Adaptive H.I.D.

Viability Review of Low Cost, Libre Adaptive Human Interface Devices to Modern Computers

CPE 495-01

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Team Members

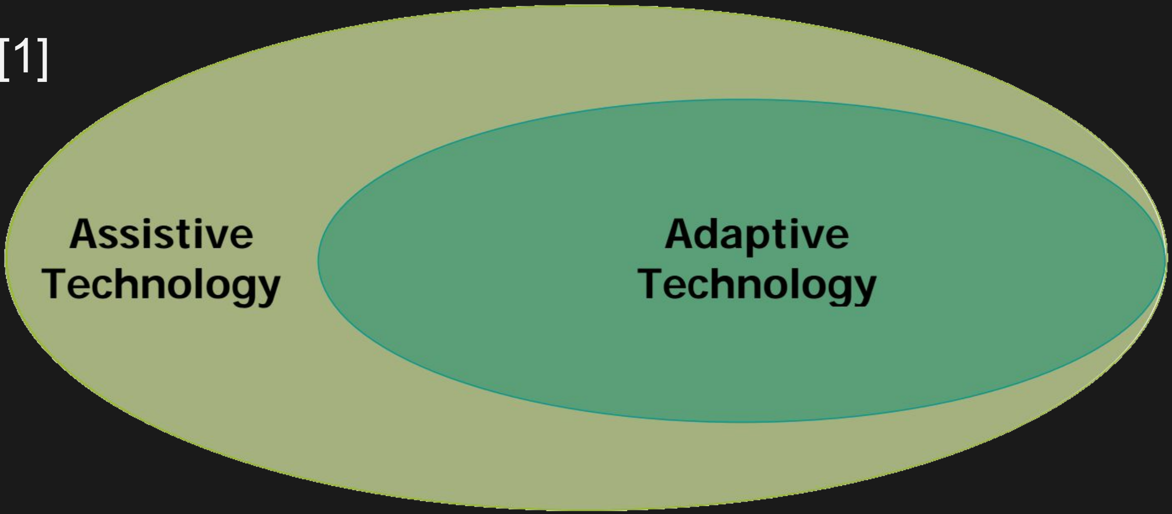
- Christopher Bero
  - Interested in Environmental Conservation
- Bryant Johnson
  - Interested in Cybersecurity
- Mike Baldwin
  - Interested in Software Development
- John Gould
  - Interested in Microcontrollers and Software Development

Team Members

- Christopher Bero
    - Hardware Lead, Community Outreach
- Bryant Johnson
    - Testing Lead, Technical Writer
- Mike Baldwin
    - Software Lead, Systems Interface
- John Gould
    - Systems Lead, Microcontrollers

Vocabulary

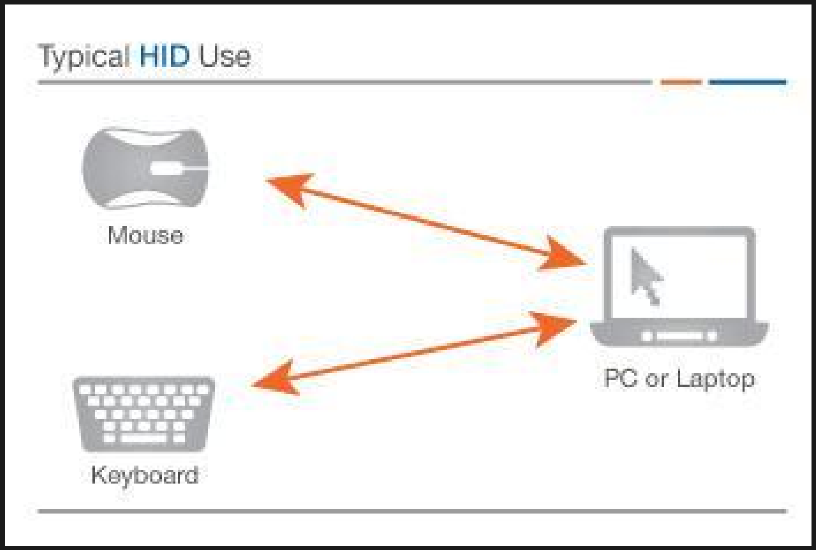
[1]

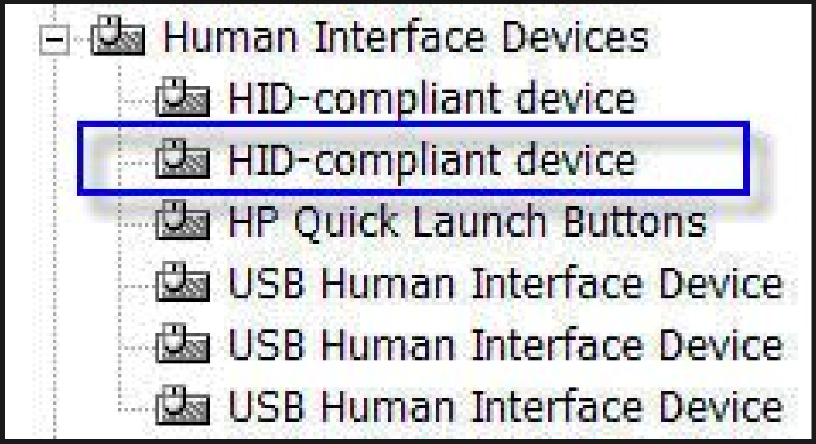


- Assistive Technology
  - Any item, equipment, or product that can be used to increase functional capabilities of persons with disabilities.
- Adaptive Technology/Systems (A.T.)
  - A device or component which is specifically designed for persons with disabilities.

Vocabulary

- Human Interface Device (H.I.D.)
    - A method by which a human interacts with an electronic information system either by input or output [1].
    - That thing that Windows XP could never recognize.





Existing A.T. Shortfalls

- Why Computers
  - In the United States alone:
    - 12 million visually impaired persons
    - 11.7 million physically disabled persons
  - These people perceive the format of books and paper as an obstruction to information access [1].
  - Computers offer access to this information and have allowances to implement highly customized interfaces.
  - Our generation consists of a voice that Internet access is a human right [2]. Unless it extends to *all* people, such discussion is farcical.

http://www.independentliving.org/docs6/mates2000.html#chapter1
http://foreignpolicy.com/2015/02/02/unrestricted-internet-access-human-rights-technology-constitution/

Existing A.T. Shortfalls

- Adaptability and Improvement
  - Due to high development costs and low volume market, adaptive technology tends to be less than.. adaptive.
  - Systems developed a decade ago were not targeted toward efficient flat panel monitors or high speed USB connections.
  - But they are still in use today, and either have no replacement or are prohibitively expensive to exchange.

Existing A.T. Shortfalls

- Expense
  - A.T. is currently prohibitively costly to obtain.
  - This is often attributed to the “niche market” and left to government programs and health insurance to offset [1].
  - Such reasoning leaves out persons without insurance and developers who wish to create software for these systems.
- In order for A.T. to reach as many people as effectively as possible, the cost must be brought down.

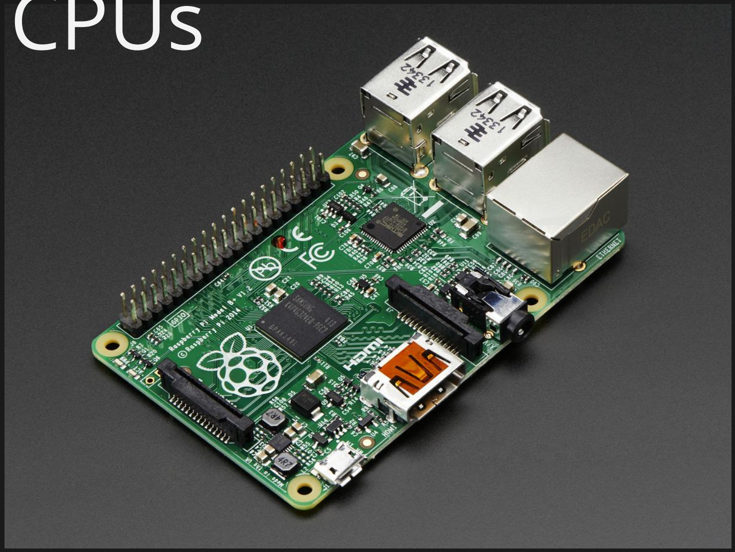
http://www.atia.org/i4a/pages/index.cfm?pageid=3859

Moving A.T. Forward

- The maker / hacker movement has brought widespread adoption of:
  - Capable, easy to use prototyping tools
  - Access to low volume manufacturing
- There should no longer be a barrier to providing modern, affordable interface systems to persons living with disabilities.

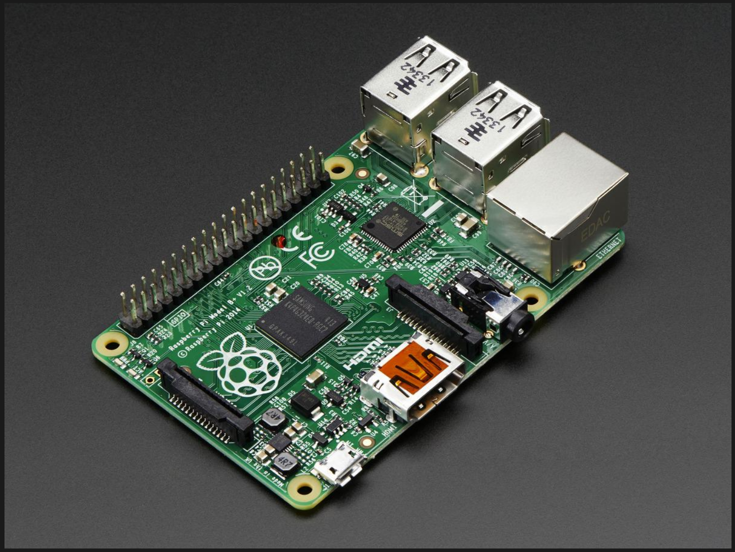
Why Do This?

- Consider with us the well known Raspberry Pi
  - What appeal does this device have over a standard PC?
    - PCs don't require GPIO
    - PCs have real BIOS
    - PCs have hard disks
    - PCs have high performance CPUs



Why Do This?

- Well
  - The RPi is CHEAP
  - It uses very little POWER
- This makes the RPi well suited for use in developing and impoverished regions
- So in the past decade we've seen an incredible shift in computing
  - Where does that leave A.T.?



Why Do This?

From the UNICEF World Report on Disability:

> “Manufacturing or assembling [AT] products locally, using local materials, can reduce cost and ensure that devices are suitable for the con-text.”

This is our basis of purpose.

http://www.unicef.org/protection/World_report_on_disability_eng.pdf

Marketing Requirements

- Open Source Design
  - Require only items available to common makerspaces
  - Easy to iterate and customize
  - Low cost requirements for parts and machinery
- Easy to Operate
  - Must provide as good or better functionality than existing solutions
- Reliable
  - Must accept improper input and have a robust mechanical design

Engineering Requirements

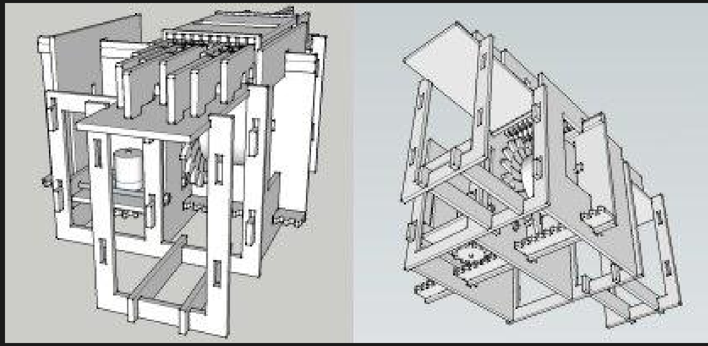
- Hardware bounce time during activation < 6ms
- 10 Million Cycle Lifetime
- Operation [1]
  - 30 Words Per Minute
  - 90% Typing Accuracy
- Operating Temperature: -10C – 70C
- Materials
  - Thermoplastics – Case, Mounts
  - Stainless Steel – Springs, Case
  - Gold Alloy – Switch Contacts

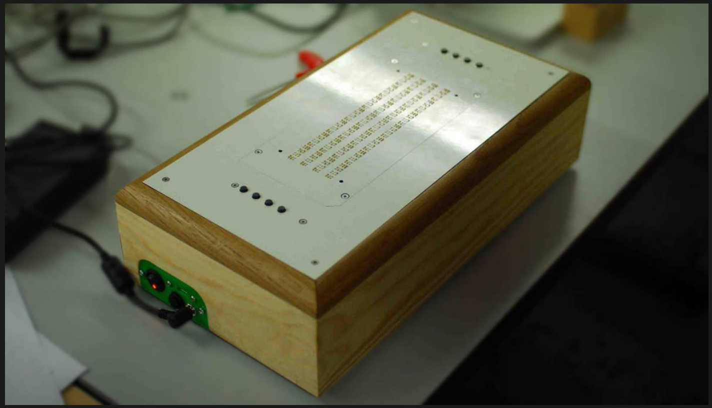
Existing Products

- Large Switch Keyboards
    - Less costly
    - Separate purpose
- Head/Mouth Stick Keyboards [1]
    - Very costly
    - Separate purpose
- Braille Embossed Keyboards [1]
    - Less efficient
- Keyless (orb) Keyboards [2]
    - Costly and proprietary

Existing Projects

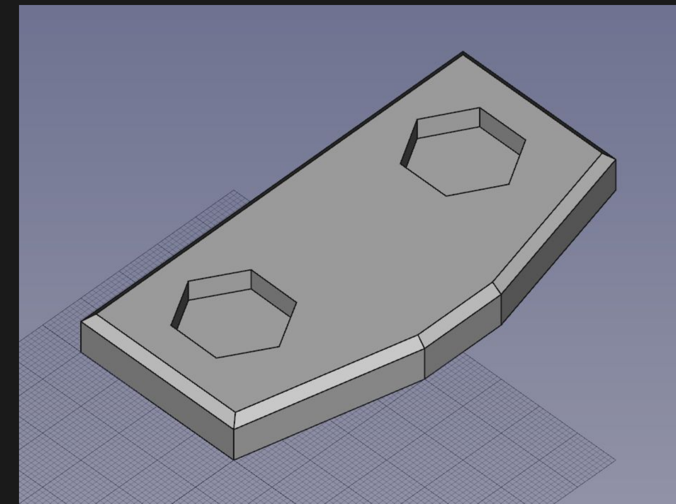
- “Audrey” Braille Display
  - Appears to be defunct since 2012
- Ferrofluid Braille Display
  - University project to create a braille display with electromagnets
- PandaBraille
  - University project to create a braille display with electrodes
- Canute
  - Open source software

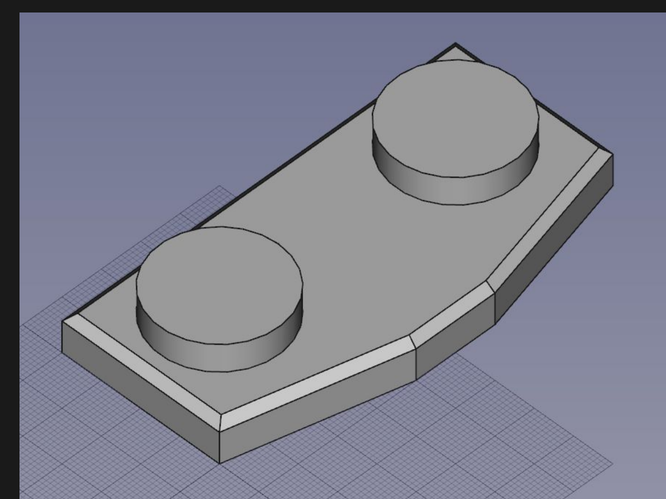




Proposed Systems

- Sliding Keyboard
  - Reduce the dexterity required for text input by utilizing two large control surfaces.
- Software Package
  - Improve the state of A.T. interface software for computers.
- Braille Keyboard
  - Lower the cost to obtain a braille keyboard by using consumer parts and equipment.
- Refreshable Braille Display
  - Lower the cost to obtain a braille display by using common robotics equipment.





Alternatives

- Sliding Keyboard
  - MSP430
  - ATmel
- Braille Input Keyboard
- Refreshable Braille Display
  - Sliding rows
  - Combinational gears
- Braille 8x11 Printer
  - Gantry
  - Deltabot
- Bluetooth Braille Phone Case

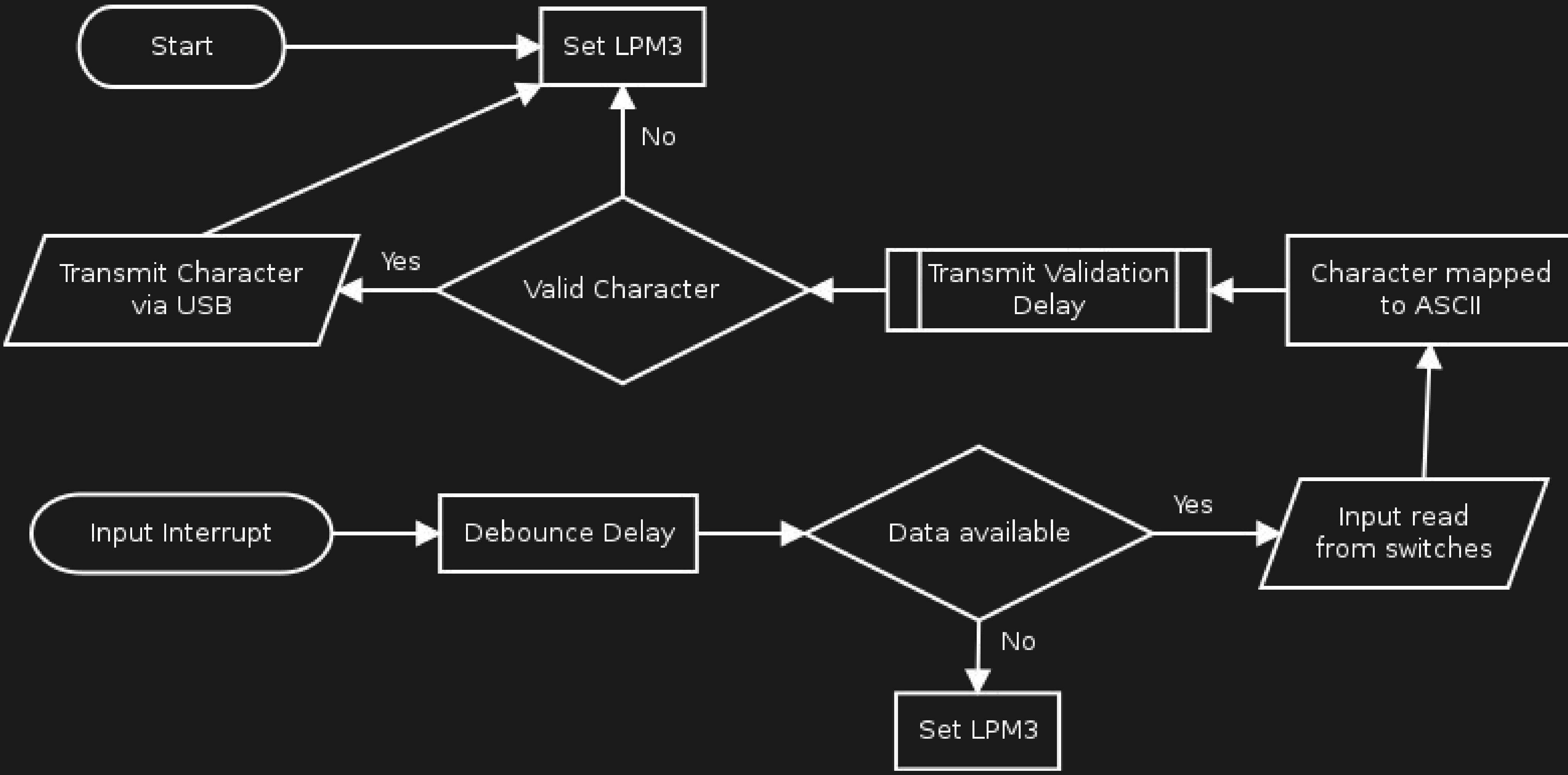
Proposed Approach

- Contact customer
- Triage Systems
- Design iteration w/ customer
- Go/No Go: Primary system hardware and software prototype
- Integration testing with customer
- Metrics for study collected
- Deliverables brought to customer

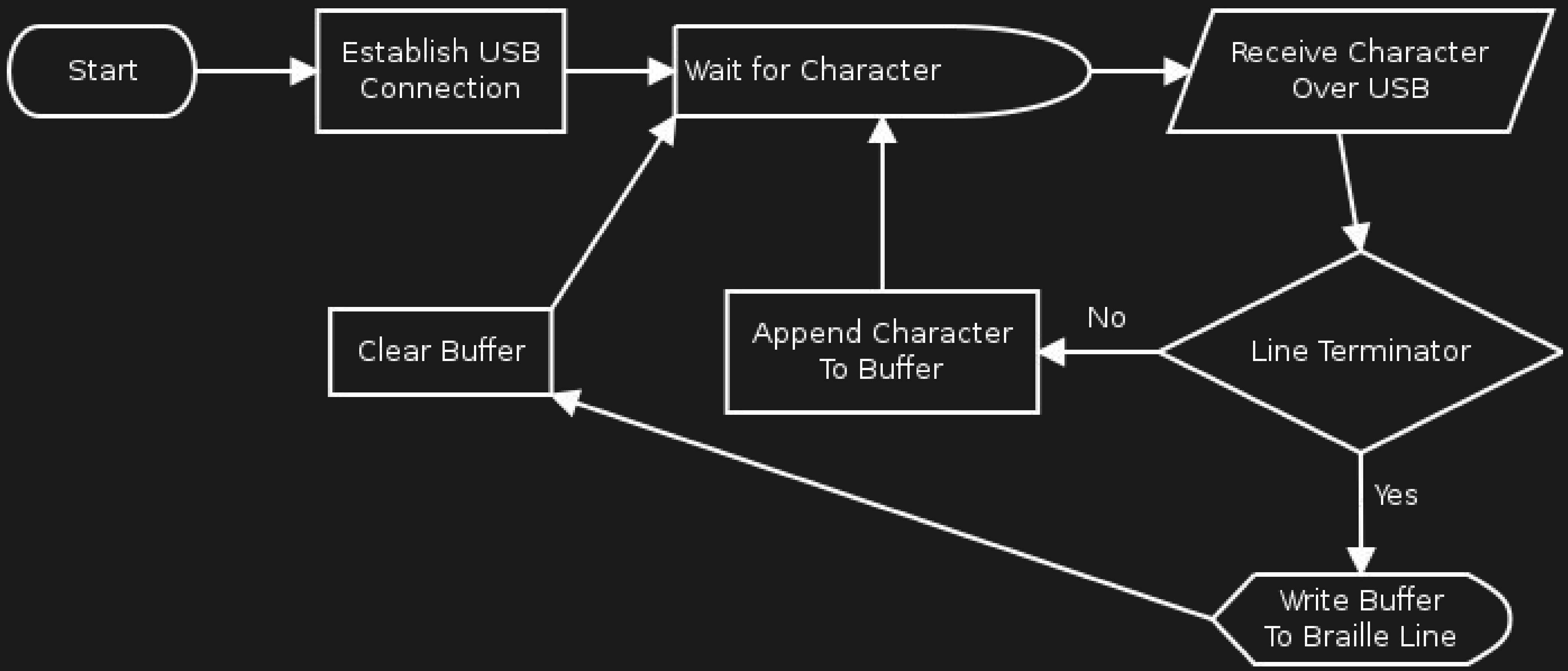
Project Summary

Our project is to research and design an adaptive interface device for modern computers. The device will have a focus on affordability, iterative design, and easy operation. Construct and test the device for viability in general use; then generate a case study on the effectiveness of this approach to bringing adaptive technology to a larger audience.

System Design Description



System Design Description



Testing

Primary testing will be dependent on the cooperation of outside organizations. We have already reached out to several organizations and are waiting on feedback.

Optimally we would like to allow several people from our target audience to try several of our prototypes so we can determine values such as words per minute and get feedback on the system for improvements.

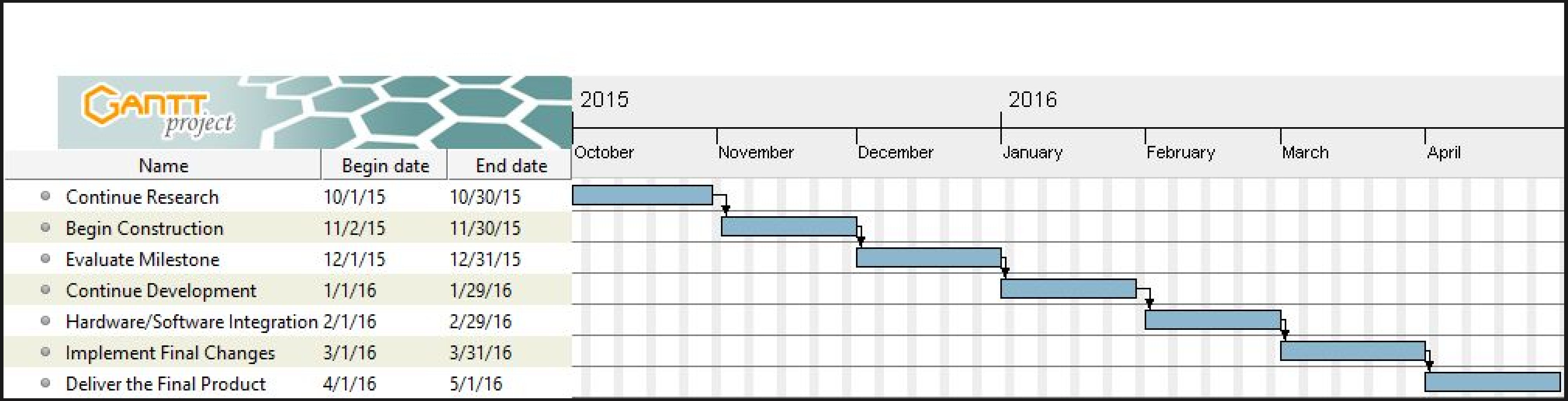
Testing

Testing will consist of qualitative and quantitative feedback from the user.

- Qualitative:
  - Ease of use, time required to learn.
  - Ergonomics, comfortable use.
- Quantitative:
  - Setup time for a new user.
  - Words per minute.
  - Daily use setup/boot time

Timeline

October – Continue Research and establish contact with our customer
November—Begin Construction for our prototype.
December—Evaluating Go/No Go milestone.
January—Continue the development of hardware/software systems.
February—Integration testing between the hardware and software
March—Implement final changes
April—Conduct a case study
May—Deliver the Final Product



Name	Begin date	End date
Continue Research	10/1/15	10/30/15
Begin Construction	11/2/15	11/30/15
Evaluate Milestone	12/1/15	12/31/15
Continue Development	1/1/16	1/29/16
Hardware/Software Integration	2/1/16	2/29/16
Implement Final Changes	3/1/16	3/31/16
Deliver the Final Product	4/1/16	5/1/16

Individual Responsibility

- Chris
  - Development of hardware, with a subtask of communicating with outside organizations.

- Mike
  - Developing the software.

- John
  - Interface between the hardware and software for each system we develop.

- Bryant
  - Testing and documenting both the hardware and the software.

Individual Responsibility

Contingency

The responsibility of the lost member will be divided among the remaining members for the rest of the course.

Cost Estimate

Supplies	Cost
Microcontrollers (2)	$37.94 - $200
Switches (25)	$37.50
Case (4)	$50.00 - $150
PCB (10)	$31.00 - $200
Total cost	$156.44 - $587.50

Course Deliverables

Detailed feedback on what approaches worked well and would be worth further investigation in future projects as well as what approaches were less than successful.

Working prototypes of input or output device for the handicapped.

A collection of software enhancing the prototypes from a simple I/O peripheral to a more useful tool.

Questions/Comments?