

# 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.

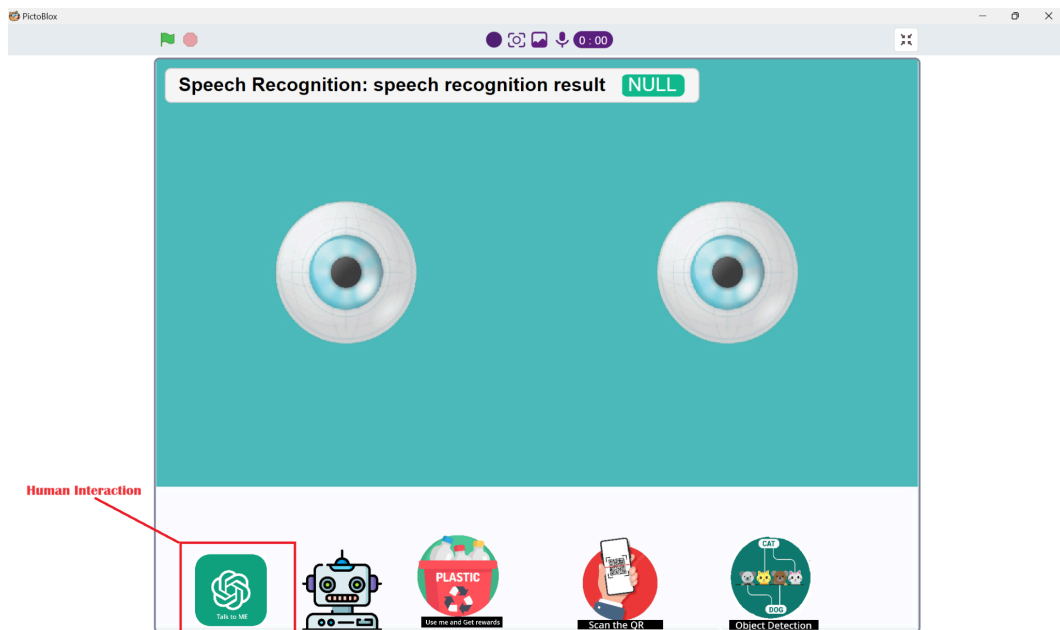
**Eco Rewards App:** Tracks points earned through recycling and manages reward redemption.

**Communication Module:** Facilitates user interaction and educational content delivery.

## 6. Functional Description

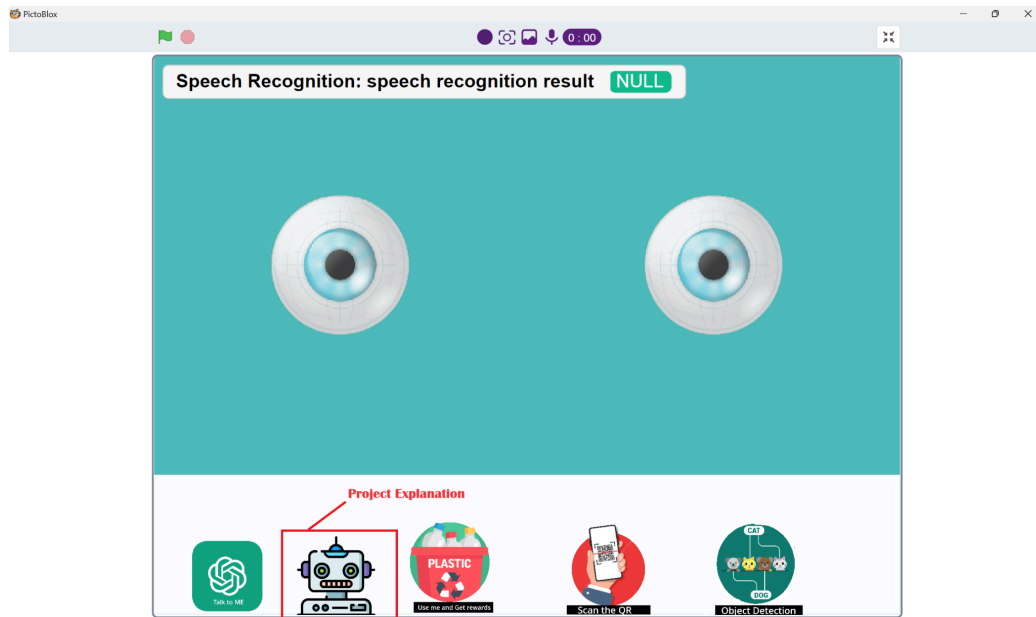
### Human Interaction

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.



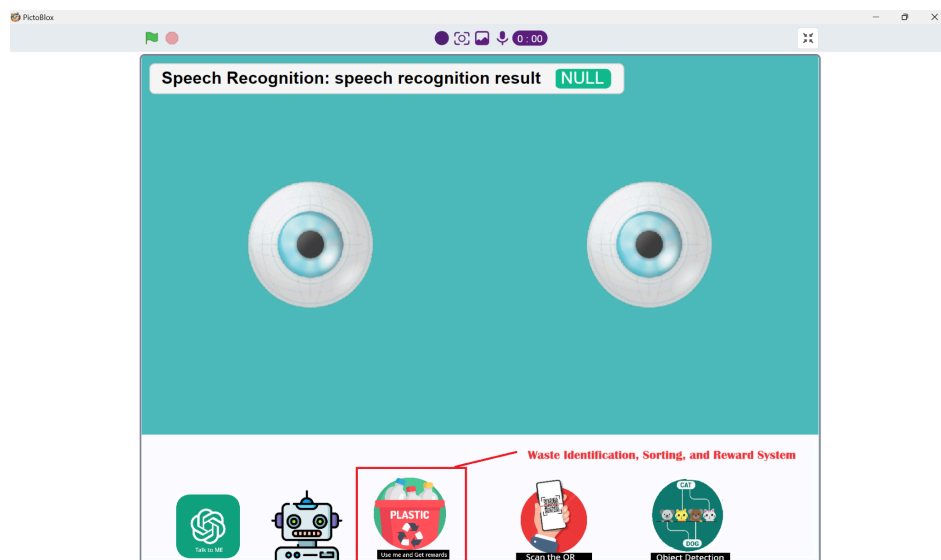
### Project Explanation

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

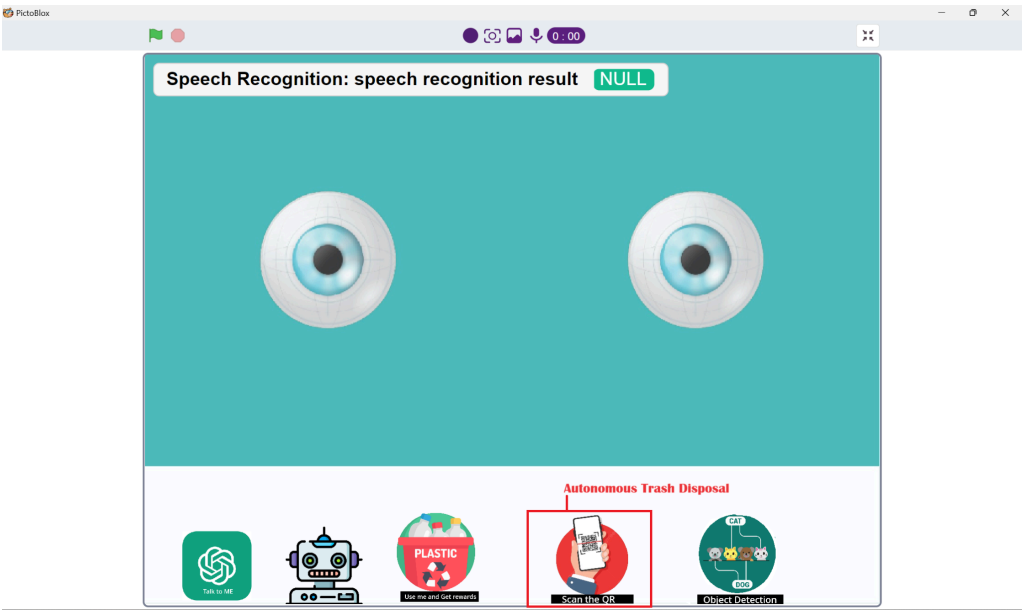
The AI model trained with Teachable Machines enables Eco-Bot to identify and classify different types of waste. After sorting the waste into designated bins, Eco-Bot rewards users with points through the Eco Rewards app. Users can accumulate points and redeem them for various rewards, such as toys or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



## Autonomous Trash Disposal

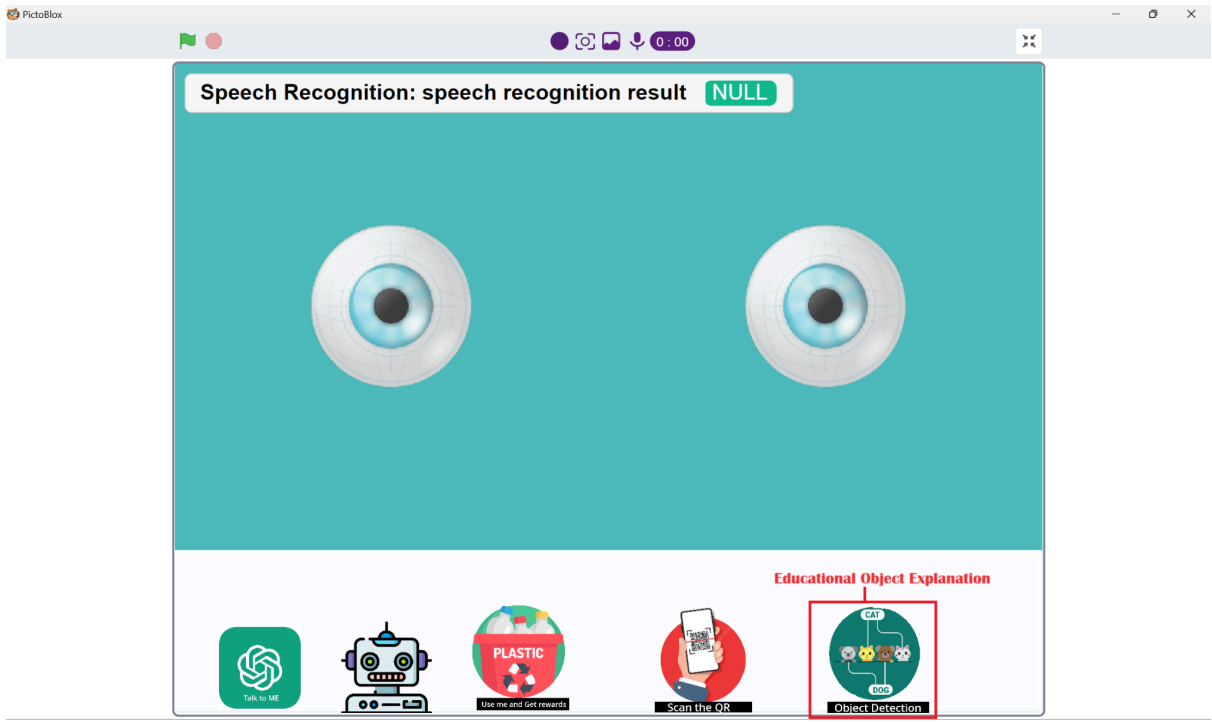
When the internal bins are full, Eco-Bot navigates to external waste bins using line-following technology. It scans QR codes on these bins to ensure that waste is

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.



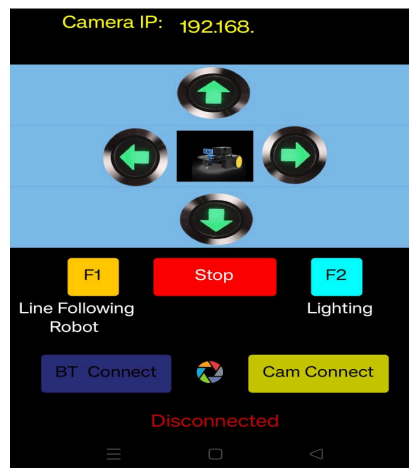
## 7. Movement Control with Leap Car Controller

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.



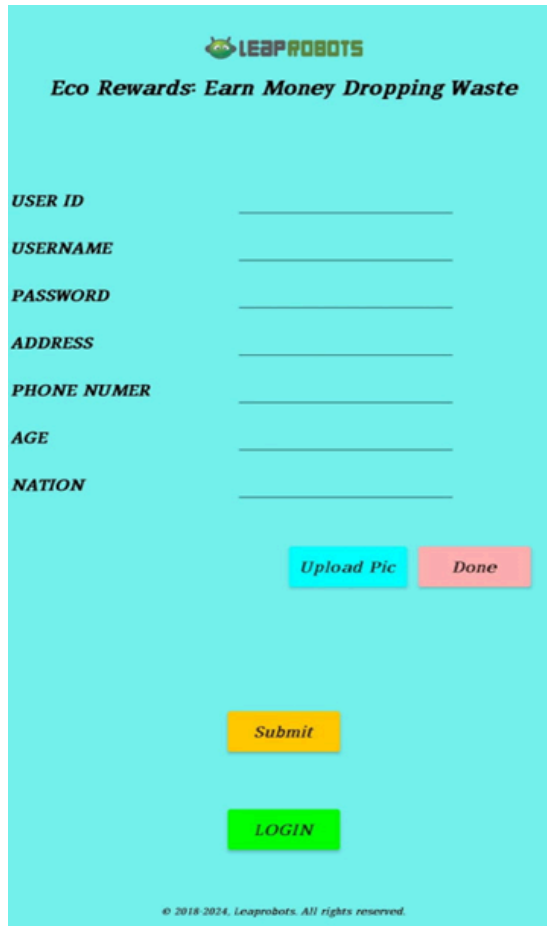
TAP TO DOWNLOAD **LEAP ECO REWARDS APP**



## Key Features:

### Registration Form:

- The app begins with a user registration form.



The image shows a user registration form for an app called LEAPROBOTS. The app's logo, featuring a green robot head, is at the top center. Below the logo is the tagline "Eco Rewards: Earn Money Dropping Waste". The form consists of several input fields with labels: "USER ID", "USERNAME", "PASSWORD", "ADDRESS", "PHONE NUMER", "AGE", and "NATION". To the right of the "PASSWORD" field is a small eye icon for toggling visibility. Below the input fields are three buttons: a blue "Upload Pic" button, a red "Done" button, and a yellow "Submit" button. At the bottom of the form is a green "LOGIN" button. A copyright notice "© 2018-2024, Leaprobots. All rights reserved." is at the very bottom.

**LEAPROBOTS**  
*Eco Rewards: Earn Money Dropping Waste*

*USER ID* \_\_\_\_\_  
*USERNAME* \_\_\_\_\_  
*PASSWORD* \_\_\_\_\_  
*ADDRESS* \_\_\_\_\_  
*PHONE NUMER* \_\_\_\_\_  
*AGE* \_\_\_\_\_  
*NATION* \_\_\_\_\_

*Upload Pic* *Done*

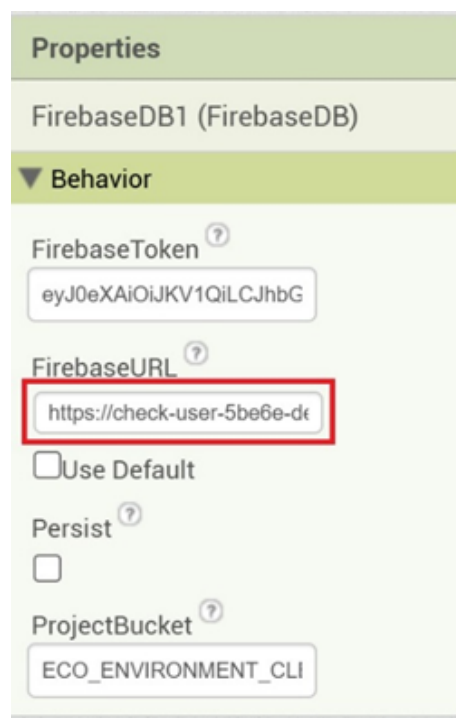
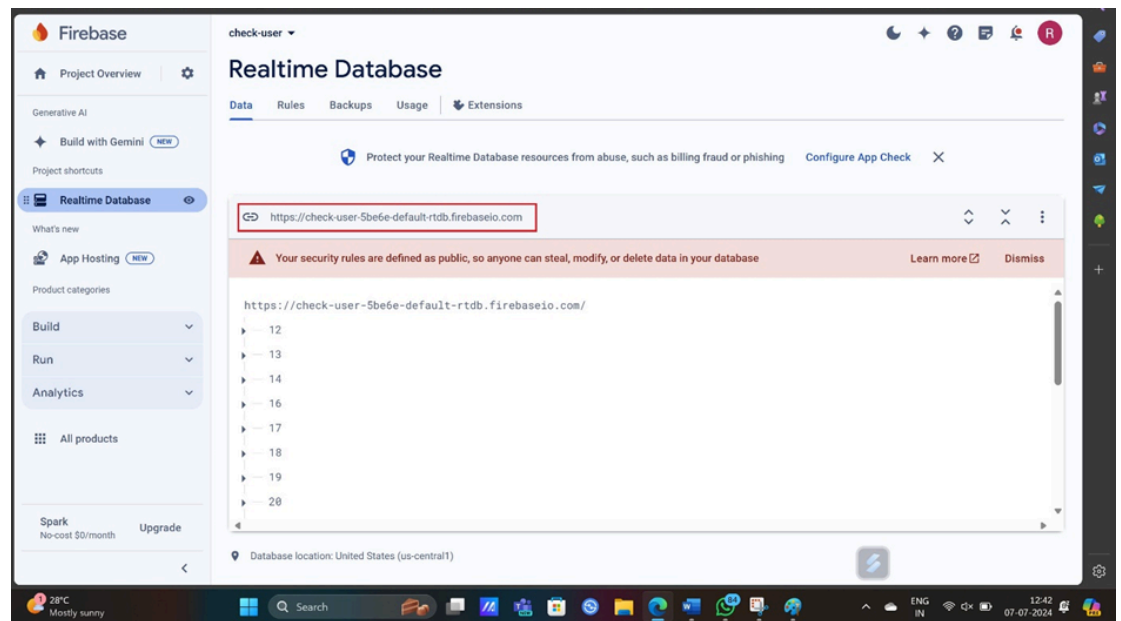
*Submit*

*LOGIN*

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### 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.

The image shows a mobile app login screen with a light blue background. At the top, there is a logo for 'LEAP ROBOTS' featuring a green robot head icon. Below the logo is the text 'Eco Rewards: Earn Money Dropping Waste'. The login form consists of two input fields: 'ENTER USER ID' and 'ENTER PASSWORD', each followed by a text input line. Below these fields are two buttons: a green 'LOGIN' button and a yellow 'SIGN UP' button. At the bottom of the screen, there is a small copyright notice: '© 2019-2024, leaprobots. All rights reserved.'

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.

Eco Rewards: Earn Money Dropping Waste

Scan and Get Coins



ID

504

Username

Ramakrishna

Age

18

Mob\_No

9182894456

Address

2-91, Srirama Street,  
sompeta.

METAL_TYPE	COUNT	POINTS
PLASTICS	0	0
DEGRADABLE_PLASTIC	0	0
PAPPER	0	0
METAL	0	0

\$

Available Coins

0 + 0 = 0

Last Getting Coins

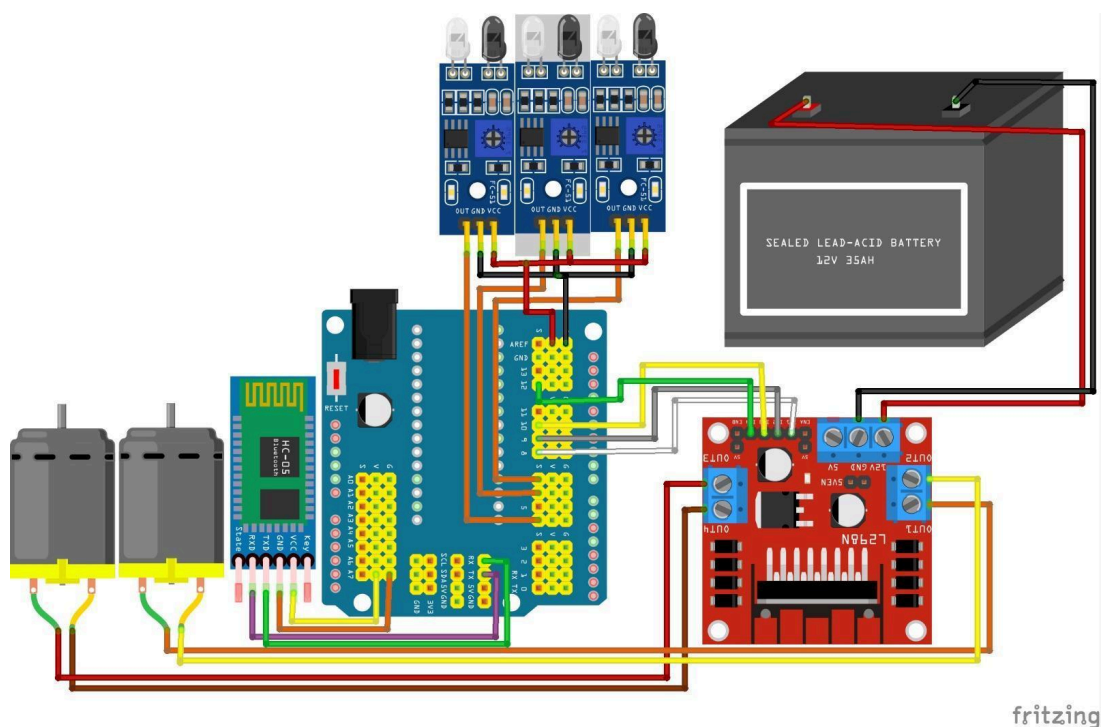
Logout

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## 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.

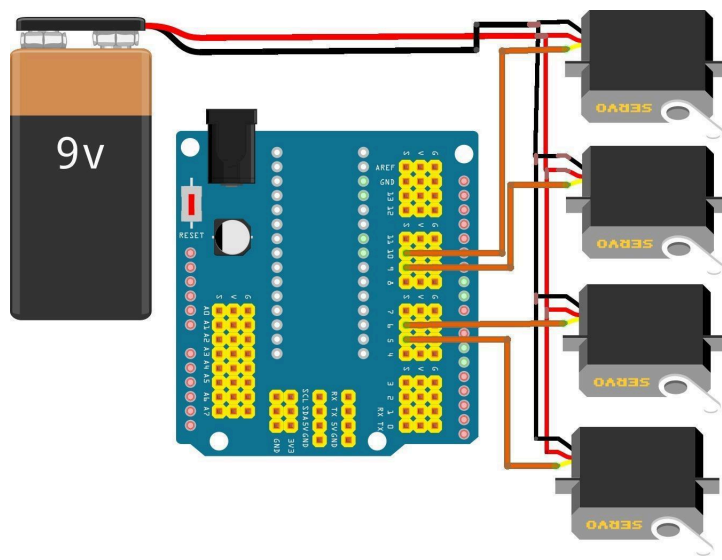


**Connections Table**

Component	Pin/Color	Connection	To Nano Pin
Motor Driver			
<b>Motor Pins</b>			
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)
<b>Motor Driver Pins</b>			
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
<b>IR Sensors</b>			
Left Sensor			
Signal Pin	Orange	Pin 4	Pin 4
VCC	Red	VCC	VCC
GND	Black	GND	GND
<b>Middle Sensor</b>			
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.

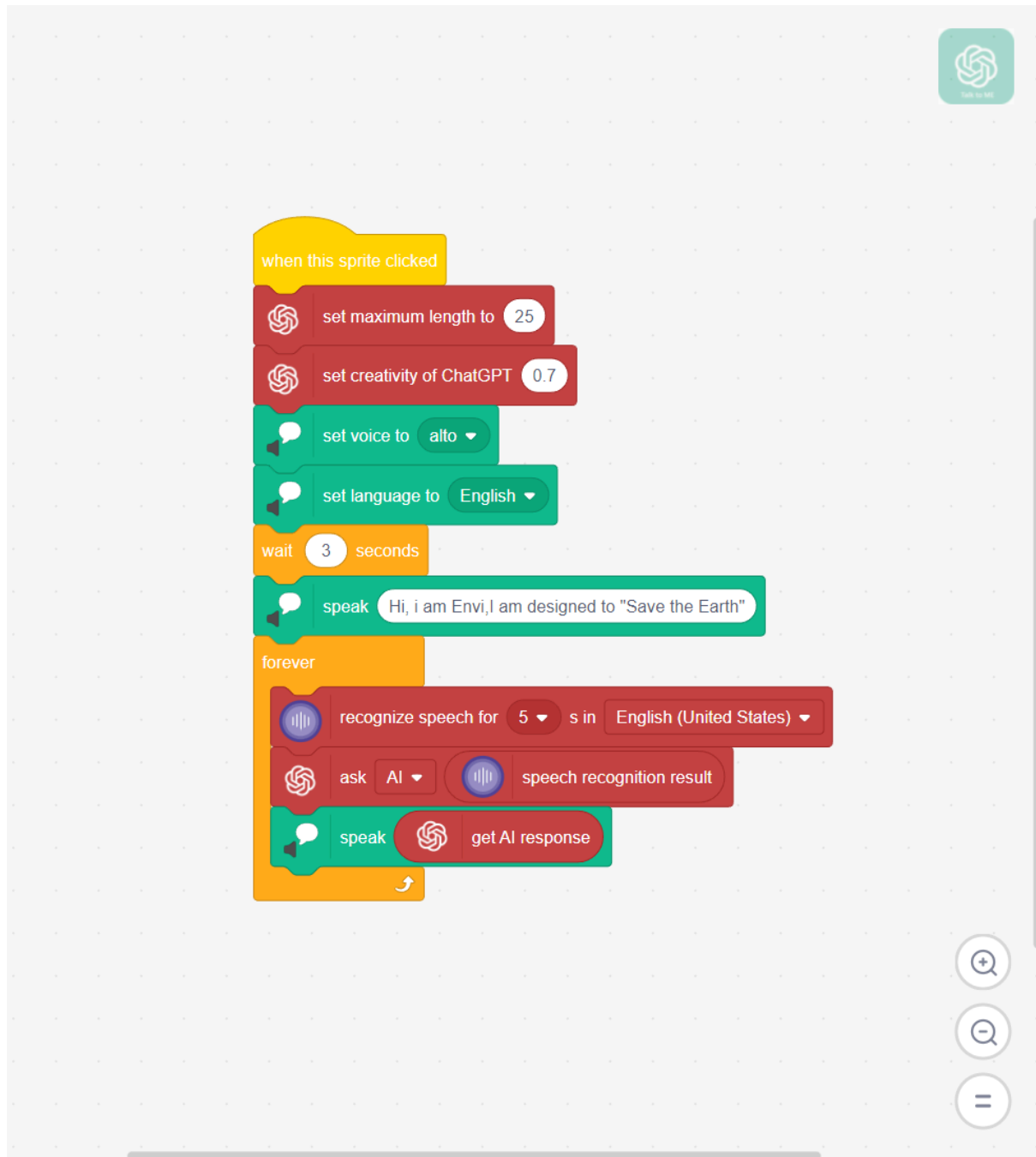
### **User Manual**

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

## 16.Source Code

AI:

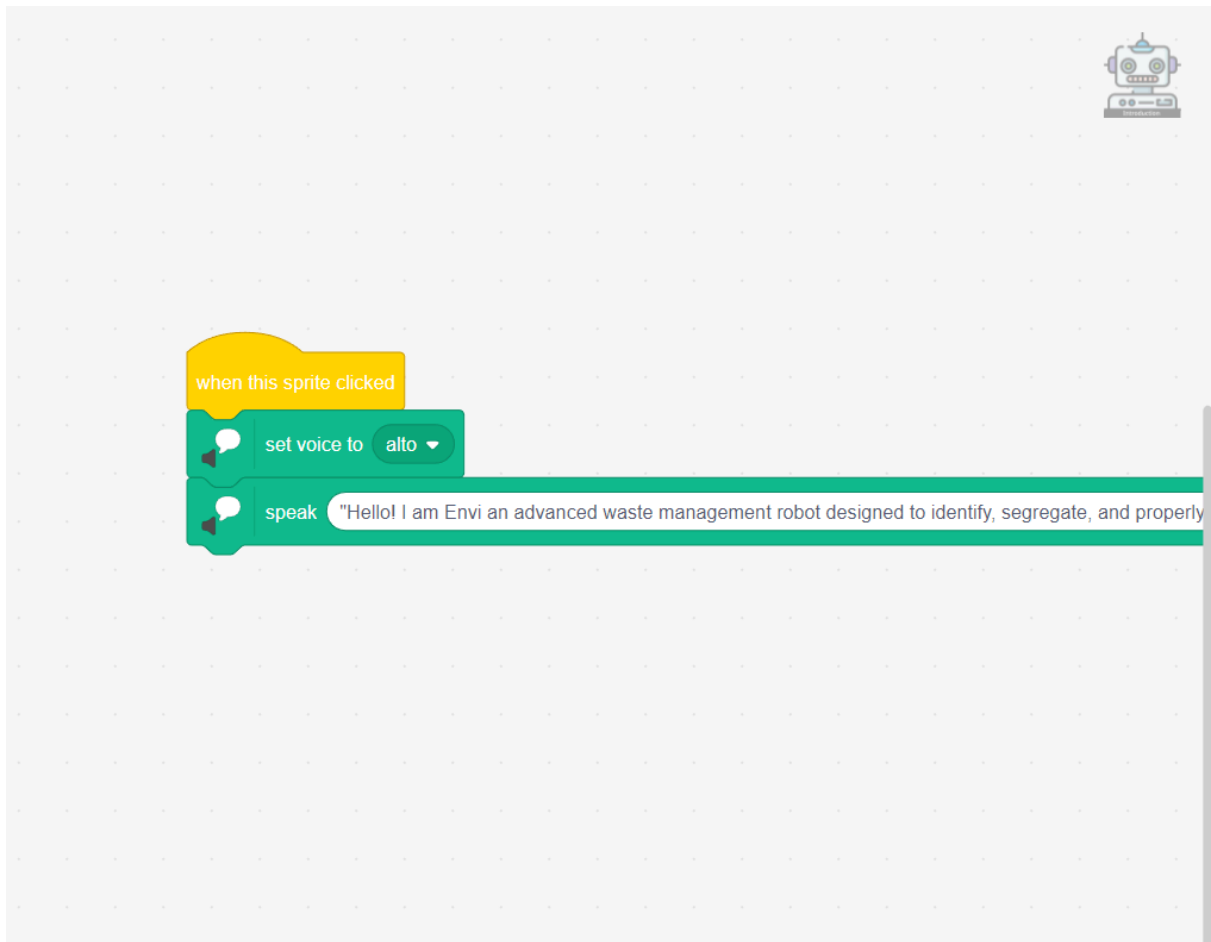
Human Interaction



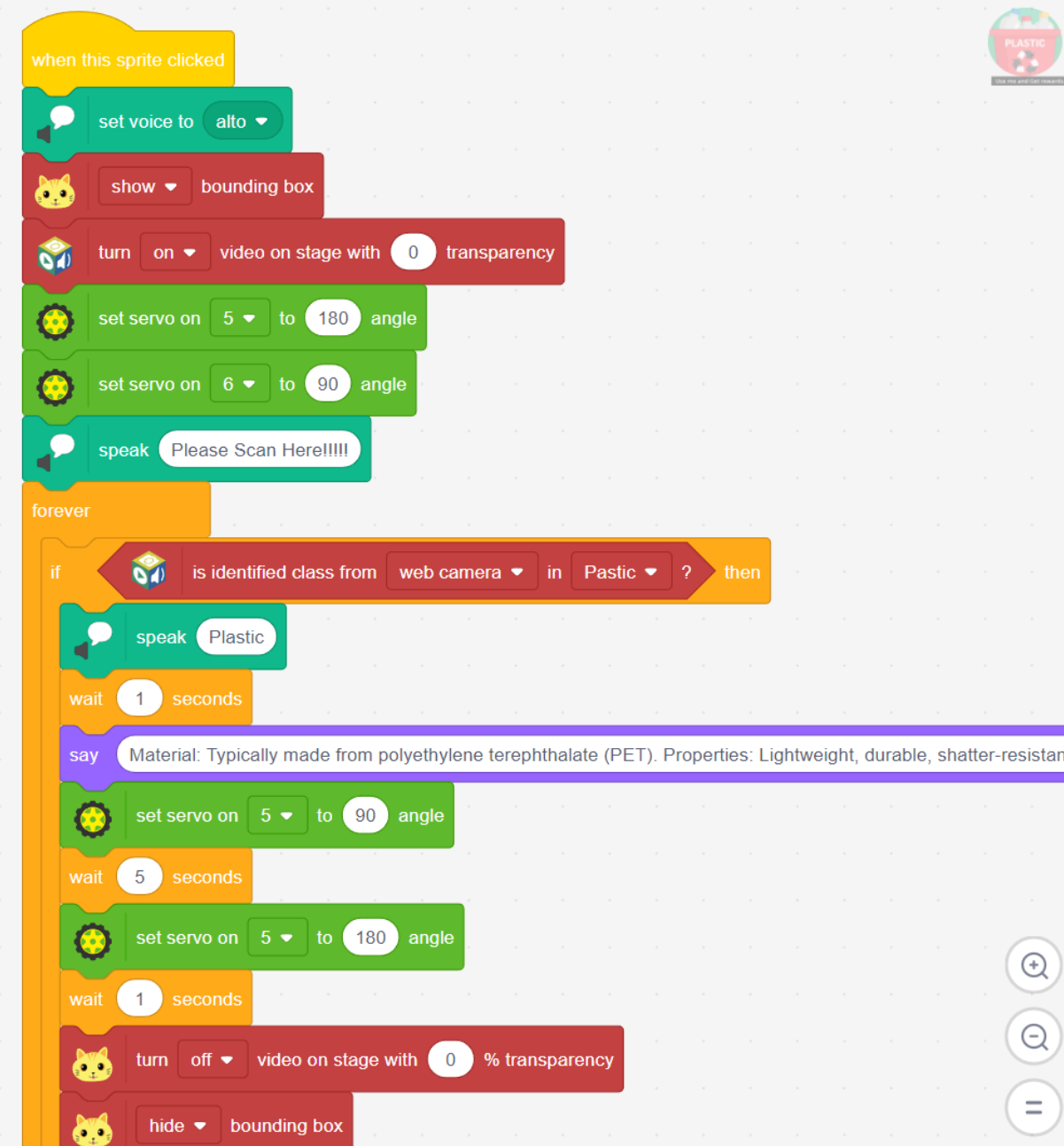
The image shows a Scratch script designed for human-AI interaction. The script begins with a 'when this sprite clicked' event block. This is followed by three ChatGPT blocks: 'set maximum length to 25', 'set creativity of ChatGPT 0.7', and 'set voice to alto'. Next, the language is set to 'English'. A 3-second wait block follows. The script then uses a 'speak' block with the text 'Hi, i am Envi,I am designed to "Save the Earth"'. A 'forever' loop contains three blocks: 'recognize speech for 5 s in English (United States)', 'ask AI speech recognition result', and 'speak get AI response'. The script is set against a light gray grid background. In the top right corner, there is a small green square icon with a white ChatGPT logo and the text 'Talk to GPT'. In the bottom right corner, there are three circular icons: a magnifying glass with a plus sign, a magnifying glass with a minus sign, and an equals sign.

```
when this sprite clicked
  set maximum length to 25
  set creativity of ChatGPT 0.7
  set voice to alto
  set language to English
  wait 3 seconds
  speak Hi, i am Envi,I am designed to "Save the Earth"
  forever
    recognize speech for 5 s in English (United States)
    ask AI speech recognition result
    speak get AI response
```

## Project Description



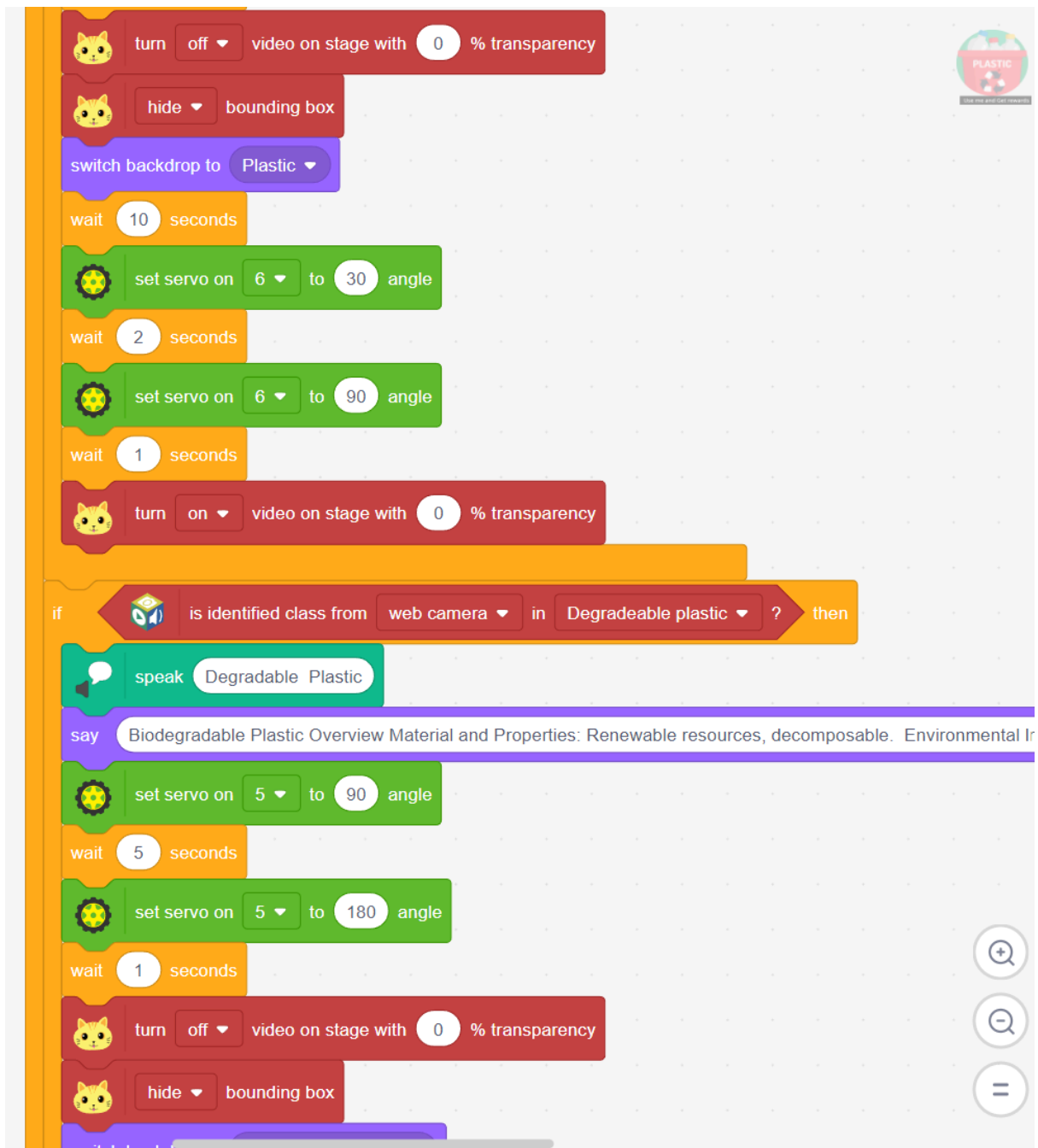
## EcoSorter



The image shows a Scratch script for a project called "EcoSorter". The script is written in a visual programming style using colored blocks. It starts with a "when this sprite clicked" event block. This is followed by a sequence of blocks: "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", and "speak Please Scan Here!!!!". A "forever" loop block contains an "if" block that checks if the "web camera" is identified as "Pastic" (sic). If true, it triggers a "speak Plastic" block, a "wait 1 seconds" block, a "say" block with the text "Material: Typically made from polyethylene terephthalate (PET). Properties: Lightweight, durable, shatter-resistan", a "set servo on 5 to 90 angle" block, a "wait 5 seconds" block, a "set servo on 5 to 180 angle" block, a "wait 1 seconds" block, a "turn off video on stage with 0 % transparency" block, and a "hide bounding box" block. The script is set against a light gray grid background. In the top right corner, there is a small circular logo with the word "PLASTIC" and a recycling symbol. On the right side, there are three circular icons: a magnifying glass, a minus sign, and an equals sign.

```
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!!!!

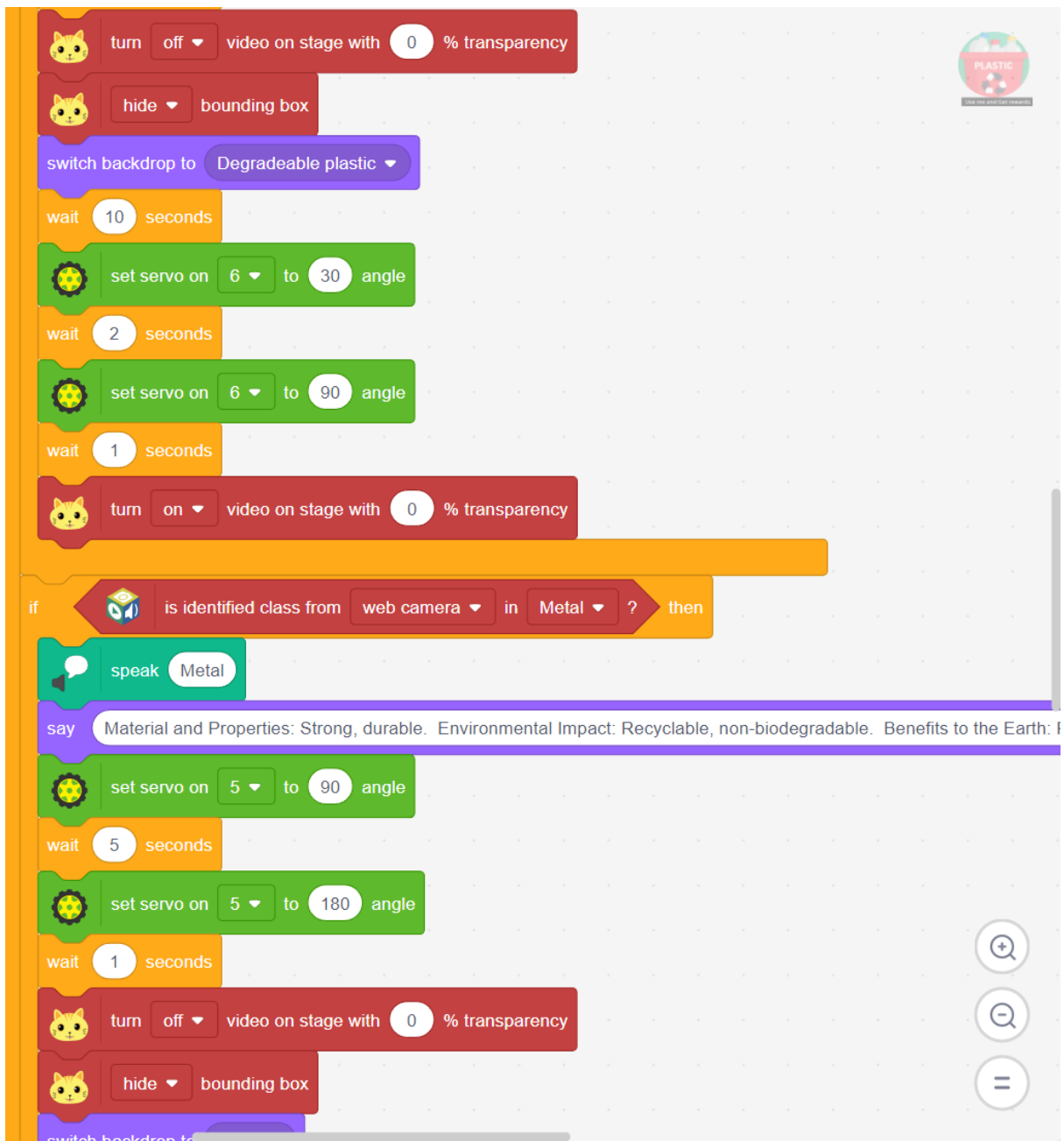
  forever loop
    if web camera is identified class from Pastic ? then
      speak Plastic
      wait 1 seconds
      say Material: Typically made from polyethylene terephthalate (PET). Properties: Lightweight, durable, shatter-resistan
      set servo on 5 to 90 angle
      wait 5 seconds
      set servo on 5 to 180 angle
      wait 1 seconds
      turn off video on stage with 0 % transparency
      hide bounding box
```



This Scratch script is designed for a project titled "PLASTIC" (as indicated by the logo in the top right corner). The script is organized into several blocks:

- Initial Setup:**
  - 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.
- Identification Loop:**
  - An if-then loop that checks if the "is identified class from web camera" in "Degradable plastic" is true.
  - If true, the script performs the following actions:
    - Speak "Degradable Plastic".
    - Say "Biodegradable Plastic Overview Material and Properties: Renewable resources, decomposable. Environmental Ir" (the text is partially cut off).
    - 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.
    - Switch backdrop to (the text is partially cut off).

The script is set against a light gray grid background. On the right side, there are three circular icons: a magnifying glass with a plus sign, a magnifying glass with a minus sign, and an equals sign.



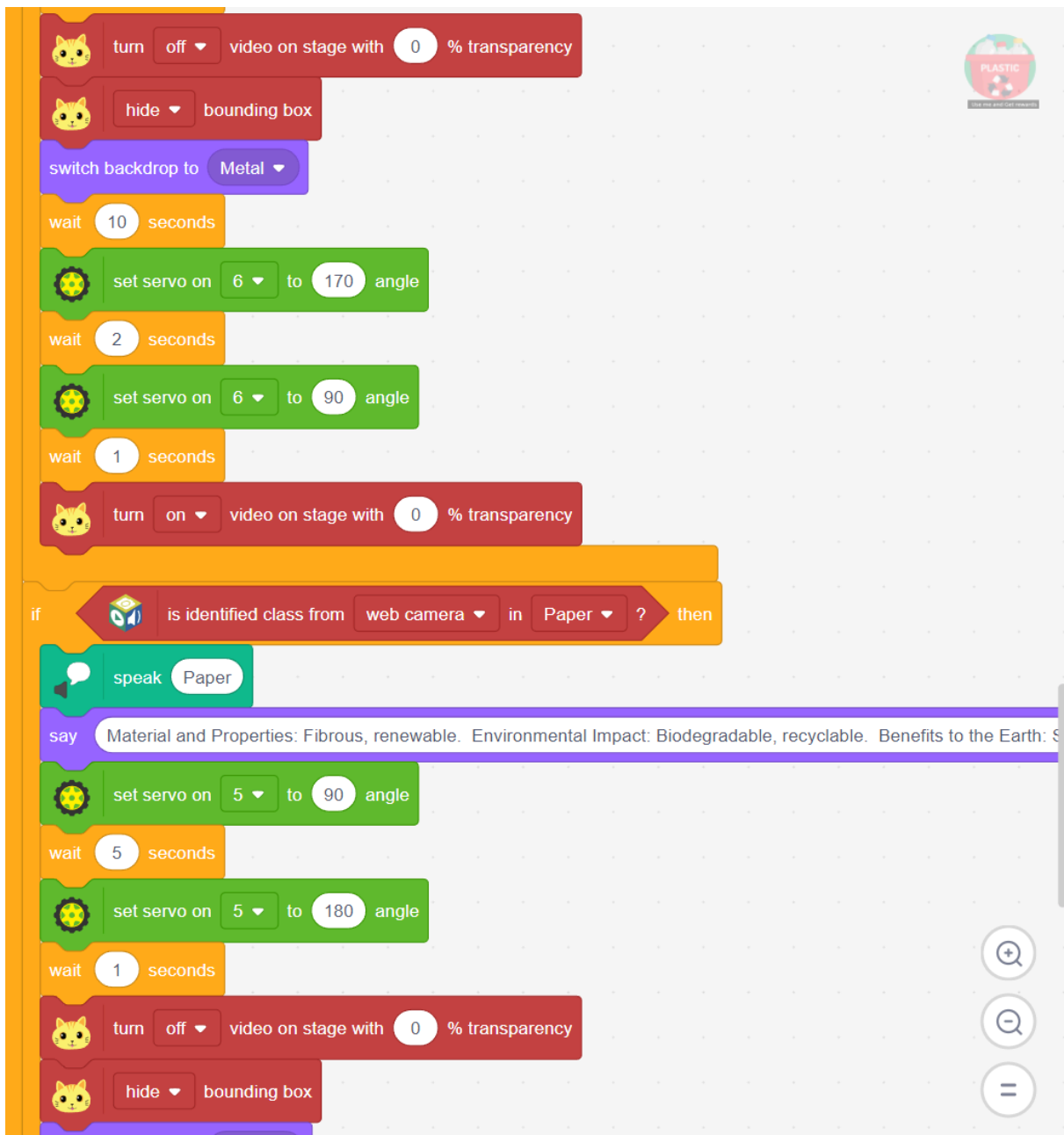
This Scratch script is designed to present information about plastic and metal. It begins by turning off a video on stage with 0% transparency and hiding the bounding box. The backdrop is switched to 'Degradable plastic'. A 10-second wait follows, then servo 6 is set to 30 degrees and waits 2 seconds, then set to 90 degrees and waits 1 second. A video is then turned on with 0% transparency. An if-condition checks if the 'web camera' is identified as 'Metal'. If true, it speaks 'Metal', says 'Material and Properties: Strong, durable. Environmental Impact: Recyclable, non-biodegradable. Benefits to the Earth: f', sets servo 5 to 90 degrees (5-second wait), then to 180 degrees (1-second wait), turns off the video, and hides the bounding box. The script ends with a switch backdrop block.

```
turn off video on stage with 0 % transparency
hide bounding box
switch backdrop to Degradable 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 web camera is identified class from Metal ? then
  speak Metal
  say Material and Properties: Strong, durable. Environmental Impact: Recyclable, non-biodegradable. Benefits to the Earth: f
  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
switch backdrop to
```

PLASTIC

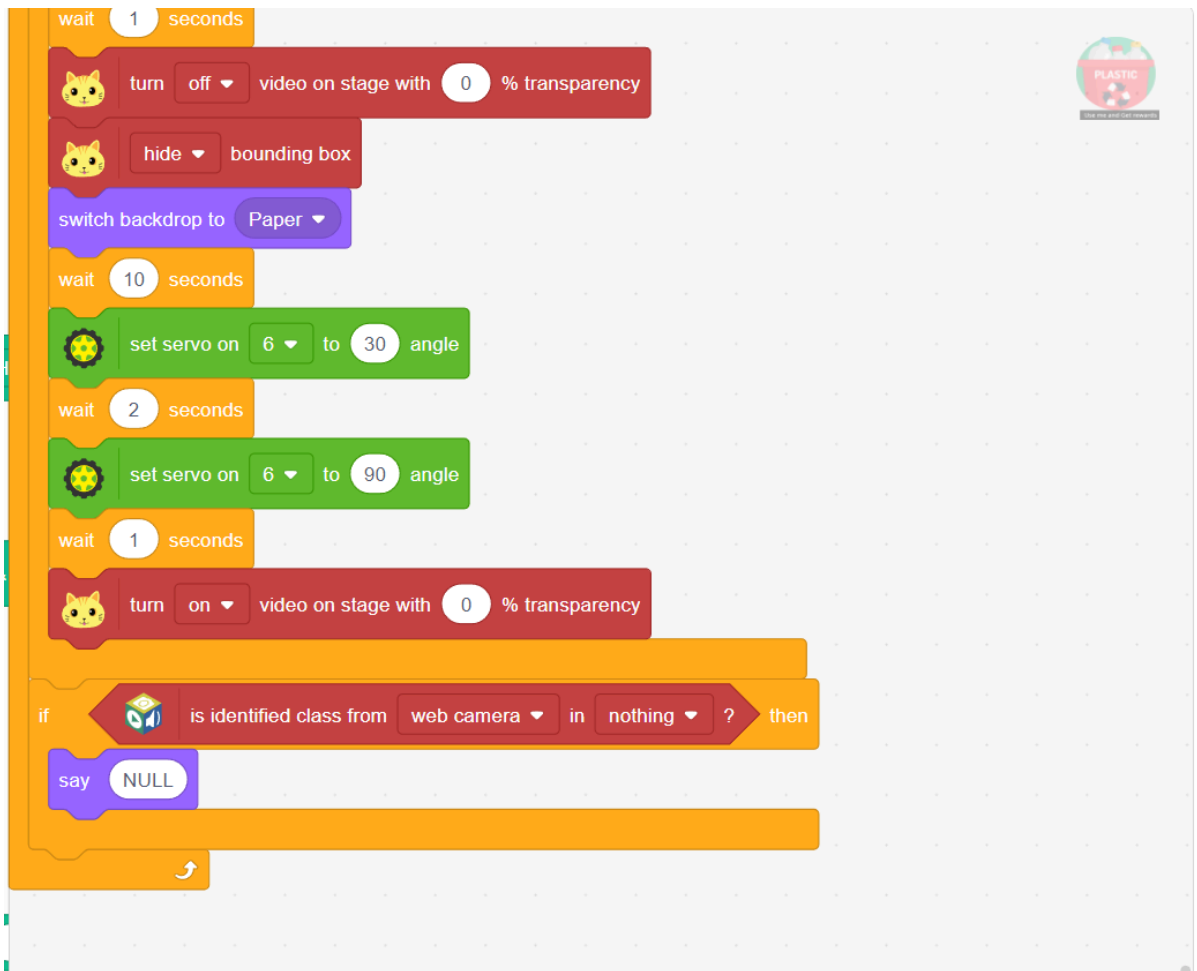
say: Material and Properties: Strong, durable. Environmental Impact: Recyclable, non-biodegradable. Benefits to the Earth: f



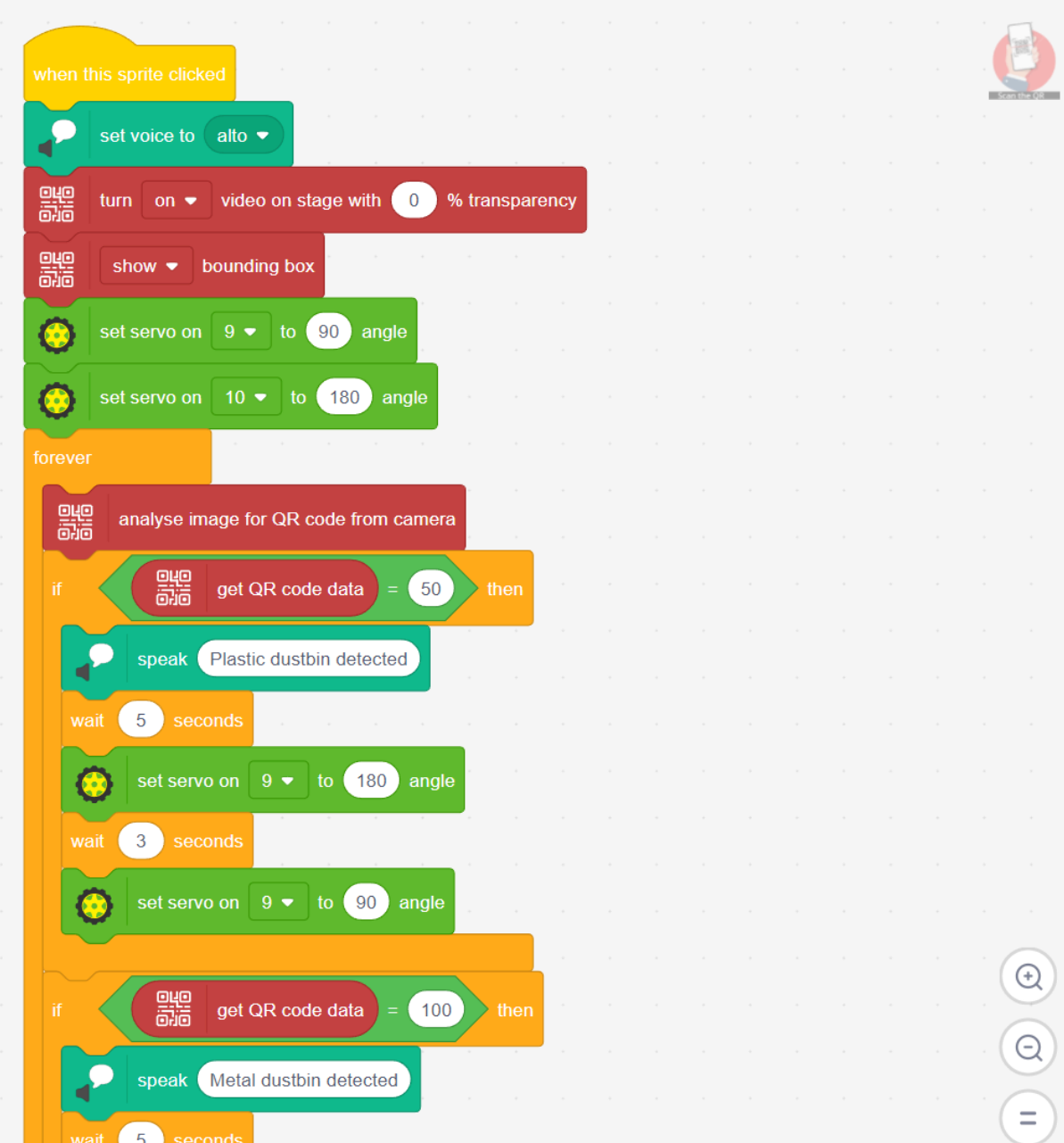


This Scratch script is designed to present information about Paper. It begins by turning off a video on stage with 0% transparency, hiding a bounding box, and switching the backdrop to 'Metal'. After a 10-second wait, it sets servo 6 to 170 degrees, waits 2 seconds, sets servo 6 to 90 degrees, and waits 1 second. It then turns on the video on stage with 0% transparency. An 'if' block checks if the class 'Paper' is identified from the web camera. If true, it triggers a sequence: a 'speak' block for 'Paper', a 'say' block with the text 'Material and Properties: Fibrous, renewable. Environmental Impact: Biodegradable, recyclable. Benefits to the Earth: S', servo 5 moving to 90 degrees, a 5-second wait, servo 5 moving to 180 degrees, a 1-second wait, turning off the video on stage with 0% transparency, and finally hiding the bounding box. The script is set against a 'Metal' backdrop. A 'PLASTIC' logo is visible in the top right corner, and navigation icons (zoom in, zoom out, reset) are in the bottom right corner.

```
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: S
  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
```

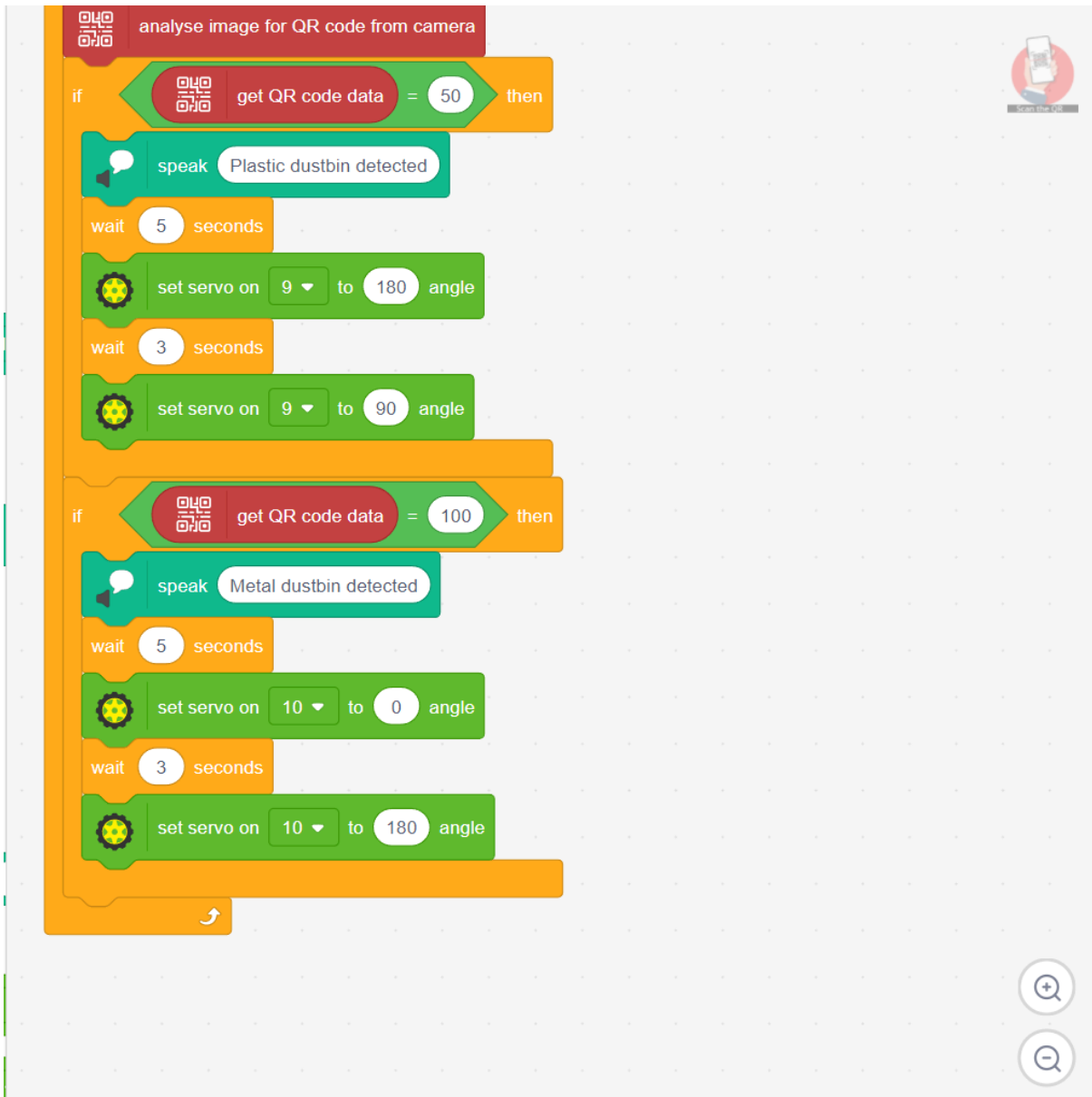


## Trash Navigator

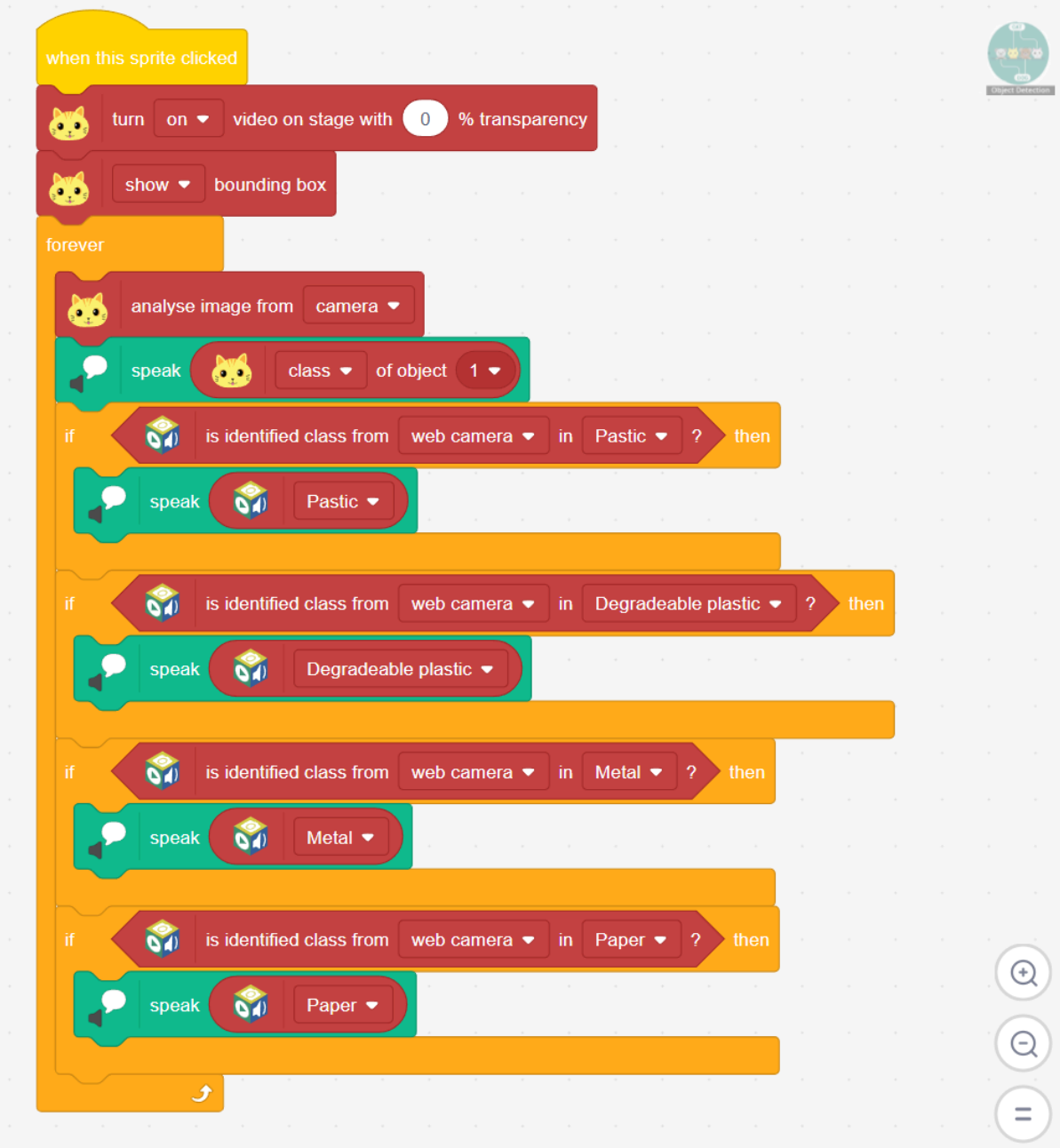


The image shows a Scratch script for a project titled "Trash Navigator". The script is set against a light gray grid background. It begins with a yellow "when this sprite clicked" block. This is followed by a green "set voice to" block with "alto" selected. Then, a red "turn on" block is used to turn on the "video on stage" with 0% transparency. Next, a red "show" block is used to show the "bounding box". Two green "set servo on" blocks follow: the first sets servo 9 to 90 degrees, and the second sets servo 10 to 180 degrees. An orange "forever" loop block contains the main logic. Inside the loop, a red "analyse image for QR code from camera" block is used. This is followed by an "if" block that checks if the "get QR code data" is equal to 50. If true, a green "speak" block says "Plastic dustbin detected", followed by an orange "wait" block for 5 seconds. Then, a green "set servo on" block sets servo 9 to 180 degrees, followed by an orange "wait" block for 3 seconds, and another green "set servo on" block sets servo 9 back to 90 degrees. After the first "if" block, there is another "if" block that checks if the "get QR code data" is equal to 100. If true, a green "speak" block says "Metal dustbin detected", followed by an orange "wait" block for 5 seconds. In the top right corner, there is a small red circular icon with a white smartphone and the text "Scan the QR". In the bottom right corner, there are three circular icons: a magnifying glass with a plus sign, a magnifying glass with a minus sign, and an equals sign.

```
when this sprite clicked
  set voice to alto
  turn on video on stage with 0 % transparency
  show bounding box
  set servo on 9 to 90 angle
  set servo on 10 to 180 angle
  forever
    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
```



## EcoEducator



The image shows a Scratch script for an application called "EcoEducator". The script is designed to respond to a click on a sprite and then enter a continuous loop to analyze images from a web camera. The script includes the following blocks:

- when this sprite clicked** (yellow block):
  - turn on video on stage with 0 % transparency** (red block): Turns on the video on stage with 0% transparency.
  - show bounding box** (red block): Shows the bounding box of the object.
- forever** (orange loop block):
  - analyse image from camera** (red block): Analyzes the image from the camera.
  - speak class of object 1** (green block): Speaks the class of the object (1).
  - if is identified class from web camera in Pastic ? then** (red block): Checks if the identified class from the web camera is "Pastic".
  - speak Pastic** (green block): Speaks "Pastic" if the condition is true.
  - if is identified class from web camera in Degradeable plastic ? then** (red block): Checks if the identified class from the web camera is "Degradeable plastic".
  - speak Degradeable plastic** (green block): Speaks "Degradeable plastic" if the condition is true.
  - if is identified class from web camera in Metal ? then** (red block): Checks if the identified class from the web camera is "Metal".
  - speak Metal** (green block): Speaks "Metal" if the condition is true.
  - if is identified class from web camera in Paper ? then** (red block): Checks if the identified class from the web camera is "Paper".
  - speak Paper** (green block): Speaks "Paper" if the condition is true.

The script is set against a light gray grid background. In the top right corner, there is a small circular icon with a camera and the text "Object Detection". In the bottom right corner, there are three circular icons: a magnifying glass, a speech bubble, and an equals sign.