# Final Design

## App

The following images represent the final design and are referenced in the following sections for element descriptions and verification.

|  |  |  |  |
| --- | --- | --- | --- |
| Icon  Description automatically generated  (a) Welcome page | Graphical user interface  Description automatically generated  (b) BT device info | Icon  Description automatically generated  (c) BT connection pending | Icon  Description automatically generated  (d) BT connection successful |
| Icon  Description automatically generated  (e) BT connection failed | Graphical user interface, text, application, chat or text message  Description automatically generated  (f) Default mode home screen | Graphical user interface, text, application, chat or text message  Description automatically generated  (g) Training mode home screen | Text  Description automatically generated  (h) Info mode |
| Icon  Description automatically generated  (i) Retrieving results | Icon  Description automatically generated  (j) Default mode result | Icon  Description automatically generated  (k) Training mode question | Graphical user interface, application, icon  Description automatically generated  (l) Training mode correction |
| Icon  Description automatically generated  (m) View scan results | A screenshot of a red phone  Description automatically generated with low confidence  (n) Accuracy warning |  |  |

**Figure 1: AmIGarbage User Interface App Screens**

## Data Storage

**Table 1: Sample Data File Stored on Jetson NANO Available for Parsing and Sending to App**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **wasteType** | **totalScans** | **incorrect** | **totalIncorrect** | **glass** | **totalGlass** | **incorrectGlass** |
| [string] | [int] | [boolean] | [int] | [boolean] | [int] | [int] |

The following are descriptions of each data type:

**wasteType** – a string of either “plastic”, “paper”, “glass”, “metal”, or “garbage”

**totalScans –** an int of total scans since shipping or most recent software update

**incorrect** – a Boolean of weather the scan was accurate. Only overwritten in training mode

**totalIncorrect** – an int of the total number of incorrect scans. Only overwritten in training mode

**glass** – a Boolean of weather the scan was *first* identified as glass. Only overwritten during scan

**totalGlass** – an int of the total number of scans identified as glass

**incorrectGlass** – an int of the total number of scans misidentified as glass

# Constraint – Must be at least 80% accurate at sorting waste + Must be at most 10% inaccurate at sorting Styrofoam and glass when shipped

From the controls testing, the system is at the following verified accuracies for sorting:

**Table 4: Accuracy of All Waste Types from Controls Testing**

|  |  |
| --- | --- |
| **Waste Type** | **Accuracy (%)** |
| Paper |  |
| Plastic |  |
| Metal |  |
| Glass |  |
| Garbage |  |
| *Average* |  |

The average shipped safety accuracy is therefore expected to be 95%, and the inaccuracy of distinguishing glass vs Styrofoam is 5%.

To maintain these accuracies, users can use *Training Mode* in the app. The following logic is tested and is used in *Training Mode*. To measure the current accuracy, the following equations are used:

# Constraint – Must Identify + Sort at Least 6 Items / Minute

Since the total time maximally takes 2 seconds, and provides for a safety factor of approximately 5, this criterion is met.

# Constraint – Must have an Assembled Size of less than 0.05m^3

This constraint is not applicable to software.

# Constraint - Meets Canadian Safety Standards

In order to meet Canadian safety standards for the user interface, all accessibility requirements and recommendations outlined by the Apple Developer community were met for the development of the iPhone SE compatible app (ios 14.4.1). The following is a summary of the 14 accessibility requirements and recommendations, along with verification that they were met.

## All controls and interactive elements have a hit target of at least 44x44 pt [1].

**Table 5: Interactive Element Sizes in AmIGarbage? App**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Image** | **Width [pt]** | **Height [pt]** | **Location** |
| Navigation button | A picture containing text  Description automatically generated | 251 | 51 | a,b,d,e,j,l,n |
| Text bar | Shape, rectangle  Description automatically generated | 250 | 44 | b |
| Main action button | A close-up of a logo  Description automatically generated with medium confidence | 247 | 114 | f,g |
| Tab button | A picture containing player, light  Description automatically generated | 59 | 52 | f,g,h |
| Confirmation button | A picture containing text, clipart  Description automatically generated | 112 | 51 | k |

## Don’t override the platform gestures [1].

The only gestures used in the *AmIGarbage?* app are tap and slider gestures.

## Use simple gestures for interaction [1].

The only gestures used in the *AmIGarbage?* app are tap and slider gestures.

## Use system-define haptics [1].

**Table 7: Haptics in Used in AmIGarbage? App**

|  |  |  |  |
| --- | --- | --- | --- |
| **Haptic Category** | **Class** | **Haptic Type** | **User / App Action** |
| **Notification** | [UIImpactFeedbackGenerator](https://developer.apple.com/documentation/uikit/uiimpactfeedbackgenerator) | Success | Bluetooth paired properly. |
| Failure | Bluetooth connection failed. |
| Warning | Training mode accuracy drops below 80%. |
| Impact | [UINotificationFeedbackGenerator](https://developer.apple.com/documentation/uikit/uinotificationfeedbackgenerator) | Medium | Scan result comes into view. |
| Selection | [UISelectionFeedbackGenerator](https://developer.apple.com/documentation/uikit/uinotificationfeedbackgenerator) | Selection | User chooses appropriate waste category in training mode. |
| Selection | User chooses weather scan was accurate in training mode |

## Use a consistent style hierarchy to communicate the relative importance of buttons [1].

## All buttons in the *AmIGarbage?* app have the following structure:

Navigation buttons all same size and location.

Scan and Results button same size in center of page.

Secondary tab buttons are bottom and lighter colour.

## Use typical navigation frameworks [1].

Experience-driven navigation style is used for Bluetooth setup. A flat / hierarchical hybrid navigation style is used for main functionalities.

Diagram

Description automatically generated

**Figure 4: Experience-Driven Navigation Style of Bluetooth Connection Setup for First-Time Users**

Diagram

Description automatically generated

**Figure 5: Hyrbid Hierarchical and Flat Navigation of Main Functionalities of AmIGarbage? App**

## Ensure that the ios ‘VoiceOver’ functionality allows users to navigate to every element [1].

See the example below for a code snippet of accessible elements.



**Figure 6: Example of Accessibility Tags for IOS**

A description of all elements, tags, and corresponding descriptions are documented in the table below. Note that the page locations refer to Figure 1.

**Table 8: Element Tags and Role Description for Accessible Voice Over Use**

|  |  |  |  |
| --- | --- | --- | --- |
| **Element** | **Label** | **Role Description** | **Page Location** |
| App Name | Title | The name of the app, AmIGarbage? | a |
| Logo | Logo | A green recycling triangle with a gear, a camera, and a PCB. |
| Get started button | Button | Press to get started. |
| Page progress indicator | Page Progress | Shows the progress of setting of initial Bluetooth setup. 1/3 pages complete. |
| Bluetooth instructions | Text | Please enter the name of your Jetson NANO device. | b |
| Bluetooth name input | User Input Text | Type Bluetooth name here. |
| Confirm button | Button | Confirm and attempt to connect Bluetooth. |
| Page progress indicator | Page Progress | Shows the progress of setting of initial Bluetooth setup. 2/3 pages complete. |
| Bluetooth status text | Text | Attempting to connect via Bluetooth. | c |
| Progress circle | Process Progress | Bluetooth connection trying to be established. |
| Bluetooth status text | Text | Bluetooth connection successful. | d |
| Green check image | Image | Green check indicating Bluetooth connection is successful. |
| Continue button | Button | Press to continue to main part of the app. |
| Bluetooth status text | Text | Bluetooth connection failed. | e |
| Red X image | Image | Red x indicating Bluetooth connection has failed. |
| Try again button | Button | Press to try to connect to Bluetooth again. |
| View scan button | Button | Press to view scan result. | f,g,h |
| Default mode button | Button | Default mode button in tab bar. Press to enter non-feedback mode. |
| Training mode button | Button | Training mode button in tab bar. Press to enter feedback mode. |
| Info mode button | Button | Info mode button in tab bar. Press to show app instructions. |
| View stats button | Button | Press to view scan results history. | g |
| App instructions | Text | How to scan: Place one item of waste into machine. Press view scan and wait for results. Default mode: Users can scan waste and view the results. Training mode: Users can scan waste and view the results. They can also give feedback on whether the scan was correct. | h |
| Retrieving result text | Text | Retrieving result. | i |
| Progress circle | Process Progress | Trying to retrieve result. |
| Result certainty text | Text | I am [x]% certain that the item was: | j,k,m |
| Result icon | Image | [paper]. The scan result is [paper]. |
| Continue button | Button | Press to continue back to the home page. | j,l,m |
| Did I get it right text | Text | Did I get it right? | k |
| Yes button | Button | Yes. Press if the scan result was correct. |
| No button | Button | No. Press if the scan result was incorrect. |
| What was the item text | Text | What was the item supposed to be? | l |
| Waste type icon | Image | A picture of [paper]. |
| Waste type toggle | Toggle | Toggle if the item was supposed to be [paper]. |
| Accuracy warning text | Text | The accuracy of the system is below 80%. We recommend you install a software update to your Jetson NANO. | n |
| Ok button | Button | Press to continue to homescreen. |

## Use dynamic type such that the app layout is adaptable to all font sizes, avoid full text justification, and use regular or heavy font weights in your app [1].

All font is typed at least at 14 point was per WACG 2.0 requirements. All headings had bold. All other text have regular; both comply with the contrast ratio regulations. The table below details all locations of text and their size, justification and font weight. Note the page location refers to the image from Figure 1.

**Table 9: Text Size, Justification and Weight**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Size** | **Justification** | **Weight** | **Page Location** |
| App Name | 32 | Left | Bold | a |
| Get started button | 28 | Left | Regular |
| Bluetooth instructions | 28 | Left | Regular | b |
| Bluetooth name input | 20 | Left | Regular |
| Confirm button | 28 | Left | Regular |
| Bluetooth connection text | 28 | Left | Regular | c |
| Bluetooth succeeded | 28 | Left | Regular | d |
| Continue button | 28 | Left | Regular |
| Bluetooth failed | 28 | Left | Regular | e |
| Try again button | 28 | Left | Regular |
| View scan button | 44 | Left | Bold | f,g,h |
| Default mode button | 18 | Left | Regular |
| Training mode button | 18 | Left | Regular |
| Info mode button | 18 | Left | Regular |
| View stats button | 44 | Left | Bold | g |
| App instructions | 20 | Left | Regular | h |
| Retrieving result text | 28 | Left | Regular | i |
| Result certainty text | 28 | Left | Regular | j,k,m |
| Continue button | 28 | Left | Regular | j,l,m |
| Did I get it right text | 28 | Left | Regular | k |
| Yes button | 28 | Left | Regular |
| No button | 28 | Left | Regular |
| What was the item text | 28 | Left | Regular | l |
| Accuracy warning text | 28 | Left | Regular | n |
| Ok button | 28 | Left | Regular |

## Prefer system colours for text, and respond correctly to inverse colours [1].

All colours in the *AmIGarbage?* app are characterized in the table below.

**Table 10: Colours Used in App and Corresponding Hex Codes and Relative Luminance**

|  |  |  |
| --- | --- | --- |
| **Colour** | **Hex Code** | **Luminance** |
| Blue | 0079CE | 0.28278336145840 |
| Grey | D9D9D9 | 0.36291794320712 |
| Green | 1D8400 | 0.18265721405286 |
| Red | DF2D31 | 0.65687527738189 |
| Purple | B400FF | 0.08651636397971 |
| White | FFFFFF | 1.00000000000000 |
| Black | 000000 | 0.00000000000000 |
| Light red | C04945 | 0.21635292201714 |
| Light green | A5FF9E | 0.72652881702560 |

WACG 2.0 requirements require at minimum 4.5:1 ratio for any text less that 18pt, and 3:1 for all other text or foreground/background. All colour schemes in the app meet this criteria and are summarized in the table below.

**Table 11: Contrast Ratios for all Colours in App**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Feature Example** | **18pt** | **Colour 1** | **Colour 2** | **Contrast Ratio** |
| Text  Description automatically generated with low confidence  White and blue | Yes | FFFFFF | 0079CE | 4.53:1 |
| A picture containing text, sign  Description automatically generated  White and green | Yes | FFFFFF | 1D8400 | 4.82:1 |
| White and purple | Yes | FFFFFF | B400FF | 4.78:1 |
| A red and white logo  Description automatically generated with low confidence  White and red | Yes | FFFFFF | DF2D31 | 4.60:1 |
| Text  Description automatically generated  Black and grey | Yes | 000000 | D9D9D9 | 14.87:1 |
| Icon  Description automatically generated  Light green and blue | No | A5FF9E | 0079CE | 3.76:1 |
| Graphical user interface, text, application, chat or text message  Description automatically generated with medium confidence  White and dark grey | No | FFFFFF | 949494 | 3.03:1 |
| Text  Description automatically generated  White and light red | Yes | FFFFFF | C04945 | 4.90:1 |
| Purple and grey | No | B400FF | D9D9D9 | 3.39:1 |

# Constraint – All parts must be available within Canada

All software is available internationally, since it is posted to GitHub. The Bluetooth adapter is available to ship to Canada on Amazon.ca.

# Constraint – Must accept items of up to 0.03m^3 \*\*\*\*\*????

Not applicable to software.

# Constraint – Must fit standard size garbage bin / recycling bin

Not applicable to software.