Eco-Bot

(AI Powered Waste Collection, Segregation, and Environmental Education)

Introduction

1. Project Overview

Eco-Bot is an innovative robotic system designed to enhance environmental sustainability by automating the recycling process and educating the public about waste management. Combining advanced technologies such as artificial intelligence (AI), machine learning (ML), and interactive robotics, Eco-Bot aims to make recycling both engaging and efficient.

2. Objectives

Interactive Learning: Fun features to teach kids about recycling and protecting the environment.

Automated Waste Management: Smart bins that sort and dispose of waste automatically.

Reward System: Earn rewards for recycling correctly.

Educational Impact: Learn about different materials and how they affect the environment.

3. Technologies

Components used:

1. MRT-3 Brain
2. MRT-5 Brain
3. Arduino Nano
4. Bluetooth Module
5. Goma Motors
6. JohnSon Geared DC Motors
7. MRT Touch sensor
8. MRT IR sensors
9. 6 Cell batteries(9-12V)

Kits used:

1. Blocks kit
2. Goma kit

Software Used:

1. MRT
2. Teachable Machine
3. PictoBlox
4. Arduino IDE

4. AI concepts Covered

AI and Machine Learning: Eco-Bot learns to recognize different types of waste like plastics and metals.

Text to Speech: Eco-Bot talks to you, answering questions and explaining recycling.

Speech Recognizer: Eco-Bot listens to your commands and questions.

Object Detection: Eco-Bot uses a camera to identify and sort waste correctly.

QR Code Scanner: Eco-Bot scans QR codes to help sort waste accurately.

Sensors: Sensors help Eco-Bot know when bins are full and interact with users.

DC Motors & Motor Drivers: These allow Eco-Bot to move and sort waste.

Touch Sensors: Touch sensors let Eco-Bot respond to your touches.

MRT Boards & Jumper Wires: These connect and control Eco-Bot's electronic parts.

5. Eco-Bot Structure and Key Features

Ecobot Body: Strong body with waste container and sorting parts, includes sensors and cameras for waste identification.

Sorting Mechanism: Multiple bins for plastics, metals, and recyclables, ensures correct sorting.

Navigation System: Autonomous movement using motors, motor drivers, and sensors, navigates to waste bins and follows path

Bluetooth App Control: Control Eco-Bot remotely using a smartphone app.

IP Camera: Equipped with an IP camera for live video monitoring.

Line Follower: Uses line-following technology for precise navigation along predefined paths.

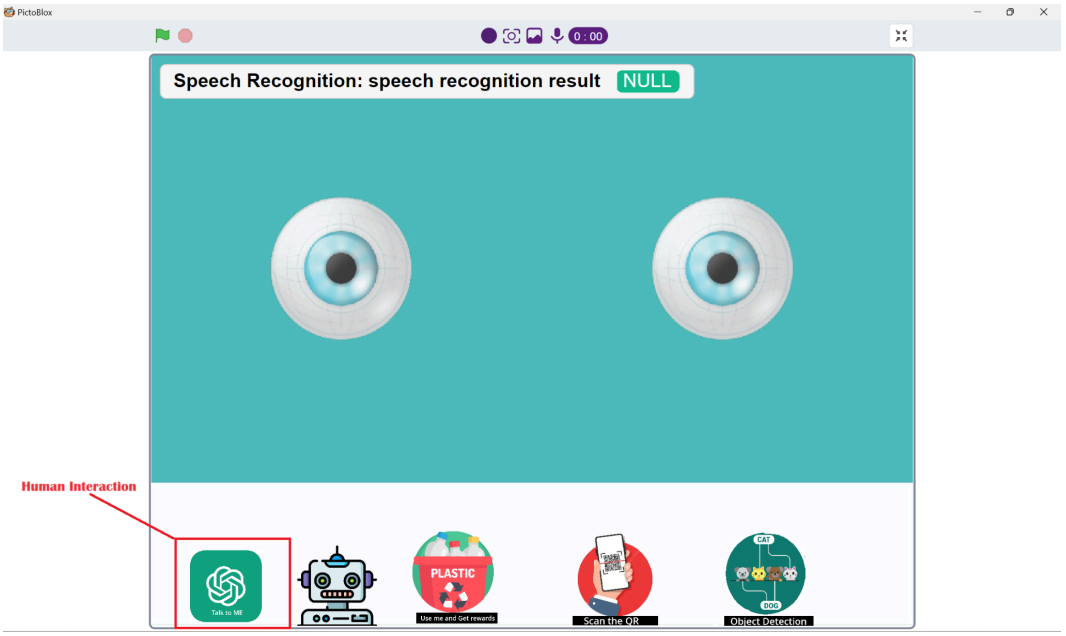
Eco Rewards App: Tracks points earned through recycling and manages reward redemption.

Communication Module: Facilitates user interaction and educational content delivery.

6. Functional Description

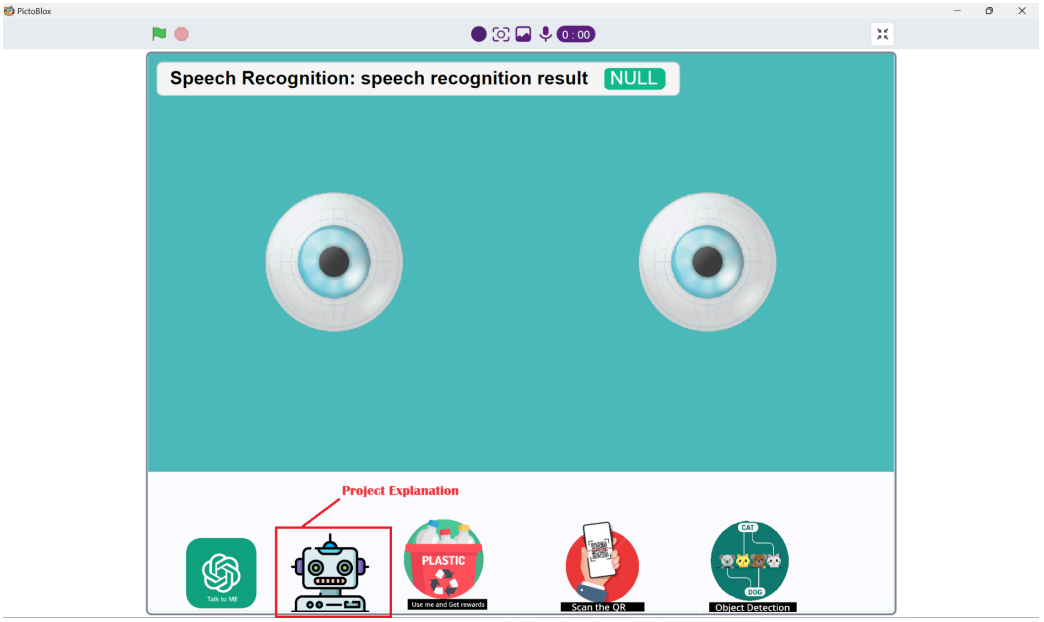
Human Interaction

Eco-Bot engages users through voice interaction. Users can ask questions about recycling, environmental conservation, and the robot's functions. The robot provides informative responses and educational content using text-to-speech technology.



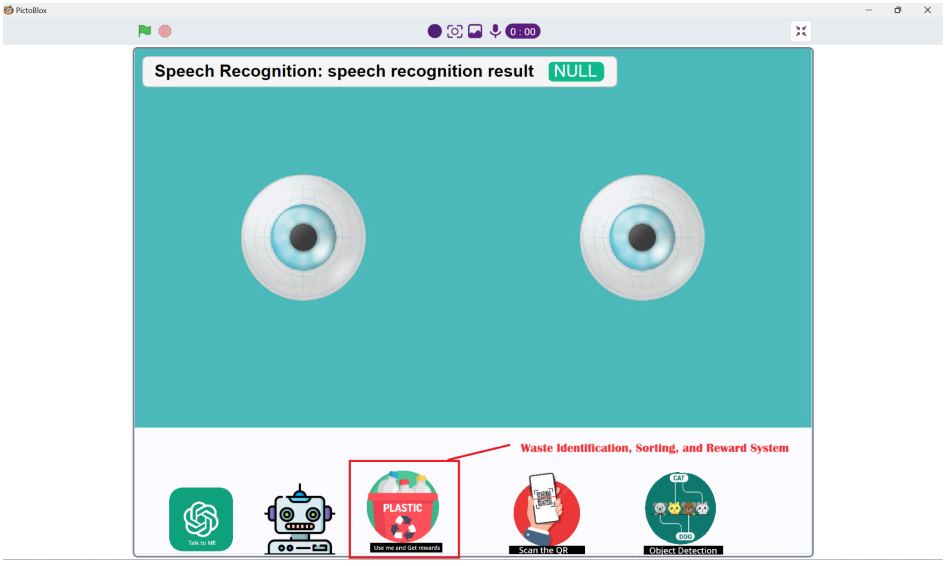
Project Explanation

Eco-Bot explains its purpose and mission to users, emphasizing its role in recycling and environmental protection. It helps users understand how proper waste management contributes to a cleaner planet.



Waste Identification, Sorting, and Reward System

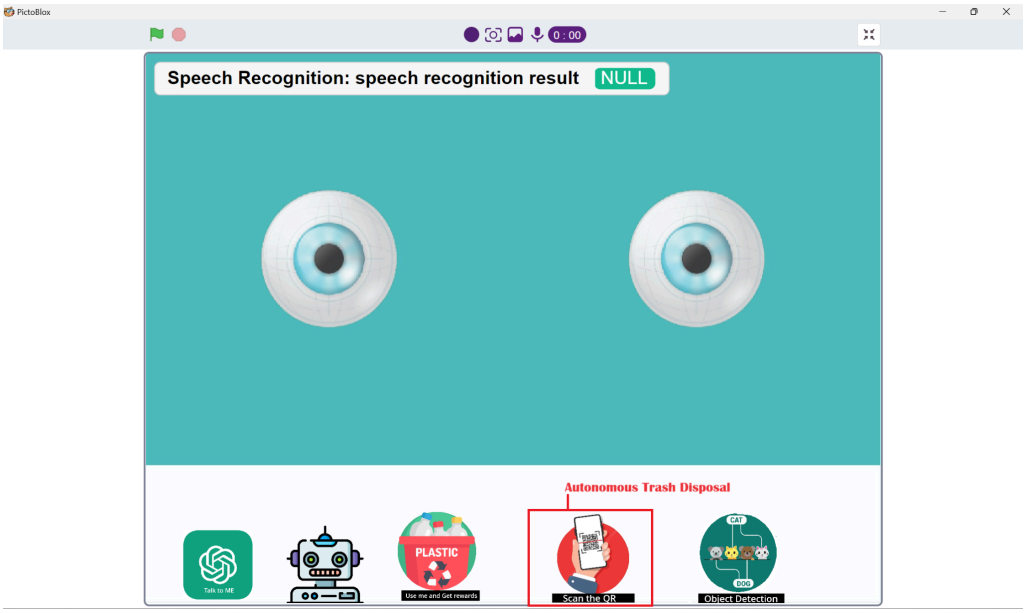
The AI model trained with Teachable Machines enables Eco-Bot to identify and classify different types of waste. After sorting the waste into designated bins, Eco-Bot rewards users with points through the Eco Rewards app. Users can accumulate points and redeem them for various rewards, such as toys or treats.



Autonomous Trash Disposal

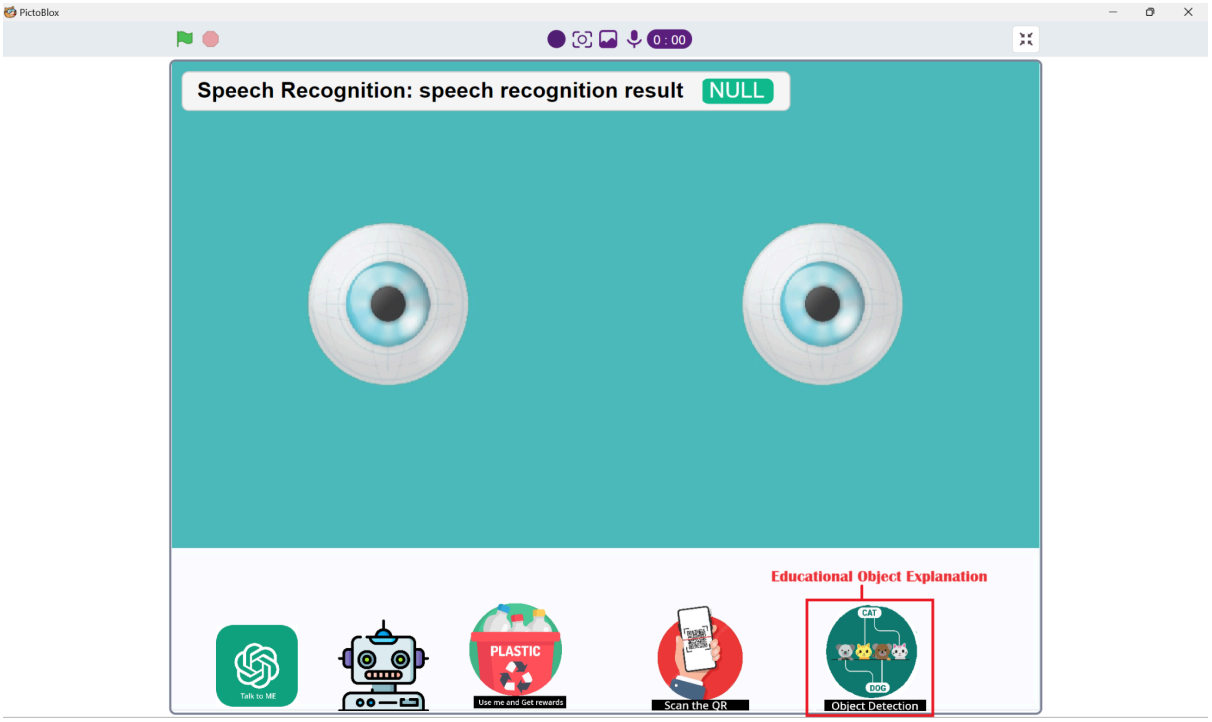
When the internal bins are full, Eco-Bot navigates to external waste bins using line-following technology. It scans QR codes on these bins to ensure that waste is

disposed of correctly. This feature minimizes manual intervention and maintains efficient waste management.



Educational Object Explanation

Once waste is disposed of, Eco-Bot moves to an educational area where it displays and explains different materials. It provides information about the environmental impact of these materials, including their decomposition rates and recycling benefits.



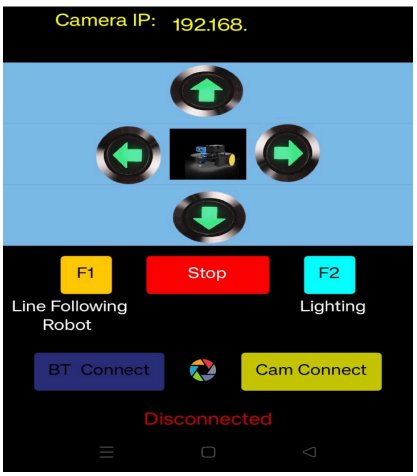
7. Movement Control with Leap Car Controller

The Leap Car Controller app allows users to manually control Eco-Bot's movements. This app includes features for steering, speed adjustment, and direction changes, providing precise control over the robot's navigation and operations.

Leap Car Controller App

1. Overview

The Leap Car Controller app provides users with the ability to manually control Eco-Bot, offering a versatile interface to manage the robot's movements and operations. One of its key features is the line-following mode, which enhances the robot's autonomous navigation capabilities.



2. Key Features

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Manual Control:

- **Movement Control:** Direct Eco-Bot's movements (forward, backward, turning) for specific navigation.

- **Operational Controls:** Activate or deactivate functions like sorting mechanisms via the app.

Line-Following Mode:

- **Autonomous Navigation:** Eco-Bot follows a predefined path or line automatically.
- **Sensor Integration:** Line-following sensors ensure accurate navigation.
- **Customizable Path:** Set up different paths for specific recycling or waste management tasks.

8. Leap Eco-Rewards App

Overview:

Create an app with MIT App Inventor that rewards users with coins for proper waste disposal. The app includes:

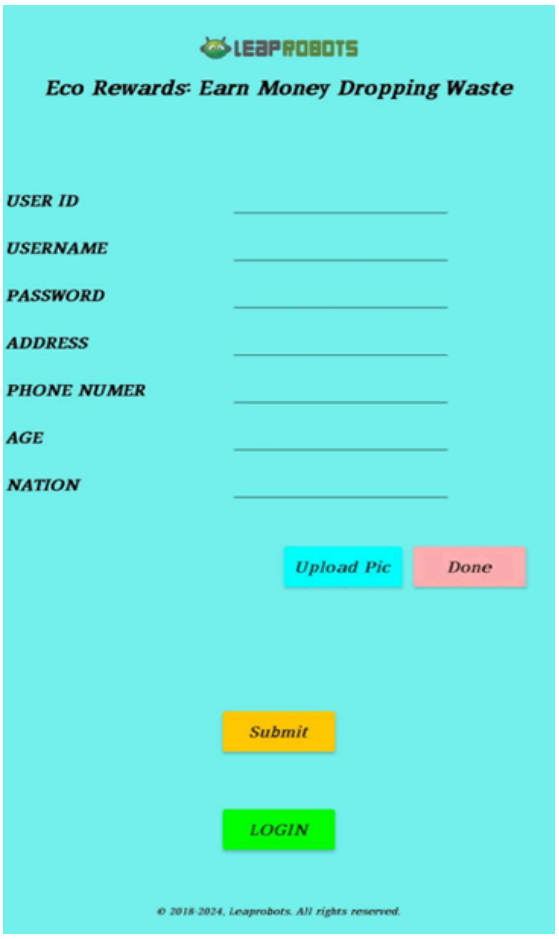
- **Registration Form:** Collects user data.
- **Firebase Cloud Database:** Stores user information.
- **KIO4_Base641 Extension:** Handles image uploads.
- **Login Page:** Authenticates users.
- **Reward System:** Calculates and stores reward coins in the database.

TAP TO DOWNLOAD LEAP ECO REWARDS APP

Key Features:

Registration Form:

- The app begins with a user registration form.



Database Setup:

- **Firebase Cloud Database** is used to store user data.
- Instructions for setting up Firebase include creating a project, enabling read/write permissions, and obtaining the database URL.

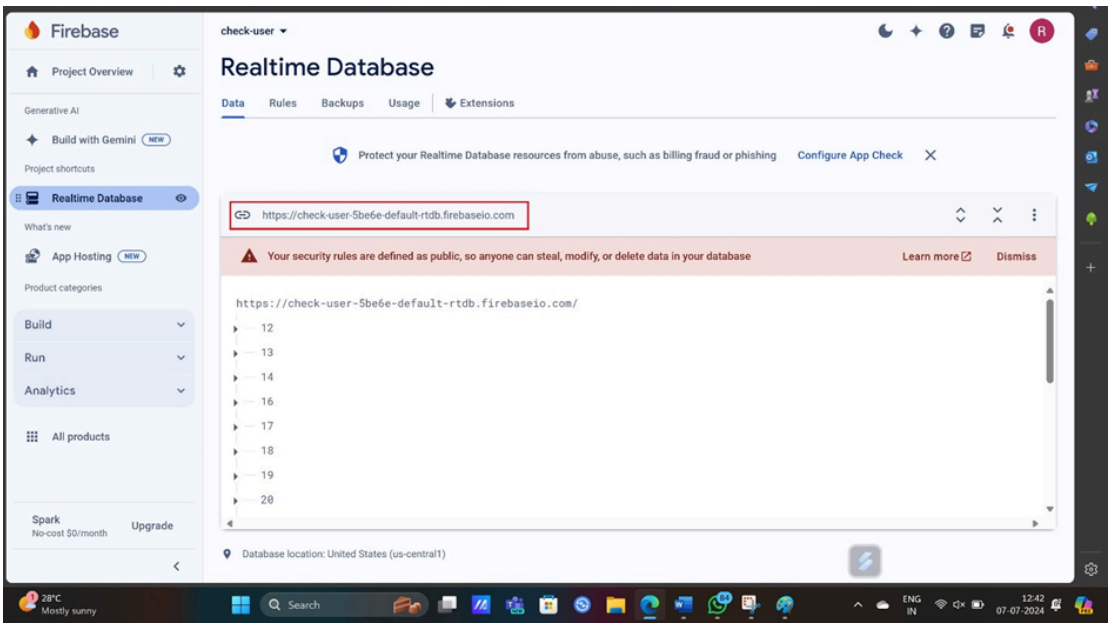


Image Upload:

- KIO4_Base641 Extension is used for image uploads.
- Steps include downloading the extension, converting images to binary format, and uploading them.

We can download it from Google; just follow these steps:

1. Go to Google and search for base64 extensions for MIT App Inventor.
2. Open the first URL and search for the base64 extension.
3. Download the 64-bit version.
4. Open MIT App Inventor, click the extension button, and upload the base64 file.

Login Page:

- A login form verifies user credentials against stored data in Firebase.
- If credentials are valid, the user can access their account data.

Create a login form as shown below.

Enter your user ID and password.

After that, we must check if the user ID and password are valid or not.

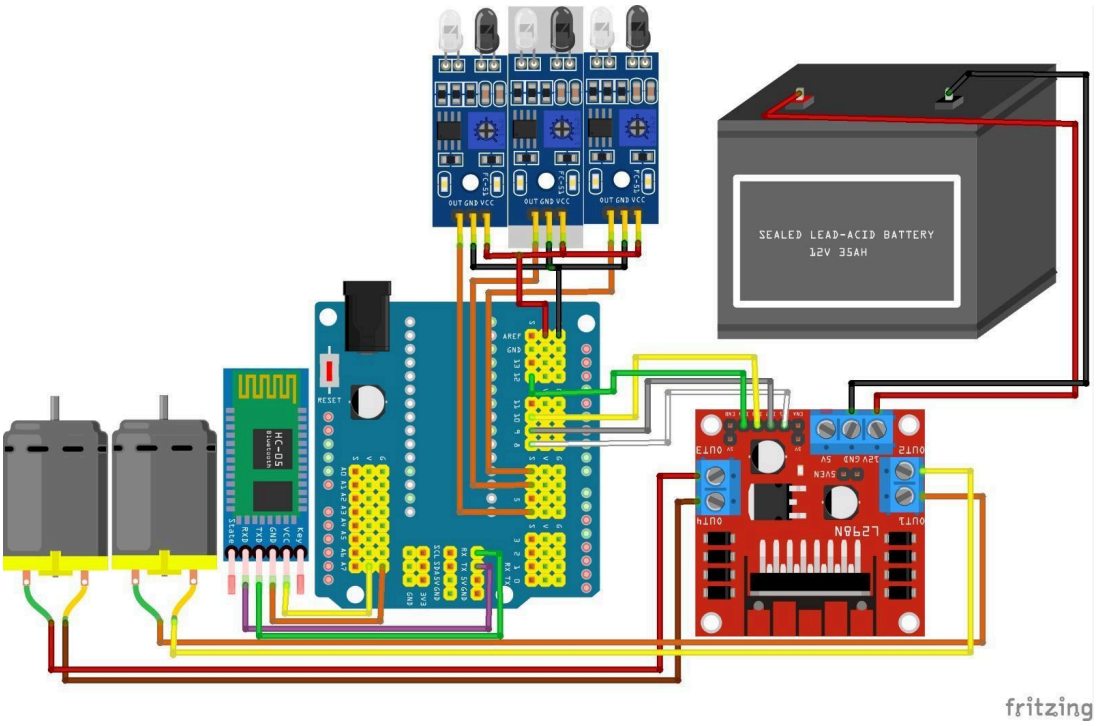
Coin Calculation:

- Variables are defined to calculate and store coins earned by users for dropping waste.
- The document includes code snippets for scanning and storing coins in the Firebase database.

9. Circuit Design & Connections for base part

The circuit design involves:

- **Connecting DC Motors and Motor Drivers**: For controlling movement and mechanical operations.
- **Integrating Sensors and Actuators**: For waste sorting, user interaction, and movement control.
- **Wiring and Connectivity**: Using jumper wires and MRT boards for component connectivity.

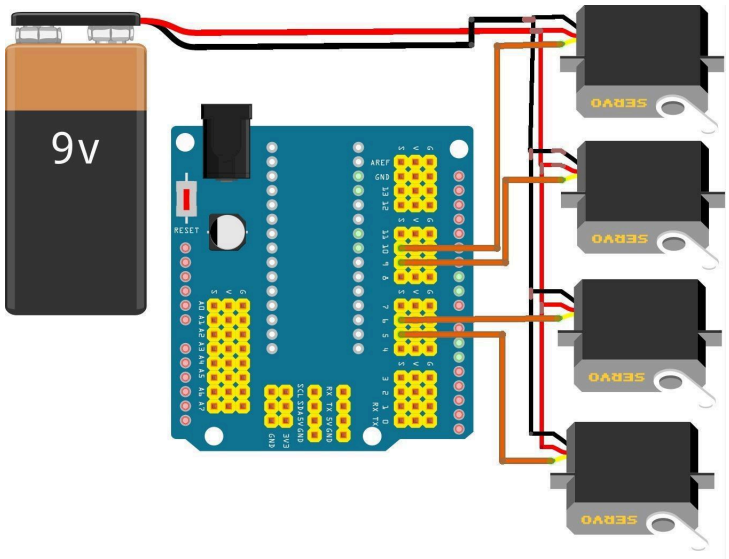


Connections Table

Component	Pin/Color	Connection	To Nano Pin
Motor Driver			
Motor Pins			
out1	Orange	Motor Pin 1	int1 (Pin 8)
out2	Yellow	Motor Pin 2	int2 (Pin 9)
out3	Red	Motor Pin 3	int3 (Pin 10)
out4	Brown	Motor Pin 4	int4 (Pin 12)
Motor Driver Pins			
int1	White	Motor Driver Pin 1	out1
int2	Gray	Motor Driver Pin 2	out2
int3	Yellow	Motor Driver Pin 3	out3
int4	Green	Motor Driver Pin 4	out4
IR Sensors			
Left Sensor			
Signal Pin	Orange	Pin 4	Pin 4
VCC	Red	VCC	VCC
GND	Black	GND	GND
Middle Sensor			
Signal Pin	Orange	Pin 6	Pin 6
Right Sensor			
Signal Pin	Orange	Pin 7	Pin 7

Bluetooth			
RX	Violet	TX	RX
TX	Green	RX	TX
VCC	Yellow	VCC	VCC
GND	Orange	GND	GND

Circuit Design & Connections for AI part



Servo Connections

Servo	Function	Pin
Servo1	Dustbin Opening	Pin 5
Servo2	Segregation	Pin 6
Servo3	Plastic Waste Door	Pin 9
Servo4	Metal Waste Door	Pin 10

10. Software Design

The software design includes:

- **AI Algorithms**: Trained using Teachable Machines for waste recognition and classification.
- **Control Logic**: Manages sorting, disposal, and movement.
- **Interaction Scripts**: Handles user interactions through speech recognition and text-to-speech.
- **Programming Tools**: PictoBlox and MRT Software for control logic and interactive features.
- **Eco Rewards App**: Manages point accumulation and reward redemption.
- **Leap Car Controller App**: Provides manual control for Eco-Bot's navigation.

11.Testing and Evaluation

Testing Procedures

Testing involves:

- **Functionality Testing**: Ensures accurate waste identification, sorting, and disposal.
- **Interaction Testing**: Verifies user interaction effectiveness.
- **Eco Rewards App Testing**: Confirms point tracking and reward processing.
- **Leap Car Controller Testing**: Assesses movement control features.
- **Autonomous Operation Testing**: Evaluates autonomous navigation and disposal.

Results

Results include:

- **Performance Metrics**: Accuracy in sorting, user engagement levels, and efficiency of operations.
- **App Performance**: Functionality of point tracking, reward redemption, and movement control.
- **Challenges and Solutions**: Issues encountered and solutions implemented.

Evaluation

Evaluation focuses on:

- **Effectiveness**: Measures achievement of educational and recycling goals.
- **User Feedback**: Assesses user experience and satisfaction.

12. How Eco-Bot Saves the Planet

Promoting Recycling

Eco-Bot automates waste sorting, ensuring that recyclables are properly separated and processed. This reduces the volume of waste sent to landfills and increases recycling efficiency.

Reducing Pollution

Proper sorting of waste reduces pollution by ensuring recyclables are processed instead of discarded. This decreases environmental pollution from production and waste.

Educating the Public

Eco-Bot educates users about recycling and environmental issues, raising awareness and promoting responsible waste management practices.

Incentivizing Recycling

The Eco Rewards app incentivizes correct recycling behavior by awarding points that can be redeemed for rewards, encouraging continuous engagement with recycling activities.

Enhancing Waste Management

Eco-Bot's autonomous trash disposal system ensures efficient waste management by preventing bin overflow and ensuring proper waste sorting and disposal.

13. Conclusion

Summary

Eco-Bot effectively combines robotics, AI, and interactive technology to promote recycling and environmental education. Its features contribute to efficient waste management and user engagement.

Future Work

Future improvements could include:

- **AI Enhancements**: Improving waste recognition accuracy.
- **Expanded Features**: Adding new educational content and interactive elements.
- **Scalability**: Adapting Eco-Bot for different environments or applications.

14. References

- **Research Papers**: Academic references related to AI, robotics, and recycling technologies.
- **Technical Manuals**: Manuals or datasheets for project components.
- **Libraries and Tools**: Software libraries and tools used for development, including Teachable Machines, PictoBlox, and MRT Software.

15. Appendices

Schematics and Diagrams

Detailed schematics and diagrams of the system architecture and circuit design.

Code Listings

Source code snippets or links to complete code with explanations.

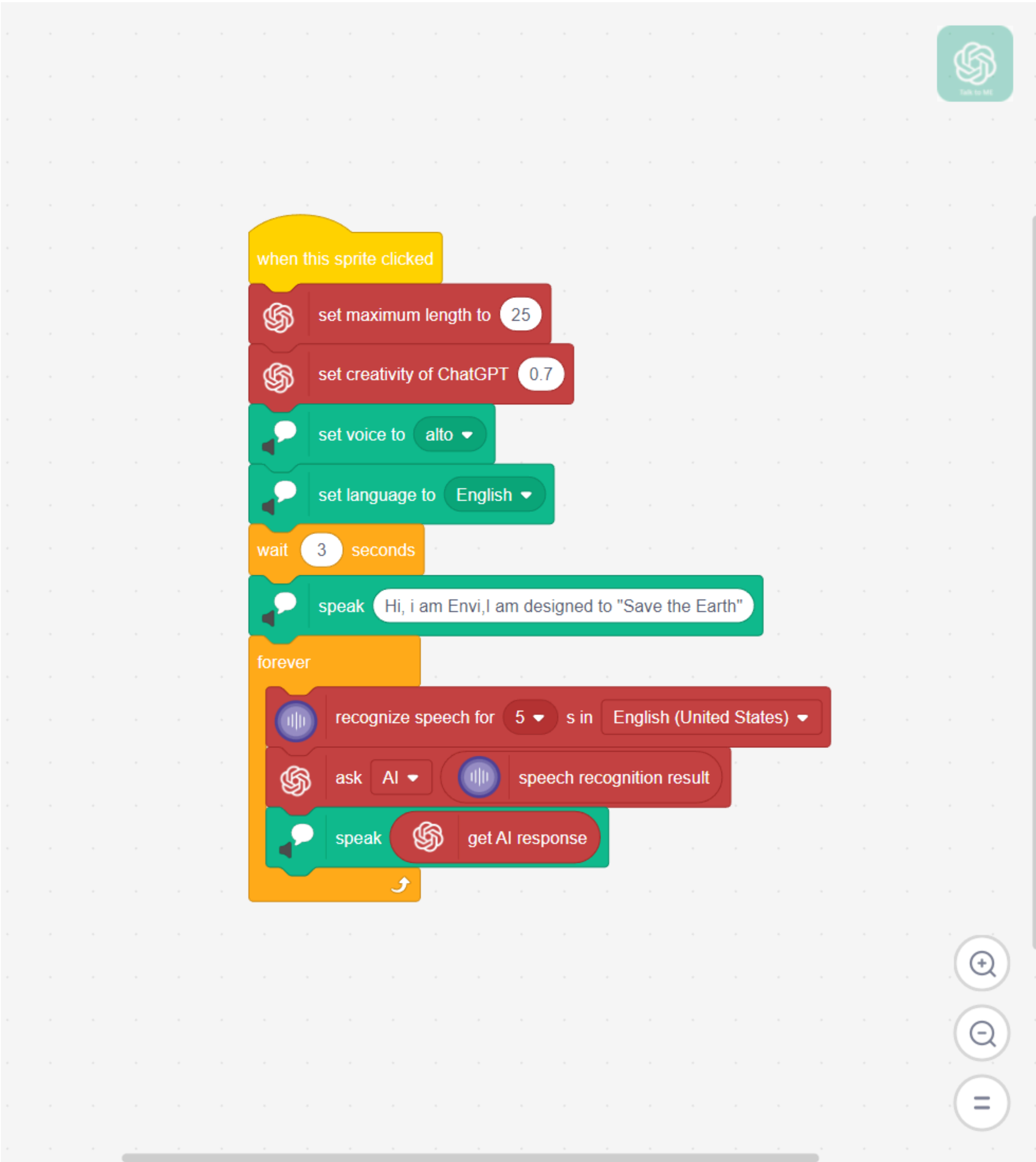
User Manual

Instructions for operating Eco-Bot, including setup, interaction guidelines, and troubleshooting.

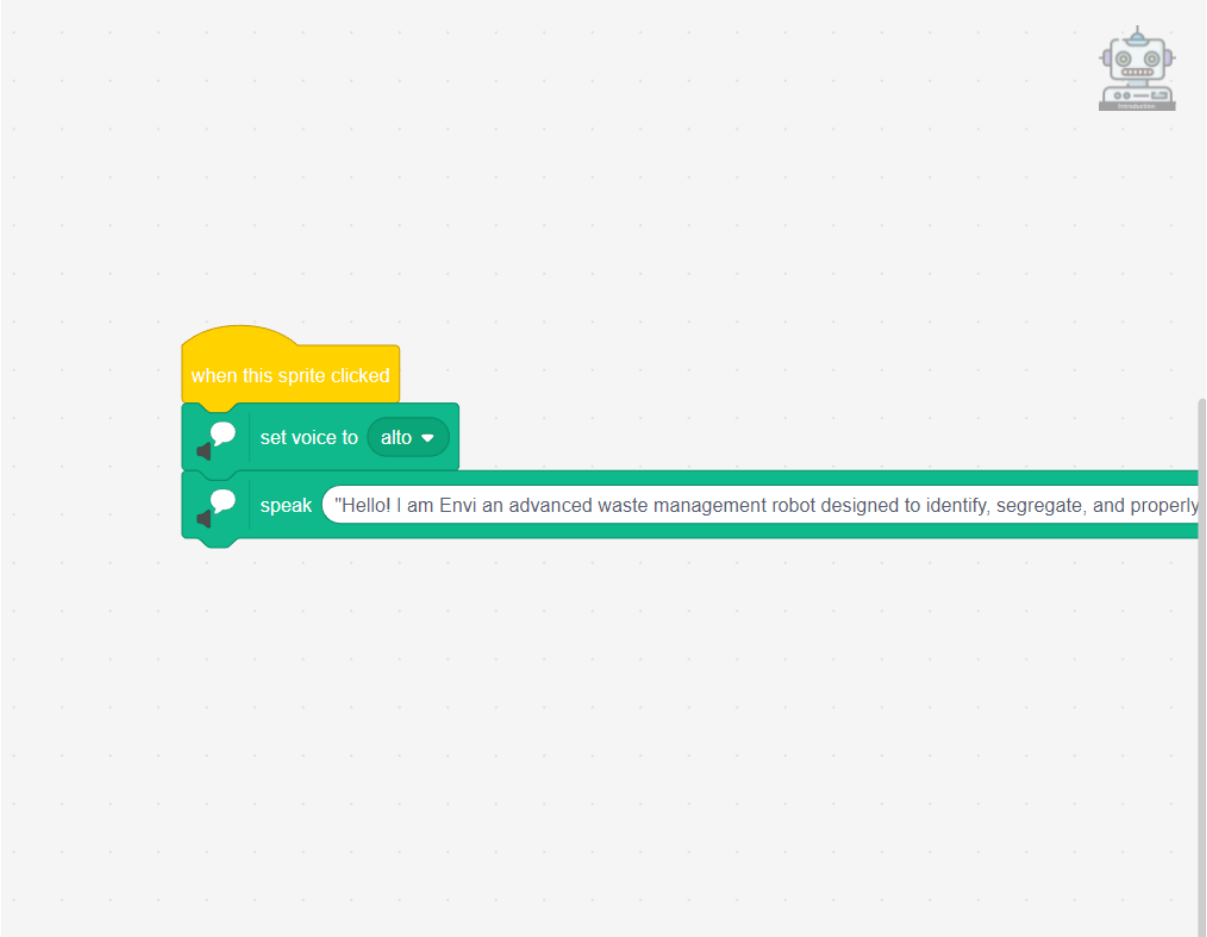
16.Source Code

AI:

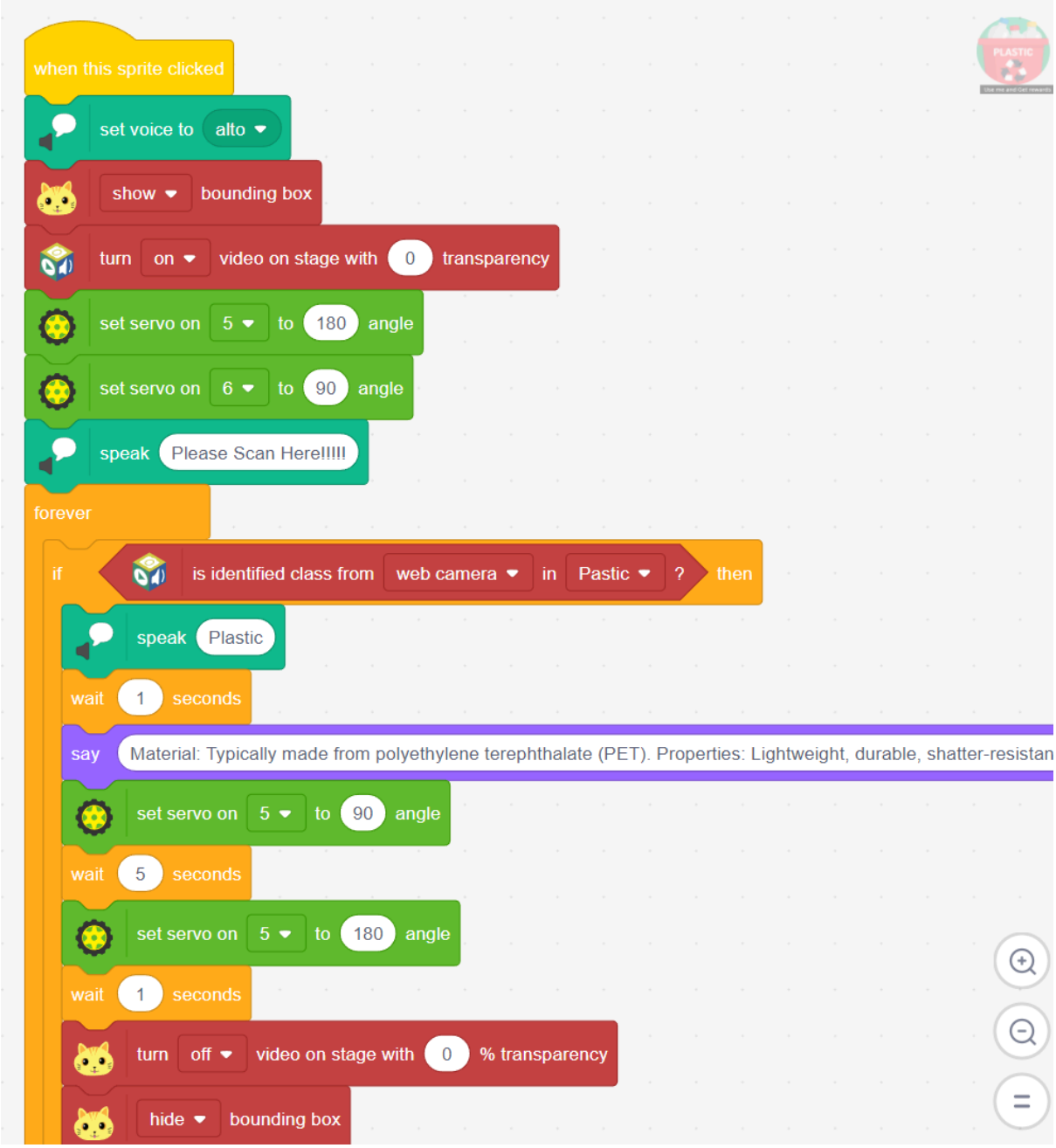
Human Interaction

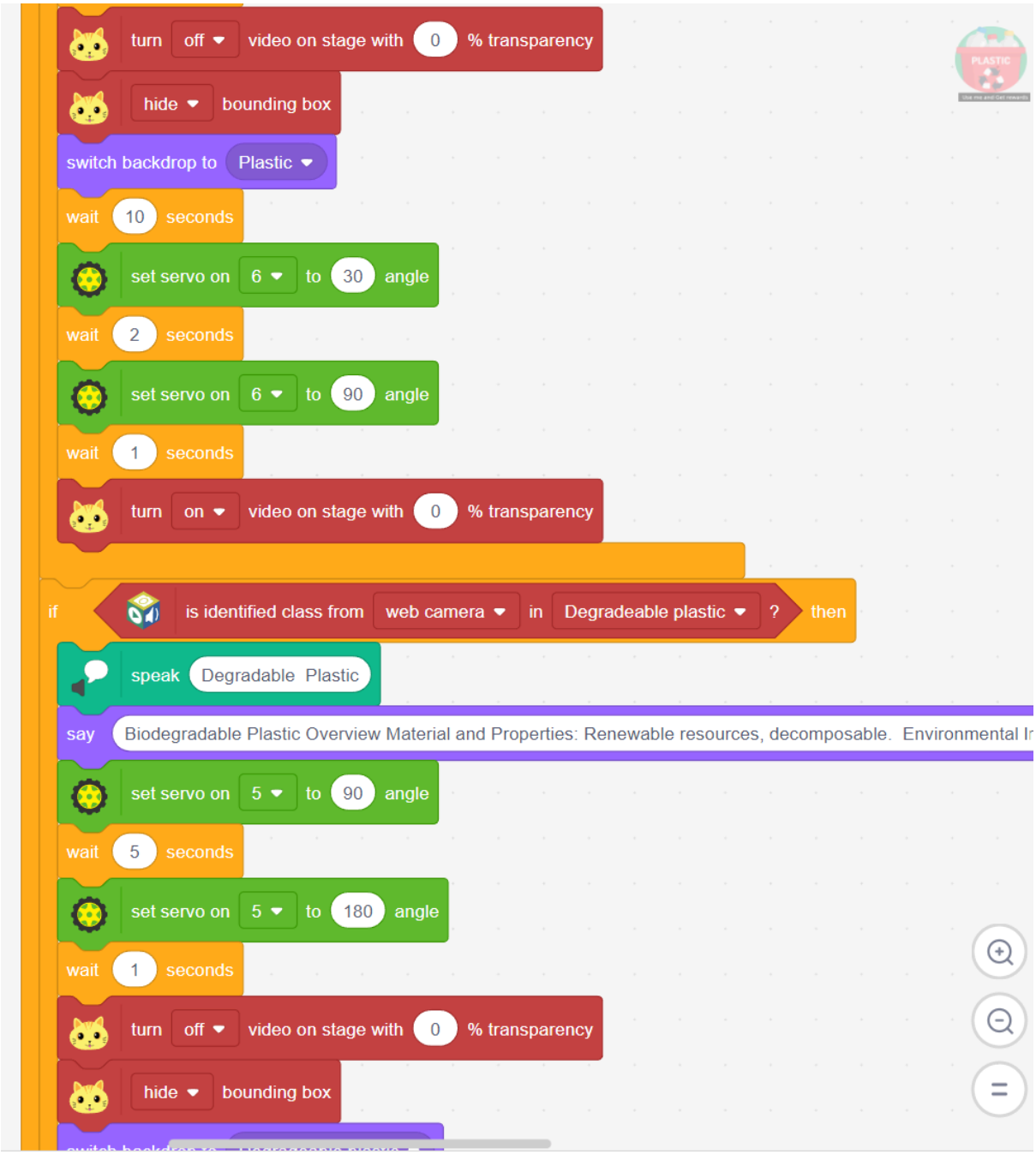


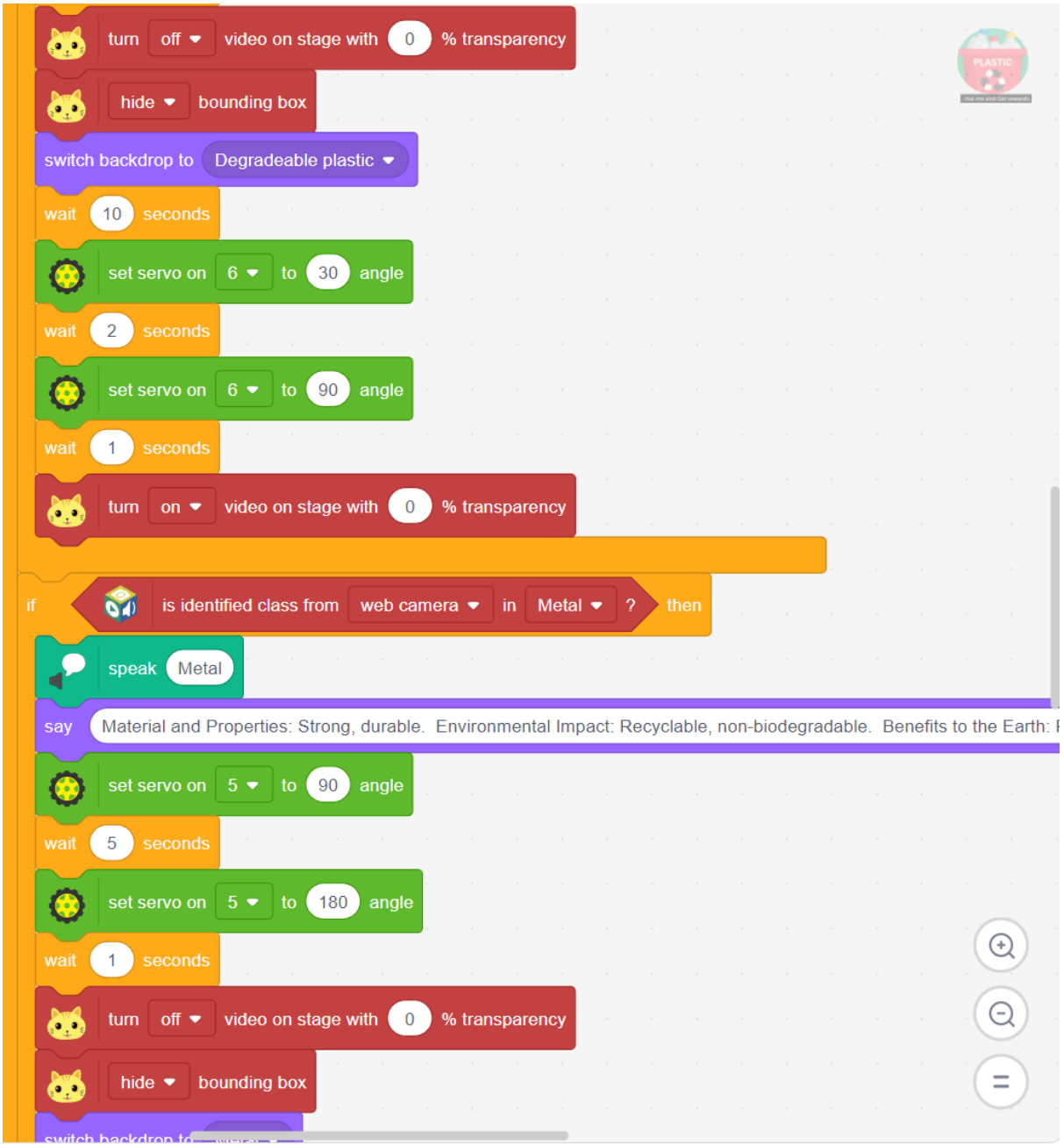
Project Description

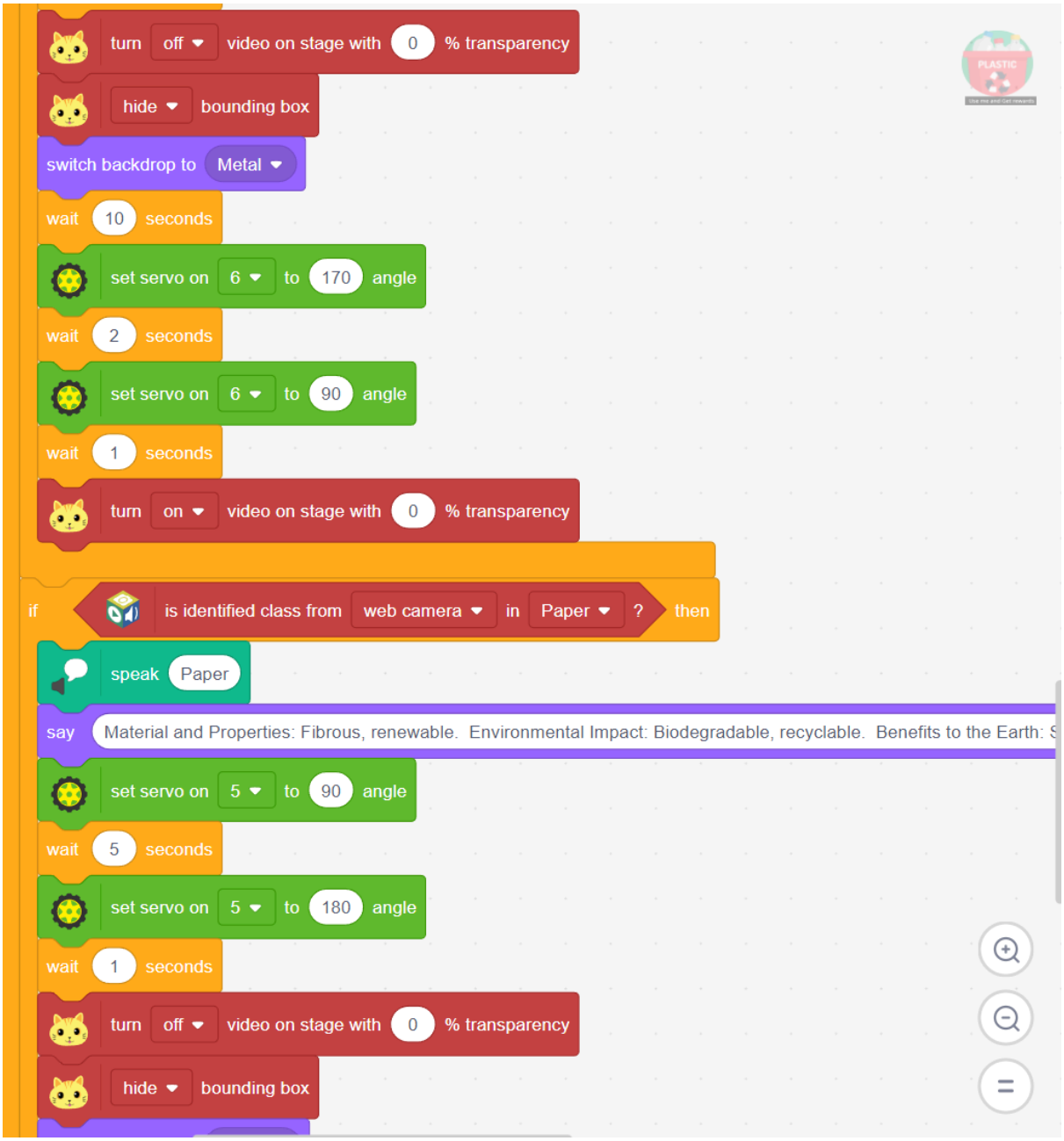


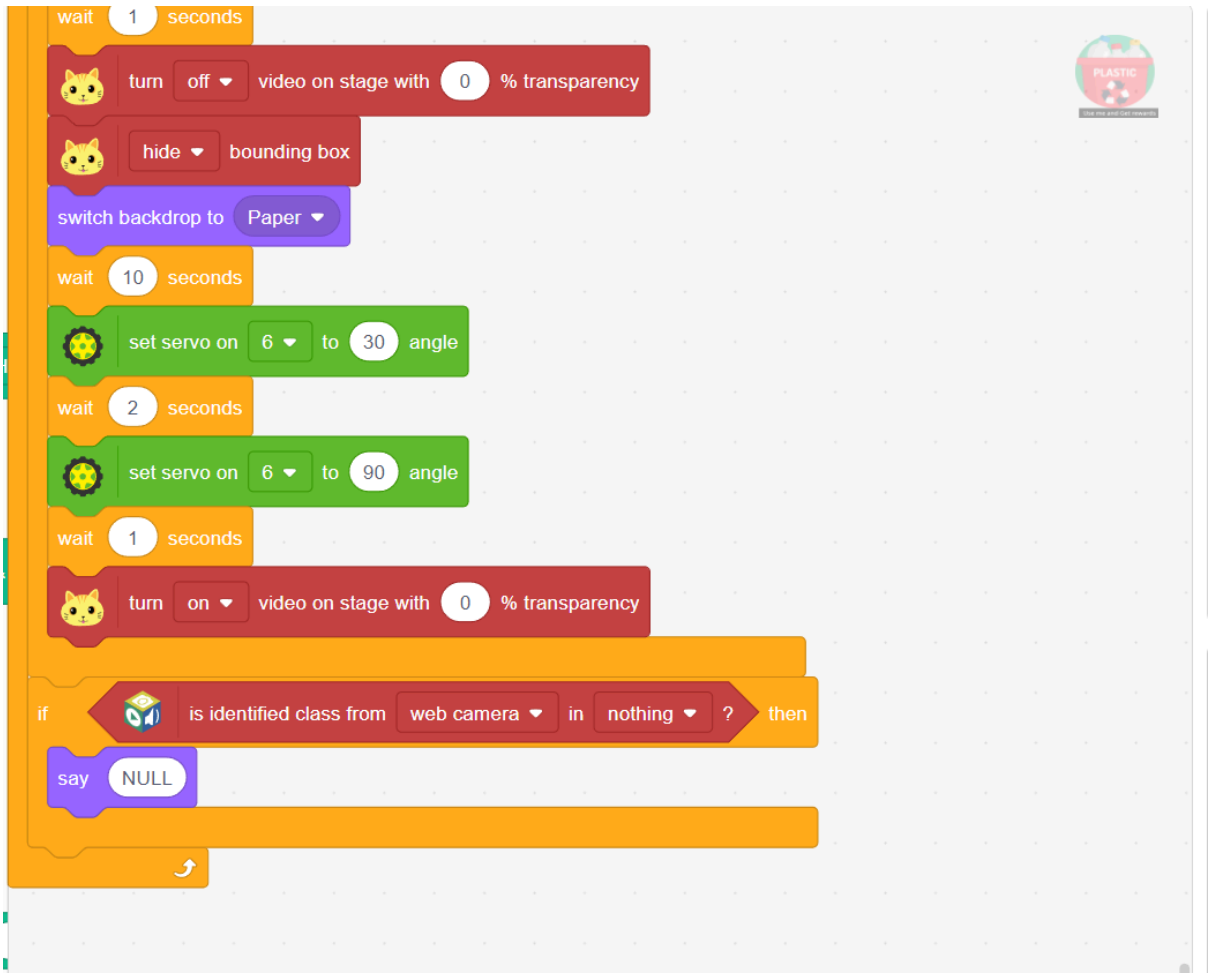
EcoSorter


when this sprite clicked
set voice to alto
show bounding box
turn on video on stage with 0 transparency
set servo on 5 to 180 angle
set servo on 6 to 90 angle
speak Please Scan Here!!!!!
forever
if is identified class from web camera in Pastic ? then
speak Plastic
wait 1 seconds
say Material: Typically made from polyethylene terephthalate (PET). Properties: Lightweight, durable, shatter-resistan
set servo on 5 to 90 angle
wait 5 seconds
set servo on 5 to 180 angle
wait 1 seconds
turn off video on stage with 0 % transparency
hide bounding box

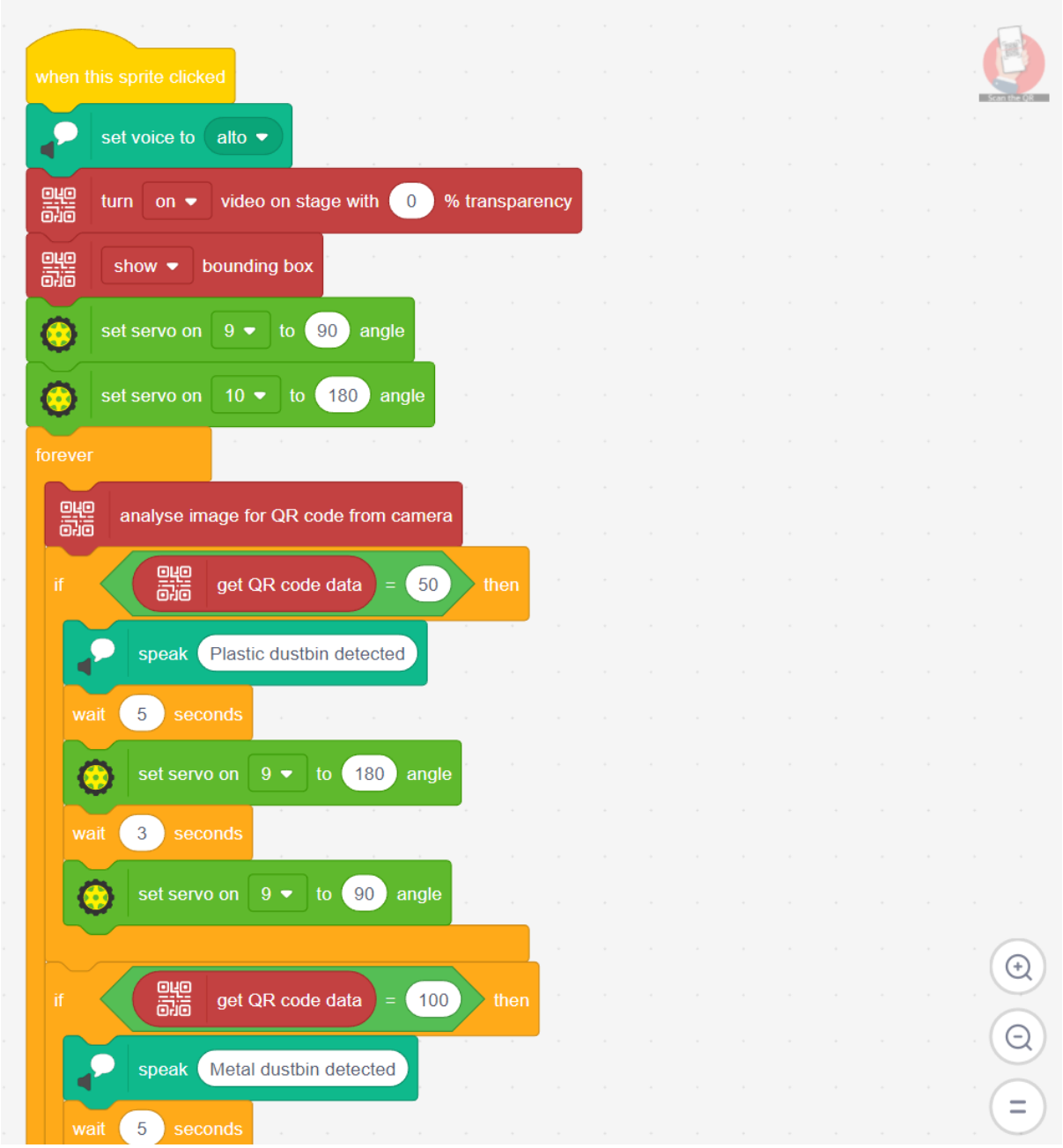

turn off video on stage with 0 % transparency
hide bounding box
switch backdrop to Plastic
wait 10 seconds
set servo on 6 to 30 angle
wait 2 seconds
set servo on 6 to 90 angle
wait 1 seconds
turn on video on stage with 0 % transparency
if is identified class from web camera in Degradeable plastic ? then
speak Degradable Plastic
say Biodegradable Plastic Overview Material and Properties: Renewable resources, decomposable. Environmental I
set servo on 5 to 90 angle
wait 5 seconds
set servo on 5 to 180 angle
wait 1 seconds
turn off video on stage with 0 % transparency
hide bounding box

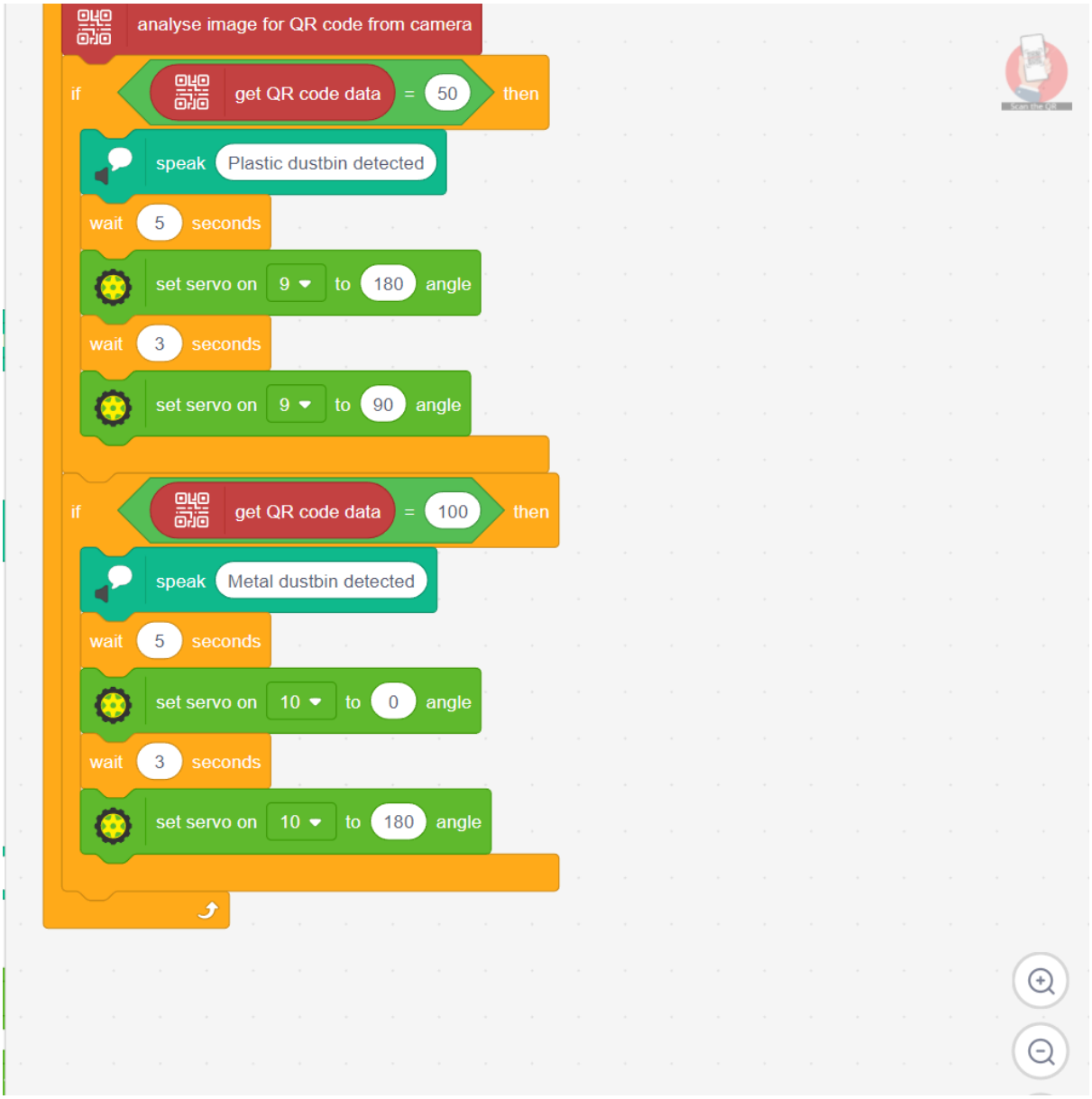

turn off video on stage with 0 % transparency
hide bounding box
switch backdrop to Degradeable plastic
wait 10 seconds
set servo on 6 to 30 angle
wait 2 seconds
set servo on 6 to 90 angle
wait 1 seconds
turn on video on stage with 0 % transparency
if is identified class from web camera in Metal ? then
speak Metal
say Material and Properties: Strong, durable. Environmental Impact: Recyclable, non-biodegradable. Benefits to the Earth:
set servo on 5 to 90 angle
wait 5 seconds
set servo on 5 to 180 angle
wait 1 seconds
turn off video on stage with 0 % transparency
hide bounding box


turn off video on stage with 0 % transparency
hide bounding box
switch backdrop to Metal
wait 10 seconds
set servo on 6 to 170 angle
wait 2 seconds
set servo on 6 to 90 angle
wait 1 seconds
turn on video on stage with 0 % transparency
if is identified class from web camera in Paper ? then
speak Paper
say Material and Properties: Fibrous, renewable. Environmental Impact: Biodegradable, recyclable. Benefits to the Earth:
set servo on 5 to 90 angle
wait 5 seconds
set servo on 5 to 180 angle
wait 1 seconds
turn off video on stage with 0 % transparency
hide bounding box


wait 1 seconds
turn off video on stage with 0 % transparency
hide bounding box
switch backdrop to Paper
wait 10 seconds
set servo on 6 to 30 angle
wait 2 seconds
set servo on 6 to 90 angle
wait 1 seconds
turn on video on stage with 0 % transparency
if is identified class from web camera in nothing ? then
say NULL

Trash Navigator




analyse image for QR code from camera
if
get QR code data
=
50
then
speak
Plastic dustbin detected
wait
5
seconds
set servo on
9
to
180
angle
wait
3
seconds
set servo on
9
to
90
angle
if
get QR code data
=
100
then
speak
Metal dustbin detected
wait
5
seconds
set servo on
10
to
0
angle
wait
3
seconds
set servo on
10
to
180
angle

EcoEducator