# Introduction

Alternative input options for computers and gaming consoles for people with physical disabilities are limited and cost prohibitive. The Ivy joystick is intended to be an open source, cost-effective, customizable joystick for people with limited gross motor control and limited dexterity.

# Problem Definition

## Who

Who will be using the device?

* The Ivy Joystick is intended to be used by people with physical disabilities who have limited gross motor control and limited dexterity.
* The Ivy Joystick may be useful for people with muscular dystrophy, cerebral palsy, and other conditions that lead to limited gross motor control and limited dexterity.

Who will be affected by the device?

* The Ivy Joystick will impact the primary user, as well as their family, friends, and caregivers.

## What

What must the device do?

* The Ivy Joystick must convert small physical movements generated by the user into joystick and mouse inputs.
* The IVY Joystick must NOT be used for mobility control.

What needs must the device serve?

* The Ivy Joystick must be compatible with Windows, and gaming platforms XBOX, Playstation, and Nintendo.
* The Ivy Joystick must be cost-effective.
* The Ivy Joystick must be wearable.

## Why

Why will the device be used?

* The Ivy Joystick is used to provide access to computers and game consoles for people who are unable to use standard input devices such as mice, joysticks, and gaming controllers.

## Where

Where will the device be used?

* The Ivy Joystick is intended to be used in an indoor setting.
* The Ivy Joystick may be used in a home or clinical setting.

## When

When will the device be used?

* The Ivy Joystick is intended to be used at all times of the day.
* The Ivy Joystick may be used for extended periods (e.g., 5+ hours)

# Functional Properties

## Goals

|  |  |
| --- | --- |
| G01 | Cost-effective |
| G02 | Optimized for low-volume builds (i.e., 1) |
| G03 | Open-Source Hardware |
| G04 | Requires minimal force to operate |
| G05 | Requires minimal range of motion to operate |
| G06 | Customizable |
| G07 | Multiple modular mounting options |
| G08 | Minimize mass |
| G09 | Minimize size |

## Functional Requirements

|  |  |
| --- | --- |
| F01 |  |
| F02 |  |
| F03 |  |

## Functional Requirements

The Ivy Joystick must have two integrated buttons.

The Ivy Joystick mu

The Ivy Joystick must be operable in a Mouse Mode and a Joystick Mode.

The joystick shall be designed to be used by either hand.

The joystick shall be designed to be used by either hand.

Mouse Mode Operation

Output cables must be detachable.

Output cables from the joystick shall have a minimum length of 1.5 m.

Output cables from the joystick shall have an appropriate cable strain relief.

Joystick designs must support multiple mounting styles (At a minimum: camera mount, hook and latch, tabletop)

The joystick design must consist of a variant with USB output and a variant with XAC-compatible analog output.

Joysticks must be PC compatible.

Joystick designs must denote up, down, left, and right directions.

The Ivy Joystick must compatible with the Microsoft Xbox Adaptive Controller.

Joysticks must be maker manufacturable. (i.e. made with common tools and materials and components can be purchased individually)

Joystick mechanism must be secure in the 3D printed case.

Sizing of joystick base and toppers are easily understood by users. Measuring options are included.

Calibration and maintenance of the device will be incorporated in the design and communicated for users

The joystick will be designed to have no sharp edges that would harm users. Design must be printed with greater than .02 resolution for users comfort.

Design must incorporate a status LED to indicate connection or feedback to user. Haptic feedback viability will be evaluated at a later time.

Overall mass of the joystick device must fall between XX-XX

Overall size of the joystick device must fall between XX-XX

The centering force of the joystick must not be significantly greater or less than the Adafruit Mini 2-axis Analog Thumbstick

Users must be able to interact with the customizable settings in the software of the joystick.

The joystick must remain stable when using this device it will stay in fixed position whether mounted or on table.

Joystick design must reduce possibilities for liquid damage to device by reducing openings to electronic components.

The joystick must be durable enough to survive a 5 ft drop test.

Topper designs shall consist of a minimum of a two different toppers.

- Topper styles are dependent on use case research

Joystick designs must support camera mounting styles

Joystick designs must support hook and loop fastener styles

Joystick designs must support the joystick being mounted on the table with no fasteners.

Joystick designs must support multiple mounting styles (At a minimum: camera mount, hook and latch, tabletop)

The joystick design must consist of a variant with USB output and a variant with XAC-compatible analog output.

The joystick should be able to be used at a minimum distance of 1.5 m away from the device.

The joystick shall be compatible with the Xbox Adaptive Controller.

The Ivy Joystick must have a visible marking that indicates the up direction of the joystick.

Design will have a topper system to allow easily interchangeable toppers

Topper shall be removeable without the use of tools.

The toppers shall not interfere with the regular function of the joystick.

Topper must have a secure connection that does not spin.

The joystick shall be designed to be used by either hand.

Design must incorporate a status LED to indicate connection or feedback to user. Haptic feedback viability will be evaluated at a later time.

Joystick must remain stable while in use.

Users must be able to interact with the customizable settings in the software of the joystick.

Joystick design must reduce possibilities of damage to electronic components of device by reducing openings to internal components.

The joystick must be durable enough to survive a 5 ft drop test.

Topper designs shall consist of a minimum of a two different toppers.

- Topper styles are dependent on use case research

Weight must result in the Joystick being stable when in usage. Weight between: [XX]

Device must not be used for mobility or medical device control

3D printed components shall be printable within a 180x180x180mm print volume.

The IVY Joystick must be based on a commercially available joystick component.

The Ivy Joystick must an USB HID compatible microcontroller.

The Ivy Joystick microcontroller must have at least 2 analog pins and 4 digital pins

### Operation

### Mounting

#### The Ivy Joystick designs must support camera mounting styles

#### Joystick designs must support hook and loop fastener styles

#### Joystick designs must support the joystick being mounted on the table with no fasteners.

### Output

### Toppers

### Compatibility

The Ivy Joystick must be compatible with a personal computer (PC).

### Design

* Ergonomic; no sharp edges
* Inform users how to turn the device on / off
* Inform users assembly orientation
* Text should be legible
* 3d printable on common, at home printers
* Design elements should adhere to expected operations (e.g. volume knob should turn left and right, not pull)
* Designs should be aesthetically pleasing

### Production

Parts shall be commercial off-the-shelf, 3D-printable, or

#### Customizable Elements

Where possible, design shall incorporate easily customisable elements.

Customizable elements shall be used to customize aesthetics, function, or both.

Customisations should be possible without the use of paid (commercial?) software

#### Procuring Parts

Parts should be available from multiple sources.

Parts should be available in low quantities (I.e., only comes in packs of 50)

The total number of different suppliers should be minimized to reduce shipping costs.

Fastener types should be minimised to reduce mix-up during assembly

Parts with small text to differentiate it from others should be minimized

Parts shouldn’t be country / region specific

#### Making Parts

* Parts should be makeable from commonly sourceable materials

(3D Printing)

(Custom PCB)

#### Assembly

* Designs should be assembled with tools that are commonly available (example)
* Assembly techniques should be safe for makers to build in an indoor space
* Assembly should not require high strength or torque
* Fit shouldn’t rely on tight tolerances

#### Testing

* Device testing should be non-destructive/not decrease the device lifespan
* Design should have clear instructions on how to handle a failed test

### Distribution

#### Shipping

Designs should be sturdy enough to ship.

Should note parts that are, or contain, dangerous goods

(Li-Ion Batteries are difficult to ship)

### Use

* Users should not expect a sterile device

#### Prepare Device

Designs should come with assembly instructions

#### Operate Device

Designs should come with an operations manual

Device shall not be used in safety critical applications.

Device shall not be used in

#### Finished Operating Device

* Should be safe for the user and disclaim any potential hazards (i.e., magnets)

### Support

Maintenance

* Devices should be maintainable by the user primarily

Cleaning

* Devices should be cleanable with supplies around the house

User Training

Repair

* All parts should be serviceable/replaceable within the completed device.

### Disposal

Designs shall have documentation that outlines how the device should be disposed.

#### Reuse Parts

Where possible, reusable parts should be removable.

#### Recycle Materials

Where possible, recyclable parts should be removable.

PLA = industrially compostable

#### Throw Away

### Semi-Horizontal

#### 3D Printing

3D printed components must be designed print on hobby-level FDM printers.

3D printed components must be printable on a maximum print bed size of 180 mm x 180 mm x 180 mm

* Where possible, PLA filament should be utilized.
* The use of ABS filament shall be avoided.
* The number of different types of filament should be minimized.
* Where possible, designs shall minimize the use of support material.
* Where support material is required, it should be minimized or optimized to facilitate easy removal.
* Designs should minimize the
* (Incorporate Design for 3D Printing)
  + Overhang
  + Unsupported hole
  + Minimum feature size
  + Usage of supports
* Raw 3d printed components shall not be used in a situation where food safety is a concern.
* 3D printed components shall not be used in situations where failure could lead to physical injury

#### Electronics

Elect

Device should use reasonably available parts

parts should be “maker friendly” through hole type where possible.

part count should be minimal to keep build times within limits, and limit chance for circuit mistakes.

Power usage

#### Custom Printed Circuit Boards

Custom printed circuit boards should not include trademark.

Inputs and outputs

### Software

Software should be written using standard coding practises.

Software shall be well documented.

Latency and refresh rate

Software needs to provide an interface method for end user to customize the software

Software should be written using modern and open programming language

Software must be modular and be customizable?

Software must be able to compile and run using free or open licence tools.

Libraries and third-party classes used in the software must be under open source or public usage licencing.

Program should be occasionally updated by the creator

#### Documentation

Documentation should be maintainable without the use of proprietary software.

Documentation must be available in a digital format.

Documentation must be printable.

Images must include alt-text

## Non-functional Requirement

Documentation should be maintainable without the use of proprietary software.

Documentation must be available in a digital format.

Documentation must be printable.

Parts must be easily sourced

Users must understand the different base and topper options and clearly be able to request the desired combination

Use of support material should be minimized

Number of different filament types should be minimized

All parts can be shipped in single quantities for makers

Design can be made with the tools found in the standard MMC build kits/common home tools

## Non-functional Requirement

|  |  |
| --- | --- |
|  | Cost |
|  |  |
|  |  |
| NF04 |  |
|  |  |

## Constraints

|  |  |
| --- | --- |
| C01 | (No medical devices) |
| C02 | The Ivy Joystick is not intended to control or operate safety critical devices. |
| C03 | (No safety critical devices) |

Joystick must be maker manufacturable. (i.e., made with common tools and materials and components can be purchased individually)