KANSAS STATE
College of Engineering

Braille eBook Reading Pad (BERP)

ECE 590 - Senior Design Project

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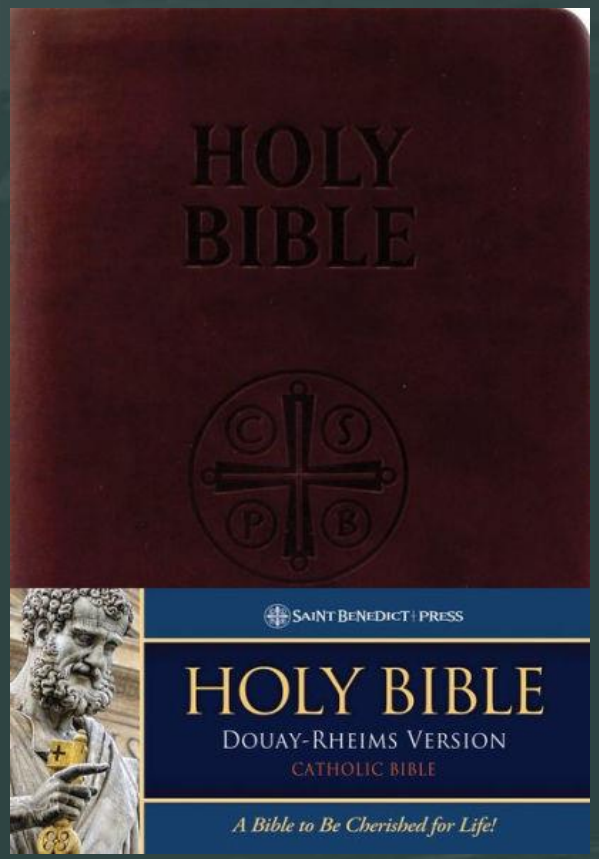
Delineation of Project

- Why
  - Problem
  - Need
- Current Solutions
  - Printers & Other Formats
  - Braille Keyboards
- Updated Concepts
  - Conceptual Designs
  - Our Design

Problem

- There is no current solution for the visually impaired to *inexpensively* transcribe physical media into Braille
- Current devices are not affordable

Problem



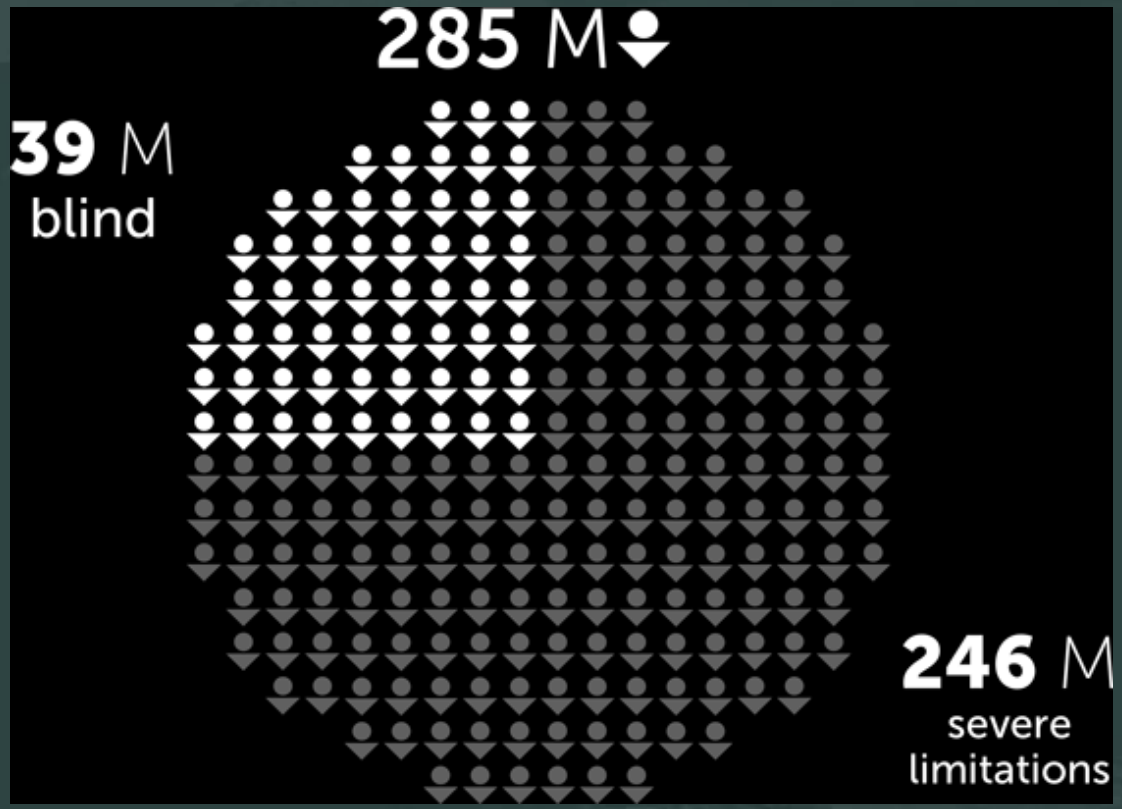
- **Less than 1% of all books** have been converted into Braille
- Transcribing printed material often costs $1 or more **per page**

For example: Douay-Rheims edition Bible

- .mp3 format: **$34.95**
- Hardcover: **$39.72**
- Braille: **$739.95**

Source: https://www.barnesandnoble.com/w/the-holy-bible-douay-rheims-version-d-r/1120582248?ean=9781935302025#/, https://www.amazon.com/Audio-Catholic-Bible-Douay-Rheims-Translation/dp/B00HS9OCDC, http://www.braillebookstore.com/Bibles

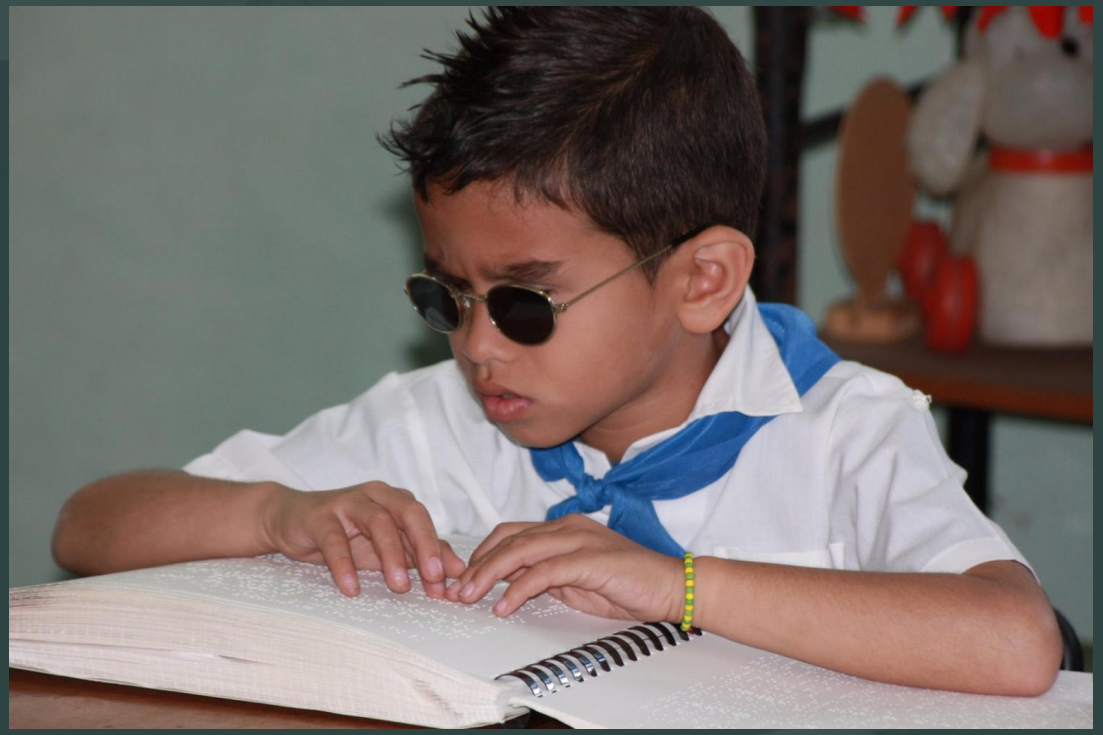
Need



- **285 Million** people worldwide are blind or visually impaired
- **7.3 Million** Americans are blind or visually impaired

Source: https://www.who.int/blindness/GLOBALDATAFINALforweb.pdf, https://nfb.org/blindness-statistics, http://www.feelipa.com/for-organizations/

Need



Worldwide Blind Academia

- **19 million** children, under 16, are visually impaired
- Audio readers and eBooks aren't capable of **teaching** by sense of touch
- Less than 10% of the visually impaired know how to read Braille

Source: https://www.knjigenadlanu.com/knjiga-za-slepe/

Need

- **At least 29%** of the visually impaired live below the poverty line, within America
- The only current technique of transcribing utilizes Braille printers and embossed paper, which can cost **$10,000 or more**
- This market obstacle greatly stifles the ability to learn
- Consumers need an affordable alternative

Source: https://www.who.int/blindness/GLOBALDATAFINALforweb.pdf, https://nfb.org/blindness-statistics, https://goo.gl/images/H4SBXf

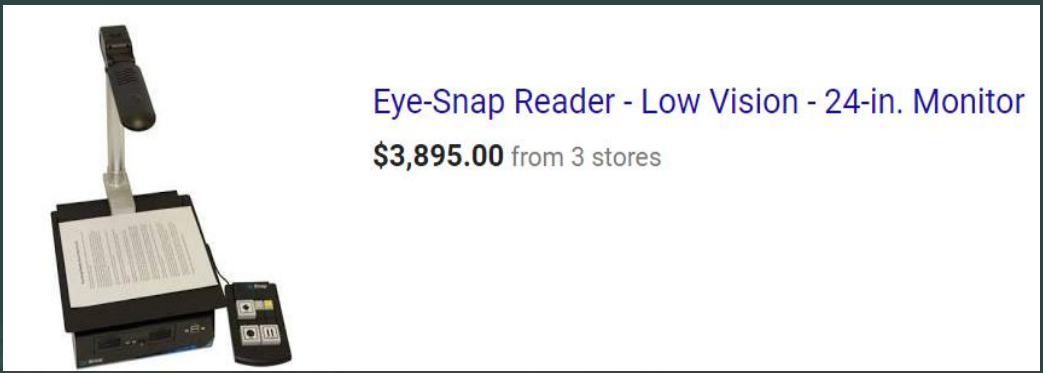
Current Braille Technology

- Braille embossing printers
- Text-to-audio readers
- Braille keyboards

These technologies do not provide high level productivity such as paper media or refreshable display screens do

Current Braille Technology

- Some products utilize a camera to convert text-based images into an audio format
  - These require headphones to maintain privacy
  - Can be difficult to operate for visually impaired



Source:
https://www.google.com/search?q=braille+embosser&safe=off&source=lnms&tbm=shop&sa=X&ved=0ahUKEwjt8L6-uMfaAhUCQ60KHdh1B_sQ_AUICigB&biw=1280&bih=653#spd=8977008341550794734

Sources:
https://store.humanware.com/hus/brailliant-bi-40-new-generation.html
http://file.scirp.org/Html/9-71493_31807.htm

Braille Keyboards

Current Braille Technology

HIMS Braille Sense U2 QWERTY

Document processor with 32 cells and QWERTY keyboard
Current price: **$4,595.00**

HIMS Braille EDGE 40

40 cell Braille display connects via computer or smartphone
Current price: **$2,495.00**

HIMS Smart Beetle Braille Display

14 cell Braille display connects via Bluetooth
Current price: **$995.00**

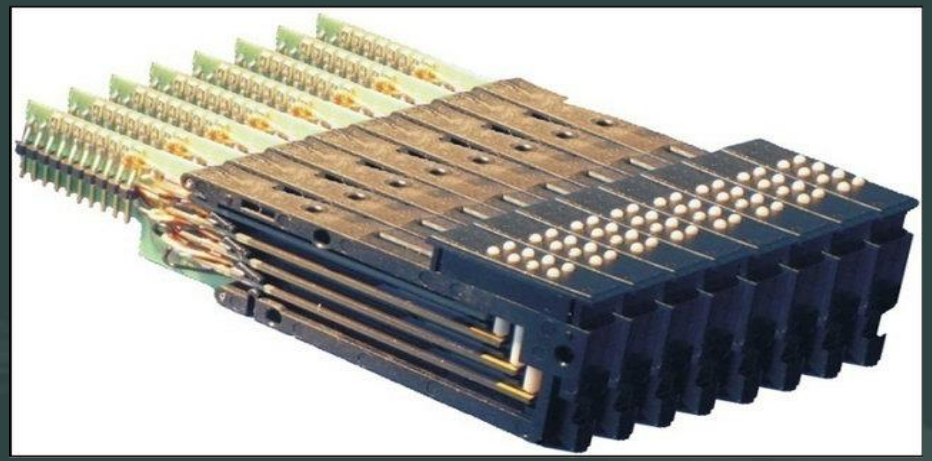
Source: https://www.enablemart.com/vision-impairment/blindness/braille-display

Braille Keyboards

Current Braille Technology

Keyboards allow the user to read and edit files, but…

- Size constraint - cannot place more than one row within the keyboard
- A full page braille display, using this technology, can cost over **$55,000**
- Piezoelectric technology is much louder due to pins clicking

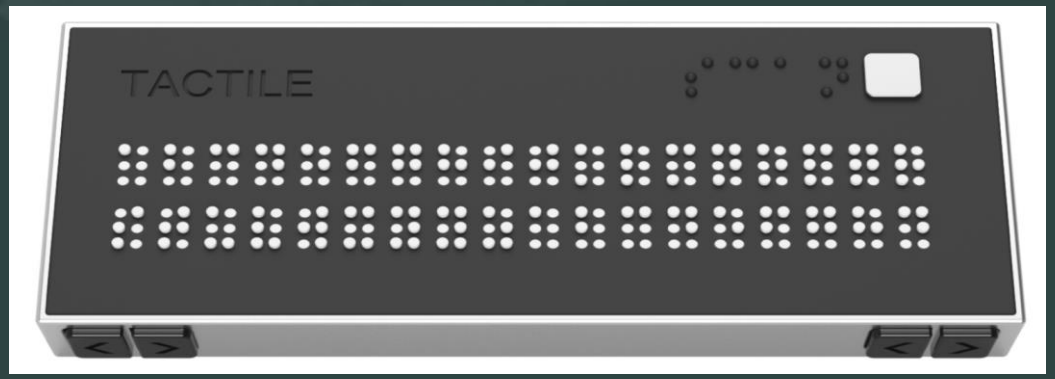


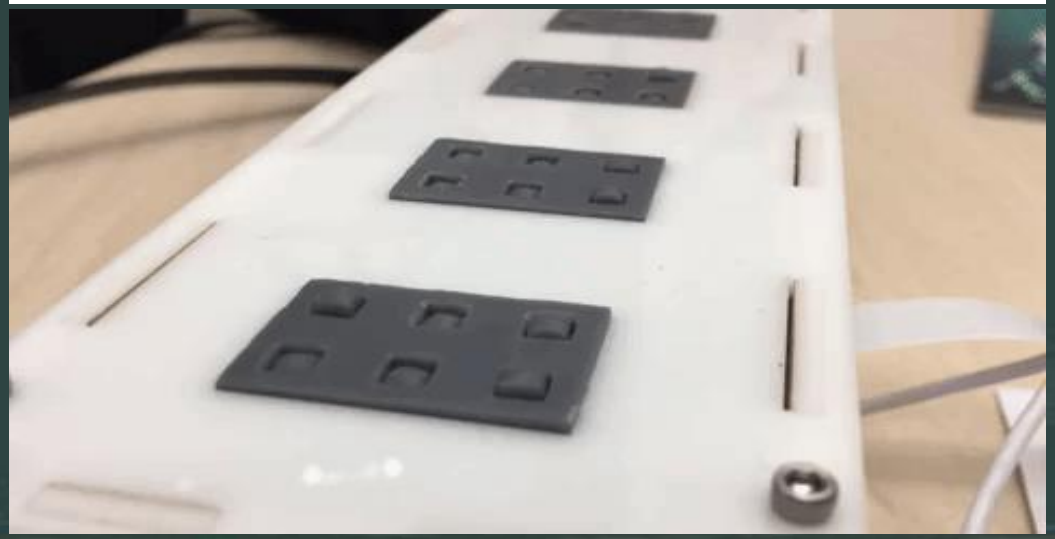
Sources: https://store.humanware.com/hus/brailliant-bi-40-new-generation.html

http://file.scirp.org/Html/9-71493_31807.html

Conceptual Designs

TACTILE - MIT





- Smaller hand held unit, better for travel and academia
- Requires a smartphone or constant physical contact
- Currently limited to 36 characters
- Not easily cleaned

Source: http://www.teamtactile.com/

Conceptual Designs

TACTILE - MIT

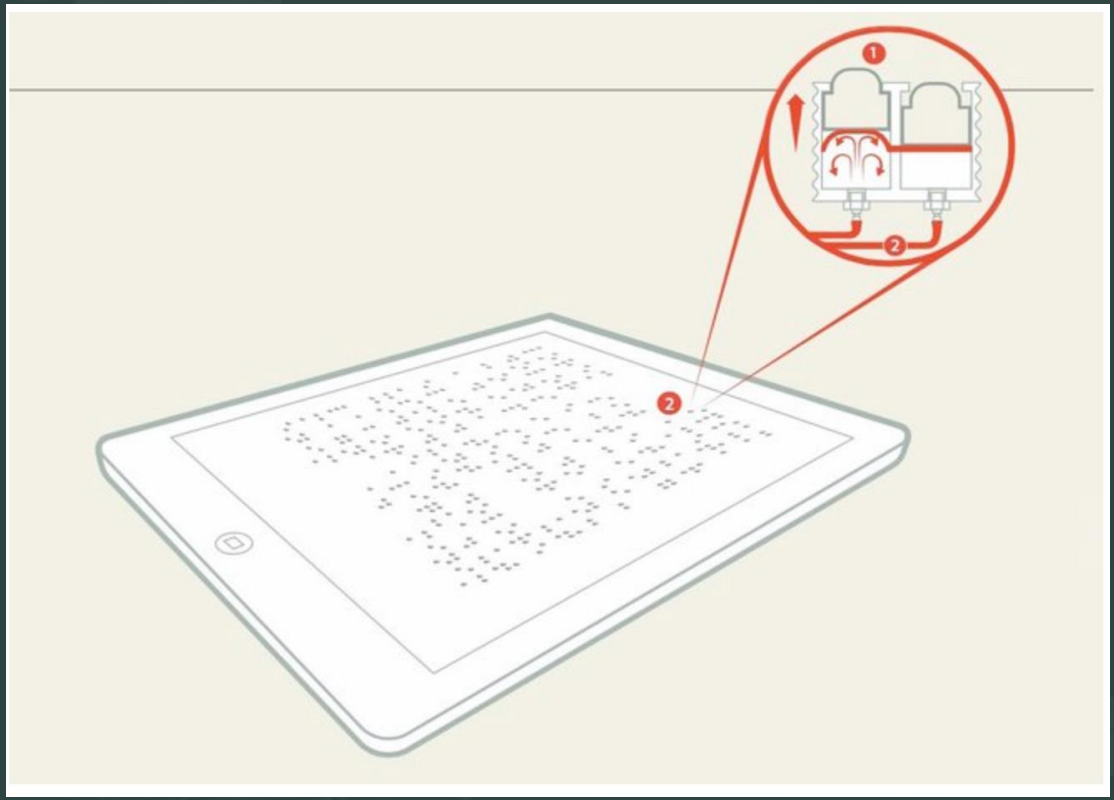
Scanning devices

- Some require constant physical contact
- Often difficult to operate by visually impaired
- Can lead to transcription errors

Source: https://www.teamtactile.com

Conceptual Designs

Holy Braille – University of Michigan, School of Information

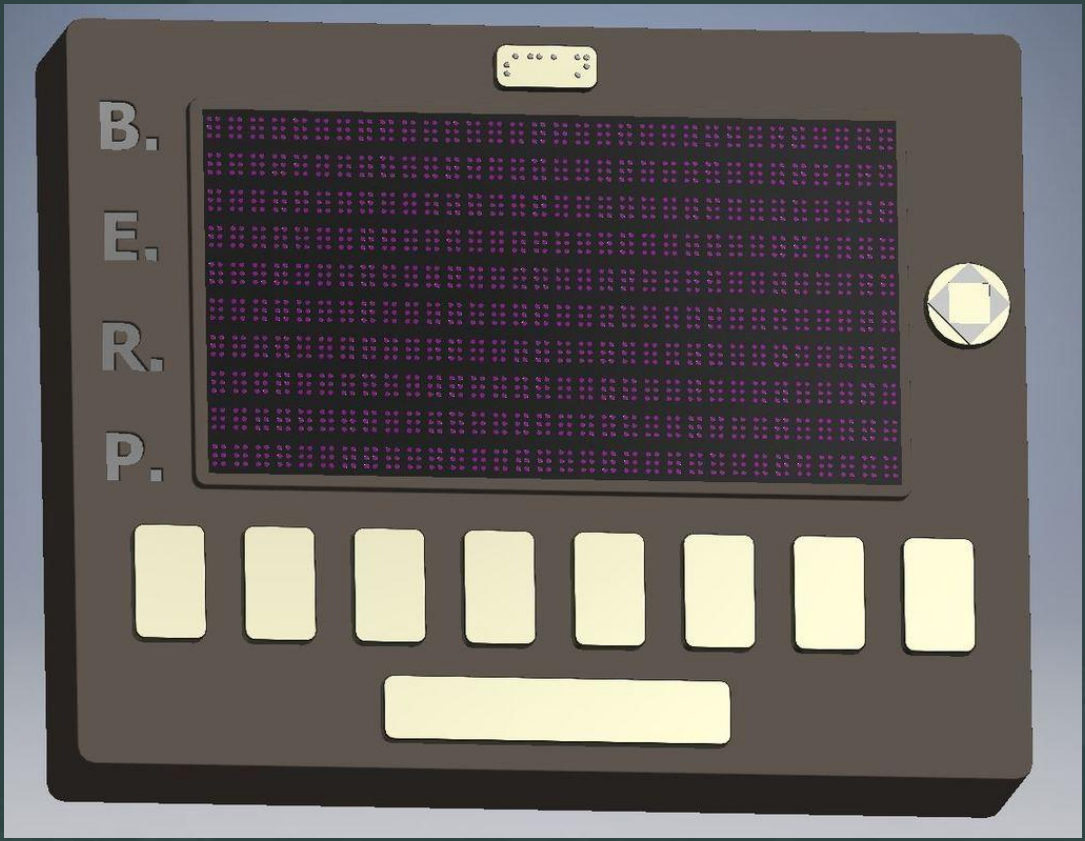


- Utilizes liquid propelled piezoelectric pads to push braille characters up
- Does not have a scanning mechanism
- Only one function - eBook

Source: https://www.popsci.com/quest-for-holy-braille

Our Design

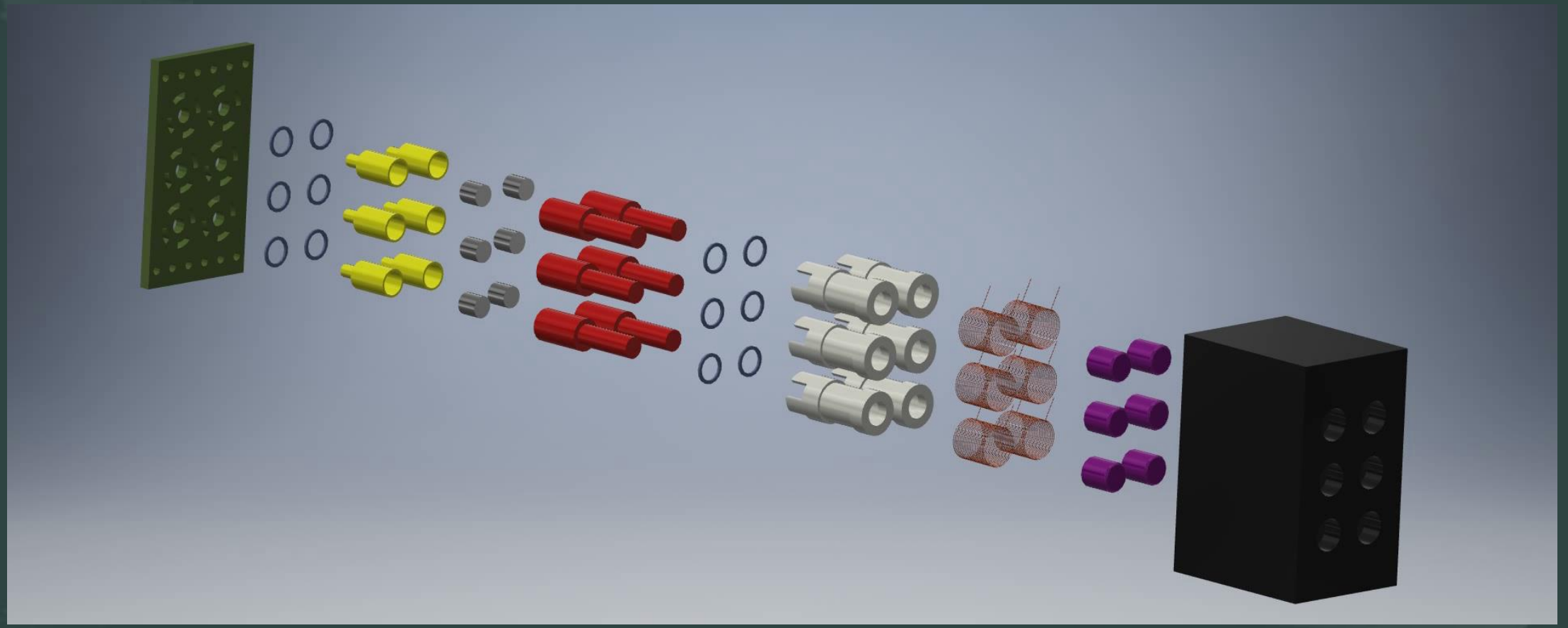
BERP | Braille eBook Reading Pad



- Integrated camera system for text-based image capturing
- Braille keyboard for editing files
- 32 cells per row, 10 lines
- ‘Plug & Play’ customizability
- Dimensions: 8 $^{1}/_{2}$ x 11 inches

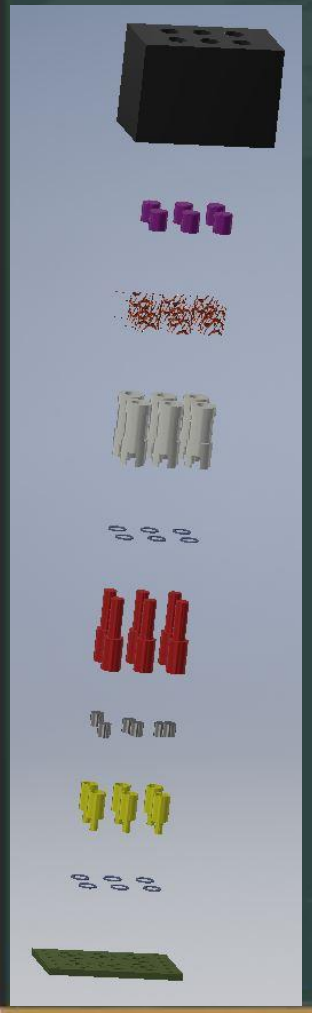
Our Design

BERP | Braille eBook Reading Pad



Our Design

BERP | Braille eBook Reading Pad



Cover

Pin Cap

Coil

Pin Casing

Felt Rings

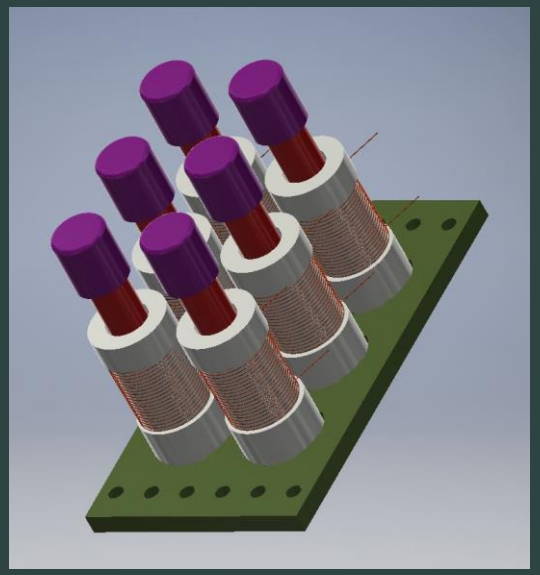
Upper Magnet Pin

Magnets

Lower Magnet Pin

Felt Rings

Circuit Plate



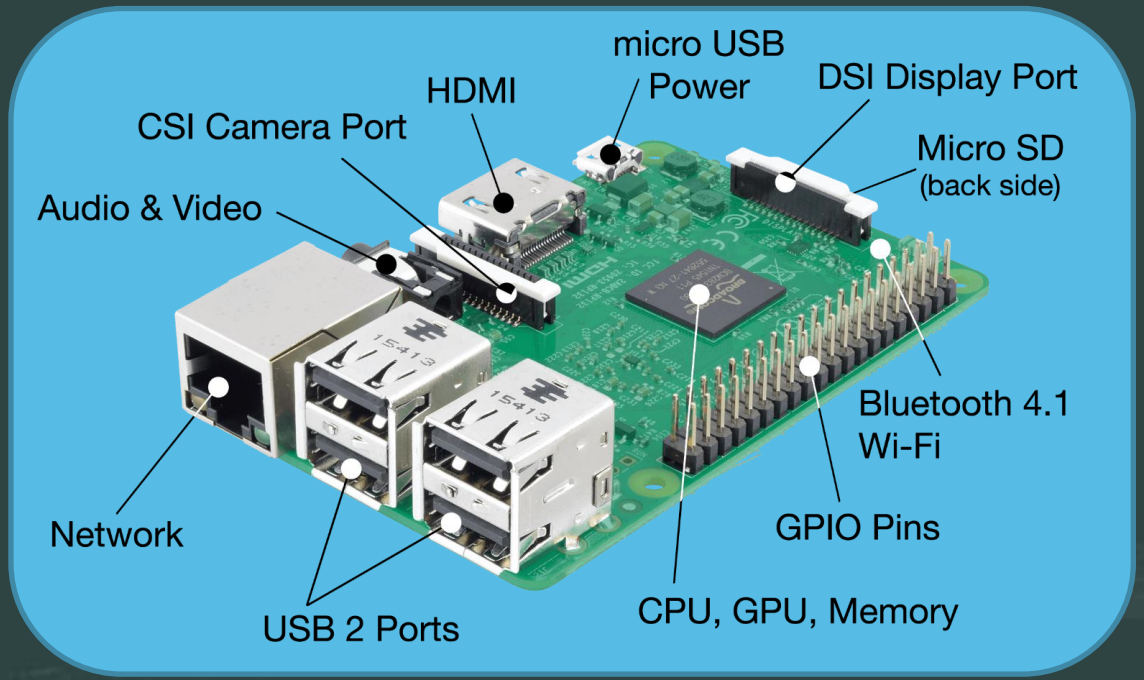
Assembled cell with no cover

- Our design offers easily replaceable cells, correlating to longer lifetime than current competition
- Larger cell area than Tactile, resulting in larger data display capabilities

Our Design

BERP | Braille eBook Reading Pad

Micro Computer System: Raspberry Pi 3B



Source: https://goo.gl/images/cLsuKe

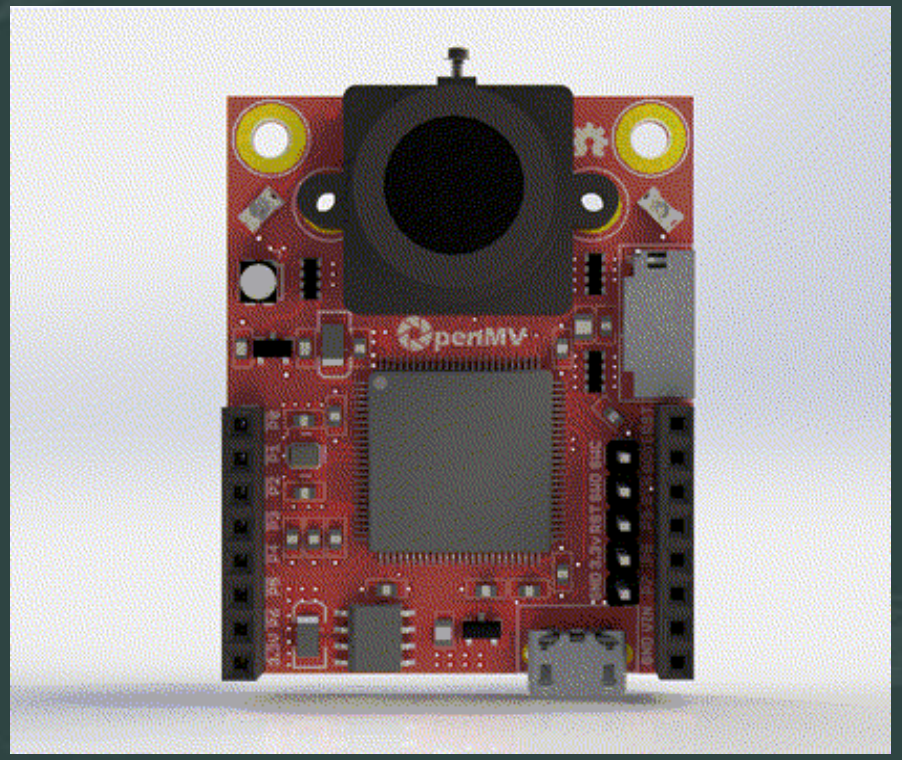
Specifications

- Integrated camera system
- Braille cells controlled via serial interface over GPIO pins
- Bluetooth compatible
- 32 GB memory storage
- Headphone audio output

Our Design

BERP | Braille eBook Reading Pad

Image Capturing System: OpenMV M7 Camera

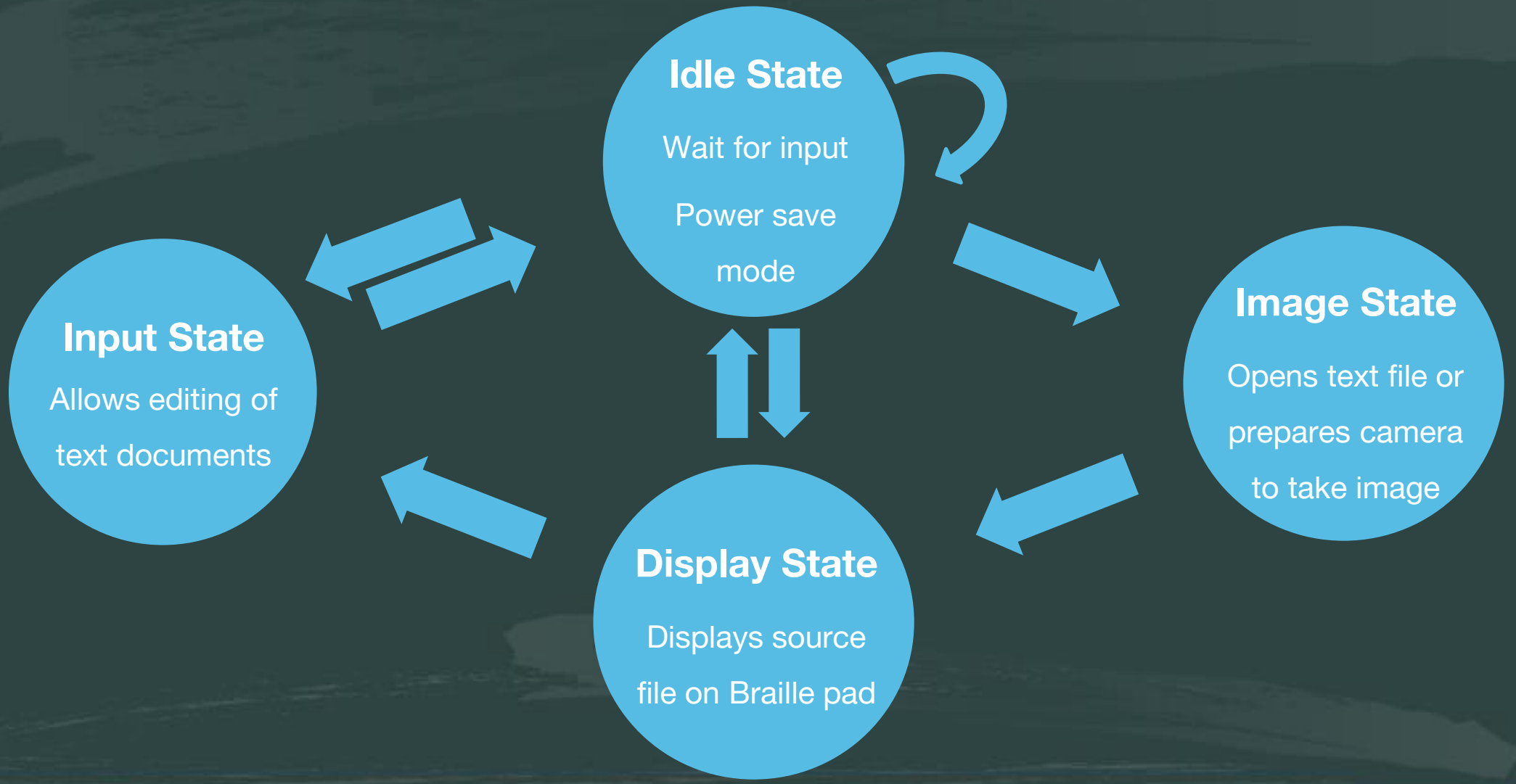


Source: https://openmv.io/products/openmv-cam-m7

Specifications

- Shape recognition will transcribe images into text file
- Physical vibration will indicate a successful page alignment
- No other device has this feature, within one unit

Our Design → State Diagram



Feature Comparison

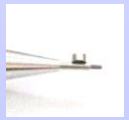
Features	Current Braille Keyboards	Audio Players	Embossing Printers	Tactile	Holy Braille	BERP
Portability	✓	✓	✗	✓	✓	✓
Transcription Functionality	✗	✓	✓	✗	✗	✓
Bluetooth	?	?	✗	✓	?	✓
WiFi	?	?	✗	✗	✗	✓
Audio Output	?	✓	✗	✗	?	✓
Keyboard Input	✓	✗	✗	✗	✗	✓
Expandable Memory	✗	✓	✗	✗	✗	✓
Computer Functionality	✗	✗	?	✗	?	✓
Easily Replicable Parts	✗	✗	?	?	✗	✓
Connect to printer	✗	✗	✓	✗	✗	✓
Pricing under $1000	✗	✓	✗	?	?	✓

✓ – Feature Available

? – Inconclusive

✗ - Feature Not Available

Components & Timeline

Part Name	Images	Cost
OpenMV M7 Camera		$65
Raspberry Pi 3 Model B		$35
3D Printed components		Free
24 AWG Magnet Wire		$15
1mm x 1mm N42 Small Round Magnets		$85
SanDisk 32GB MicroSDHC		$12
Vibrating Mini Motor Disc		$2
Total		$215

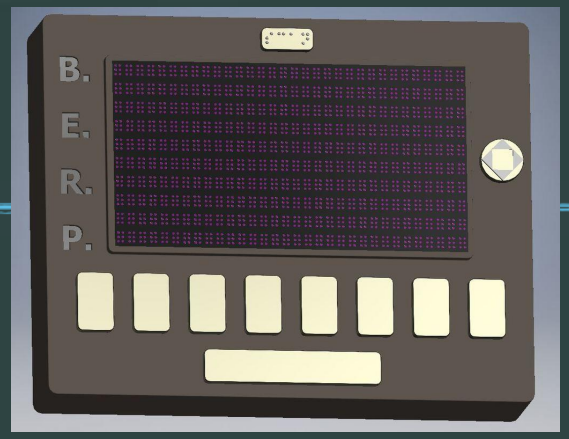
Timeline

- Parts
  - 2-3 weeks
- Pad Fabrication
  - 1 month
- Device Assembly & Testing
  - 1 month
- Optimization
  - 1 month

Future Advancements

- Grade Two Braille format upgrade
- Braille formatted plates to replace cells for complex mathematics and images
- More compact sizes, without keyboard
- Built in rechargeable battery

BERP | Braille eBook Reading Pad



Questions?