Brailliant

E-Book & Learning Tool for the Visually Impaired

Team A0 - Yujun Lee, Samay Sahoo, Ziyu Li



The Problem

Braille Statistics



- Today only 10 percent of blind children are learning Braille.
- While audio devices are useful sources of information for blind people, only Braille offers complete command of written language.
- The number of legally blind US children has increased due to several factors, including advances in medical care for premature infants.
- Most blind children (85%) attend public schools where few teachers know Braille.
- America would never accept a 10 percent literacy rate among sighted children.

Source: https://nfb.org/images/nfb/documents/pdf/braille_literacy_report_web.pdf

Use Case

<u>Problem:</u>

- Paper braille text clunky and hard to find
- Electronic braille readers are extremely expensive (~\$2000+)

Both are NOT accessible for reading and learning proposes!

Solution:

- A small form factor braille e-reader made out of cheaper components
- That double duties as a learning guide with audio feedback
- Open source and DIYable in a family garage

ECE Areas:

• Hardware & Software Systems

Use Case Requirements

<u>Product:</u>

- Portable form factor < **12" x 8"**
- Braille printed on any physical buttons to operate device (powe switch, previous/next word buttons)
- Resolution to support displaying **10 braille cells** (characters) at time; one word at a time
- Cost **< \$600**



Use Case Requirements (cont.)

Performance:

- Refresh rate < 250 ms/word (240 wpm average reading speed)
- Rechargeable battery > 1 hr battery life
- **100% accuracy** of English text to braille encoding algorithm
- >95% accuracy of producing physical braille pin patterns

Technical challenges

The Impossible Triangle?







Previous Solutions:

- Piezo Actuators
 Very small and fast, extremely expensive (~\$2000 min)
- Linear / Servo Motors
 Cheap, but slow and clunky

The Not Yet Tested Solution:

- Electromagnetic Actuators
 - Cheap, small-ish, fast-ish

Solution Approach (Actuation)

• An array of miniature electromagnetic linear actuators...

• Off-the-shelf 6mm components readily available.

• Intended to fabricate custom versions optimized in accordance of our use case.



For reference only (Product on Aliexpress)

Solution Approach (System)



Testing/Verification Metrics

Refresh rate at average reading speed	
Power consumption (battery life > 1hr)	
Text to Braille Algorithm Accuracy	
Physical braille pin pattern display accuracy on < 10 characters	
Cost cap at \$600	
Resolution to effectively display 10 readable braille characters	

Slow motion video of actuator cell for refresh time < 250ms
Measure running time of the pad under normal use
Test on 5000 samples from online braille dictionary for ~100% accuracy
Test physical grid on more than 50 braille pattern inputs between 0-10 characters to reach >95% accuracy
Cost analysis by summing all the parts needed
User testing on 10+ visually impaired students via contacting CMU Office of Disability Resources

Division of Labour

Software (Yujun Lee)	 Front-end (web app): UI for text data input from user + filtering on unidentified words Text to grid parser for Raspberry Pi
Hardware (Samay Sahoo, Ziyu Li)	 Speaker implementation - Samay Electromagnetic Actuator grid - Ziyu PCB design (power management, microcontroller, I/O buttons) - Ziyu Product design - Samay
Data Collection (All)	 Sequence of braille-translatable words Braille patterns for actuator grid testing

Schedule

	Assigned	Progress	FEBRUARY 2024 MARCH 2024								APRIL 2024				
brailliant		0%	11	18	25	3	10	17	24	31	7	14	21	28	
* Deliverables		0%	6					0.03		100					
Design Presentation Slides		0%													
Design Document		0%													
Ethics Assignment		0%													
Interim Demo		0%													
Final Presentation Slides		0%													
Poster PDF and YT		0%													
* Hardware		0%).							
CAD design for device		0%													
3D print for case		0%													
Speaker		0%													
Electromagnetic actuator grid		0%			0)									
PCB design		0%													
Initial hardware assembly		0%)							
* Software		0%													
Front-end web app		0%													
Text to braille processing algorithm		0%													
UI system		0%													
* Testing		0%													
Text to braille algorithm testing		0%													
UI testing		0%													
Front-end app testing		0%													
Actuator grid functionality		0%													
Full text-to-braille conversion functionality		0%													
Full text-to-audio conversion functionality		0%													
User testing		0%													