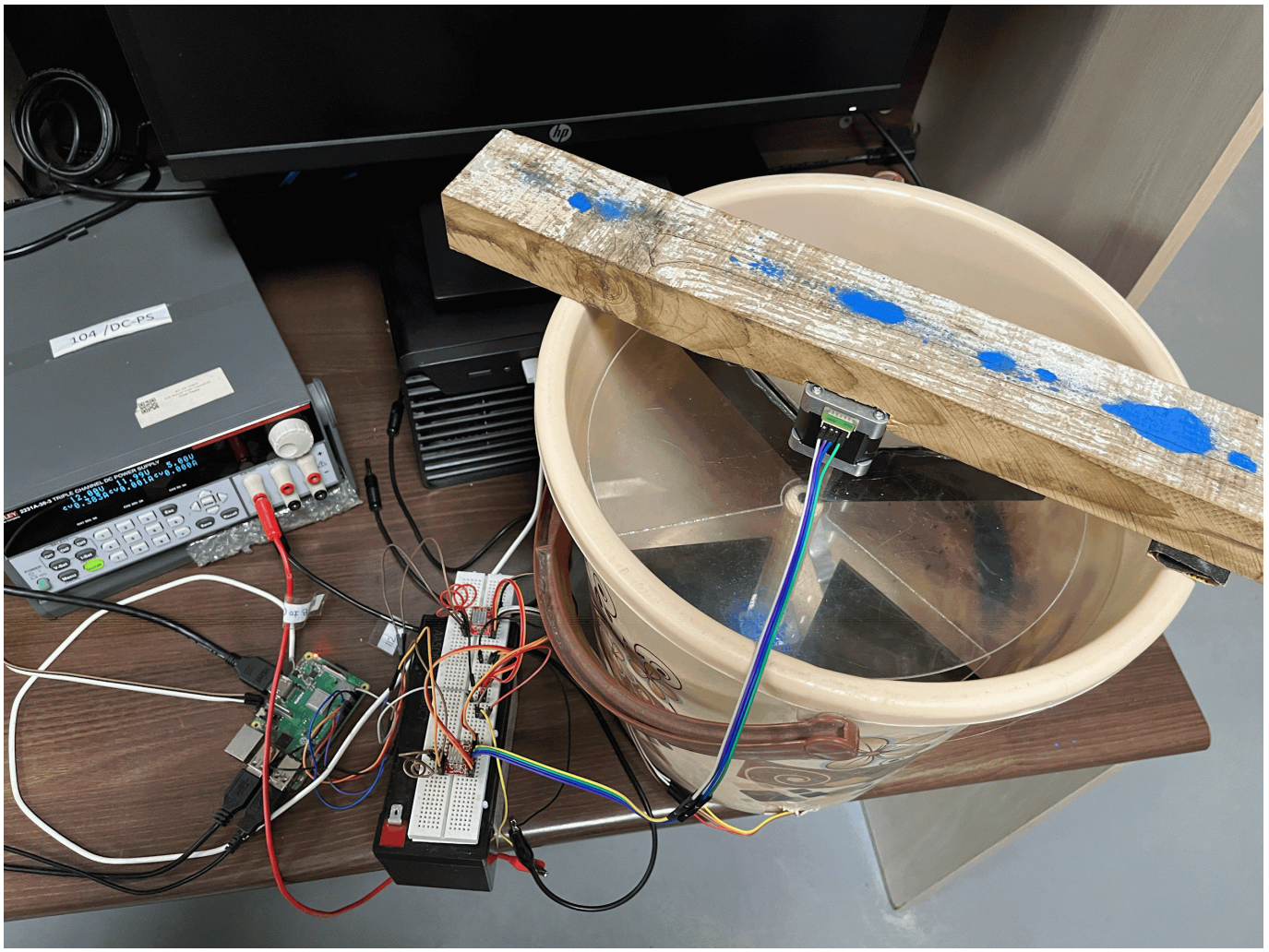
- Special Thanks to Author of YOLOv8- Glenn Jocher at Ultralytics

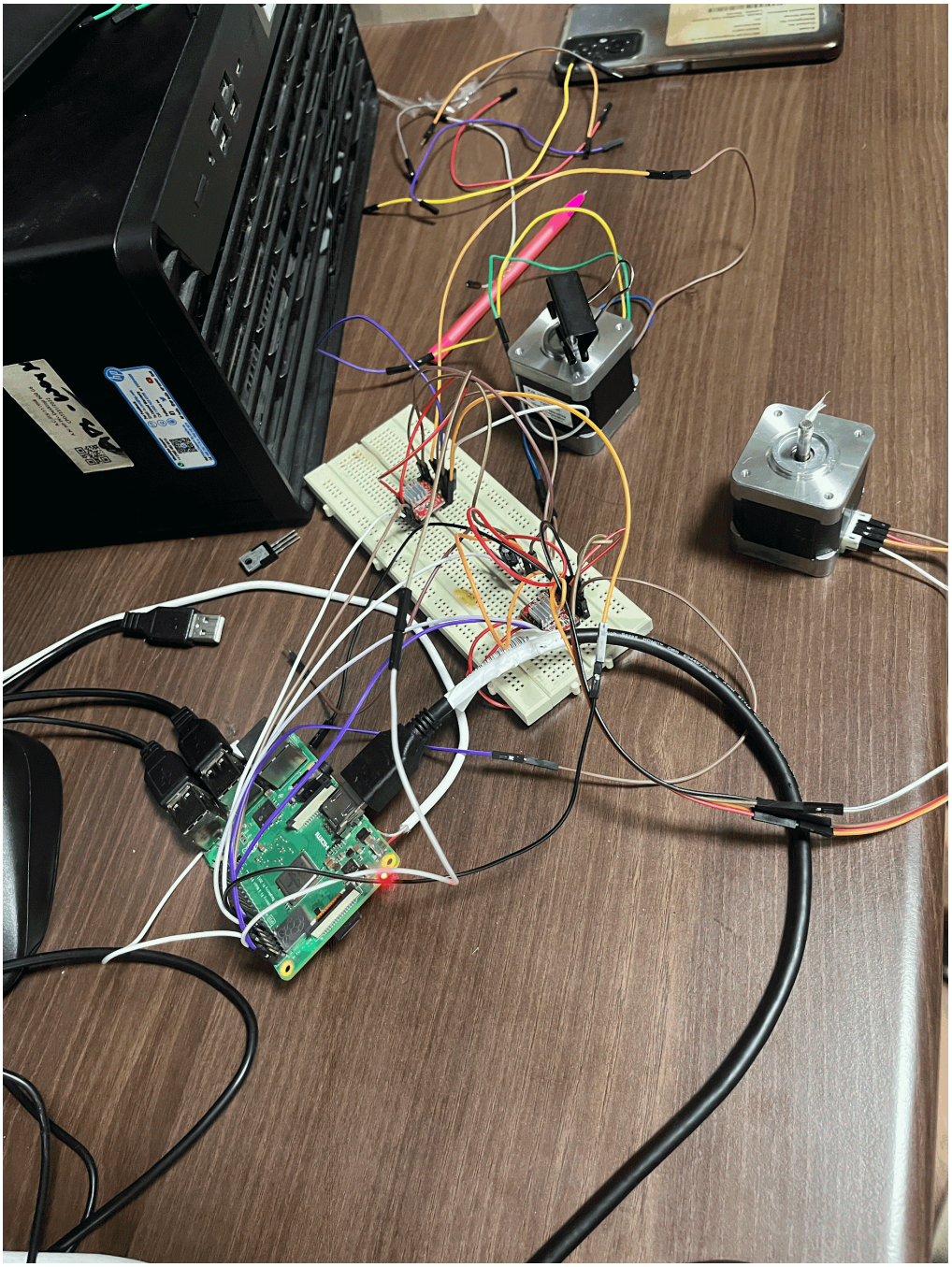
[1] All licenses are personal and subjected to copyright but it is open-source so please mention and tag us while using our code and implementation.

[2] Circuit Diagram for 2 motors with A4988 motor drivers and Raspberrypi 3B+ is self-made and not available on the internet, so kindly mention us for our efforts.

ATTACHED BELOW

SMART DUSTBIN PROTOTYPE





CIRCUIT DIAGRAM WITH 2 MOTORS