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Aware-ables

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Presented by Kevin Xie

Use Case: Who is our product for?

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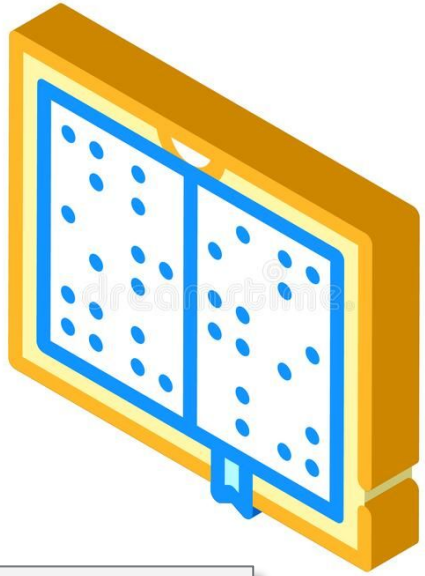
***Fewer than 10%* of legally blind Americans are *Braille literate*.**

Braille is an essential form of written language for education and navigation.

Hardware Systems
Software Systems



A new device for auditory accessibility and assistance

Wearable braille detection for increased awareness of surroundings

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Use Case Requirements

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- **Latency:**
  - Recognize up to 10 words per frame at arms-length (2-3ft)
    - *Braille reading speed can range from 200-400 wpm*
    - *Braille readers are capable of reading faster than sighted readers. ~33.55ms per character.*
  - Text-to-speech in 2 seconds or sooner
    - *Two-second guideline for web pages*

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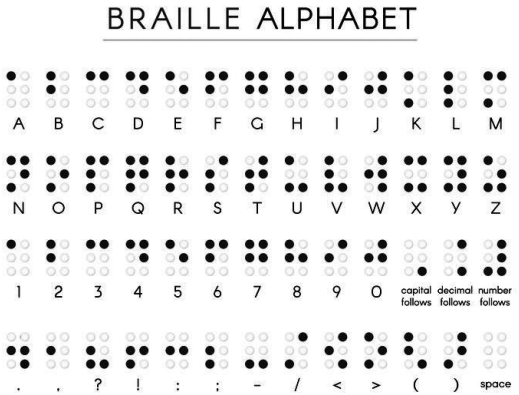
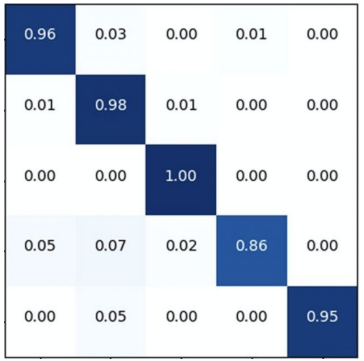
Use Case Requirements (2)

- **Accuracy:**
  - 45/50 characters recognized (10% error rate)
    - *Matches the average error rate of conventional OCR*
  - 52 braille characters (6bits) * ~30 characters per second * 0.90 = 162bps
- **Usability:**
  - Intuitive interactions/gestures that can be activated within 2 seconds without sight
  - Portable/Wearable





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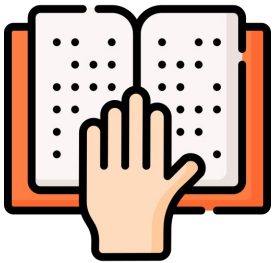
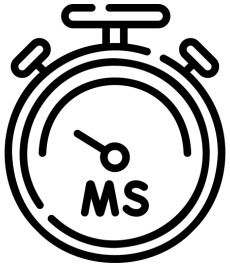
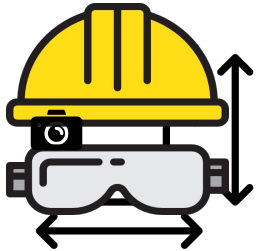
Technical Challenges

How to...

1. ...**properly detect and capture braille** from embossed or printed surfaces in a still image.
2. ...**translate** captured braille characters to speech, or other means that could be delivered through hearing.
3. ...achieve a **reasonable latency and low error rate**
4. ...optimization of the size of the wearable for the **comfortable daily use**.







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Technical Challenges (2)

Printed/Controlled Environment vs. Natural Scene Braille Detection

- Variable lighting conditions
- Unpredictable spacing, sizes, and materials
- Skewed perspective
- How to find the correct anchor?

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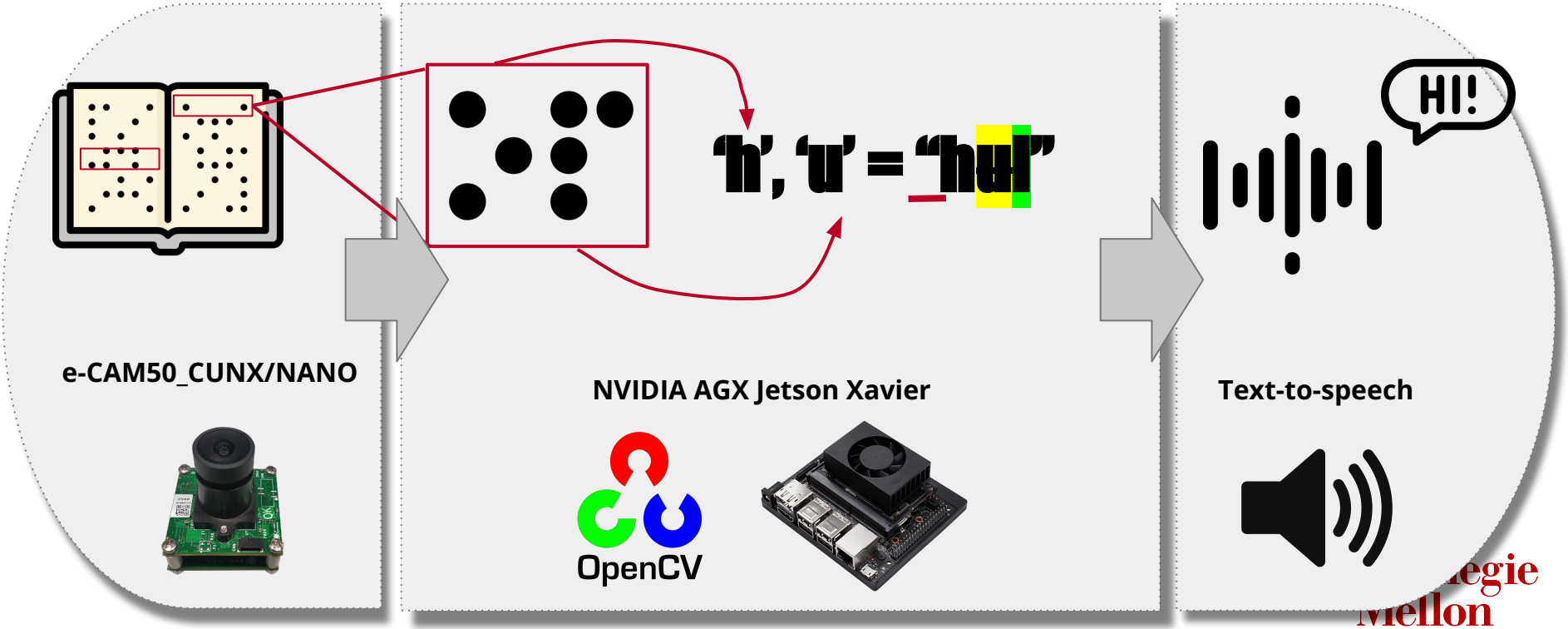
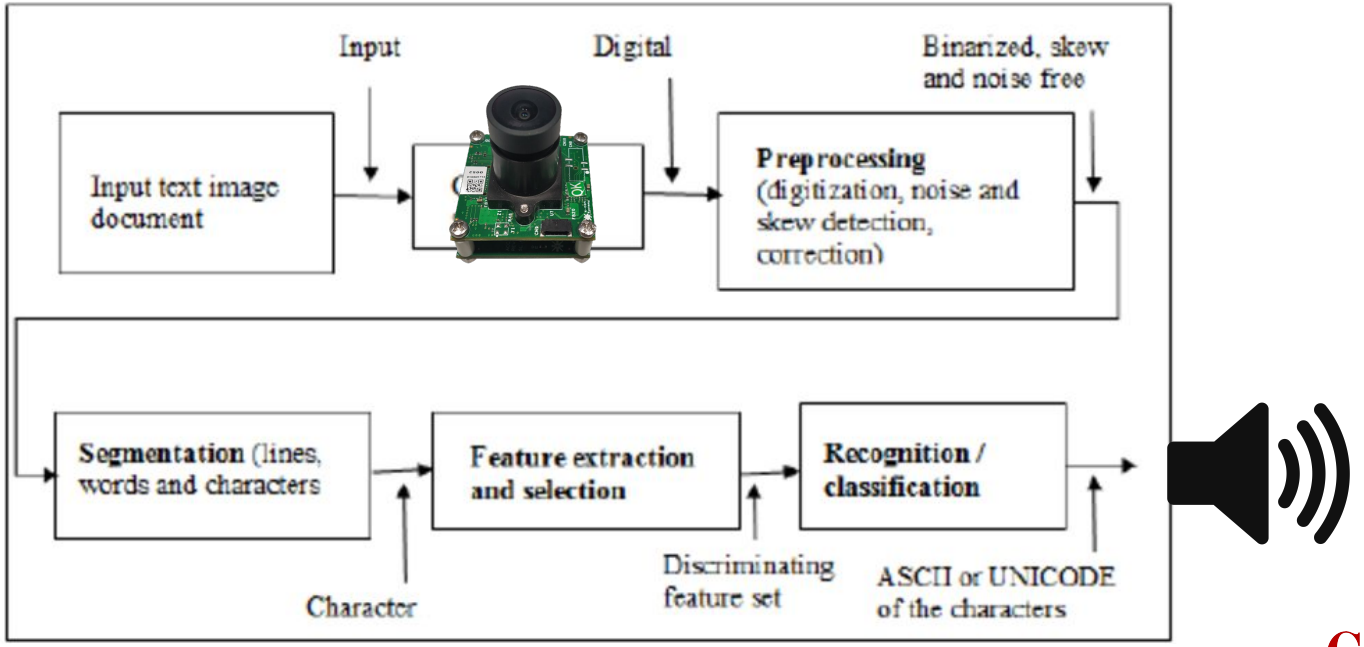
Solution Approach



Solution Approach (2)



(Source)

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Testing, Verification, and Metrics

- **Character Error Rate / Latency**
  - Trained/unit tested on open source braille alphabet dataset
  - Test against educational braille alphabet tiles (26 characters, randomly sampled twice)
  - Target of >90% accuracy and ~1.5s latency

- **Word Error Rate / Latency**
  - Test against braille children's books / signs / labels
  - MVP: Controlled lighting environment and perspective
  - Same accuracy target, increased latency target of 2s to include text-to-speech

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Tasks and Division of Labor

1. **Hardware**
   a. Camera integration
      i. *Jong Woo Ha*
   b. Speaker integration
      i. *Chester Glenn*
2. **Software**
   a. Image preprocessing and segmentation
      i. *Jong Woo Ha*
   b. Character recognition and classification
      i. *Kevin Xie*
   c. Spellcheck and text-to-speech
      i. *Chester Glenn*
3. **Logistics**
   a. Testing and administration
      i. *Kevin Xie*

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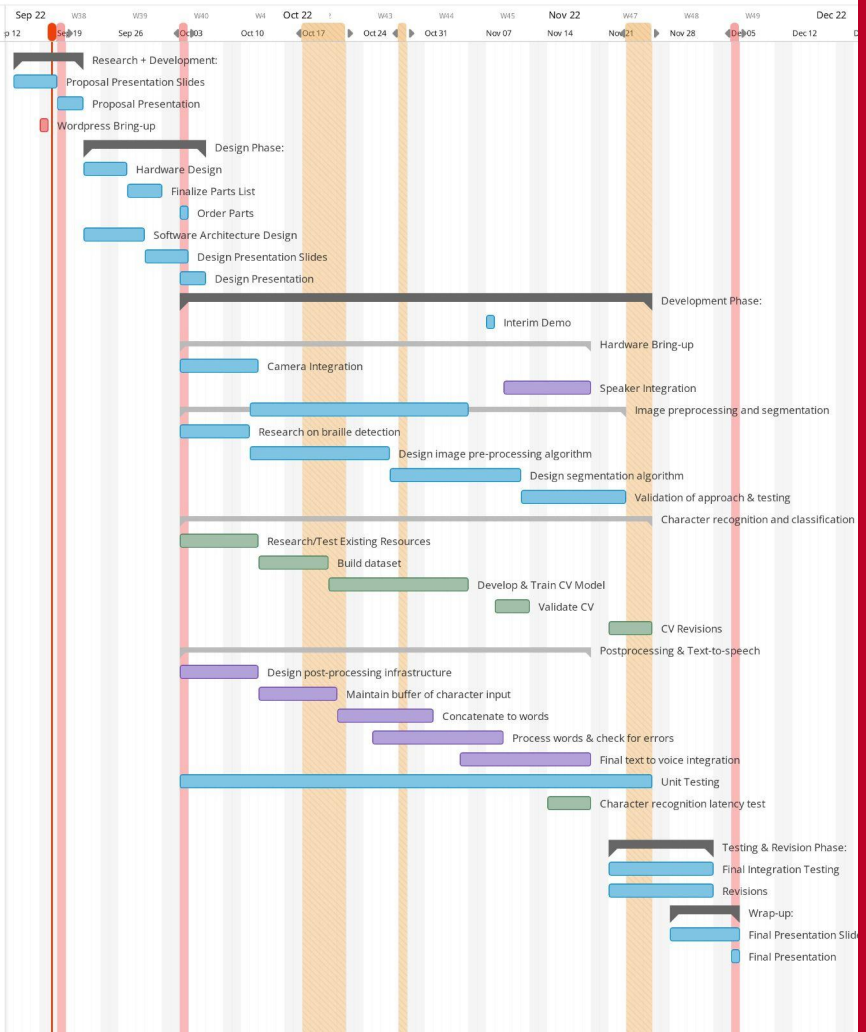
Schedule

Aware-able Schedule

Read-only view, generated on 18 Sep 2022

Instagantt

	ACTIVITIES	ASSIGNEE	EH	START	DUE	%
	Research + Development:		-	14/Sep	21/Sep	0%
1	Proposal Presentation Slides	CG, Ja, KX	-	14/Sep	18/Sep	0%
2	Proposal Presentation	Kevin Xie	-	19/Sep	21/Sep	0%
3	Wordpress Bring-up	Jay	-	17/Sep	17/Sep	0%
	Design Phase:		-	22/Sep	05/Oct	0%
5	Hardware Design	CG, Ja, KX	-	22/Sep	26/Sep	0%
6	Finalize Parts List		-	27/Sep	30/Sep	0%
7	Order Parts		-	03/Oct	03/Oct	0%
8	Software Architecture Design	CG, Ja, KX	-	22/Sep	28/Sep	0%
9	Design Presentation Slides		-	29/Sep	03/Oct	0%
10	Design Presentation		-	03/Oct	05/Oct	0%
	Development Phase:		-	03/Oct	25/Nov	0%
12	Interim Demo	CG, Ja, KX	-	07/Nov	07/Nov	0%
	Hardware Bring-up		-	03/Oct	18/Nov	0%
14	Camera Integration	Jay	-	03/Oct	11/Oct	0%
15	Speaker Integration	Chester Glenn	-	09/Nov	18/Nov	0%
	Image preprocessing and s...	Jay	-	03/Oct	22/Nov	0%
17	Research on braille det...		-	03/Oct	10/Oct	0%
18	Design image pre-proc...		-	11/Oct	26/Oct	0%
19	Design segmentation al...		-	27/Oct	10/Nov	0%
20	Validation of approach ...		-	11/Nov	22/Nov	0%
	Character recognition and c...	Kevin Xie	-	03/Oct	25/Nov	0%
22	Research/Test Existing ...	Kevin Xie	-	03/Oct	11/Oct	0%
23	Build dataset	Kevin Xie	-	12/Oct	19/Oct	0%
24	Develop & Train CV Mo...	Kevin Xie	-	20/Oct	04/Nov	0%
25	Validate CV	Kevin Xie	-	08/Nov	11/Nov	0%
26	CV Revisions	Kevin Xie	-	21/Nov	25/Nov	0%
	Postprocessing & Text-to-sp...	Chester Glenn	-	03/Oct	18/Nov	0%
28	Design post-processing...	Chester Glenn	-	03/Oct	11/Oct	0%
29	Maintain buffer of char...	Chester Glenn	-	12/Oct	20/Oct	0%
30	Concatenate to words	Chester Glenn	-	21/Oct	31/Oct	0%
31	Process words & check ...	Chester Glenn	-	25/Oct	08/Nov	0%
32	Final text to voice integr...	Chester Glenn	-	04/Nov	18/Nov	0%
	Unit Testing	CG, Ja, KX	-	03/Oct	25/Nov	0%
34	Character recognition l...	Kevin Xie	-	14/Nov	18/Nov	0%
35	Slack Time		-			0%
	Testing & Revision Phase:		-	21/Nov	02/Dec	0%
37	Final Integration Testing		-	21/Nov	02/Dec	0%
38	Revisions		-	21/Nov	02/Dec	0%
	Wrap-up:		-	28/Nov	05/Dec	0%
40	Final Presentation Slides		-	28/Nov	05/Dec	0%
41	Final Presentation		-	05/Dec	05/Dec	0%
42	Final Report		-			0%
43	Final Video		-			0%
44	Public Demo		-			0%



Conclusion - MVP

- Head-mounted hardware device that is able to accurately detect and read braille, using a camera and computer vision software
    - Expected requirements for latency and error rate
        - *Latency: 2s per image*
        - *Error rate: 10%*
- Less focus on aesthetics and minification
- Given additional time, planning on further implementing signal processing / various other detections for sound and daily life objects