

Use Case and Design Requirements

- Translation and navigation in foreign countries

Screen

≥ 10 characters of text per line
 ≥ 20 characters of text

$\geq 40\%$ ambient light transmission

> 15 millimeters virtual image distance

Goggles

$\geq 640 \times 480$ camera resolution

≤ 2 second round trip time
(camera $\rightarrow$ translation $\rightarrow$ display)

Goggles weight < 350 grams

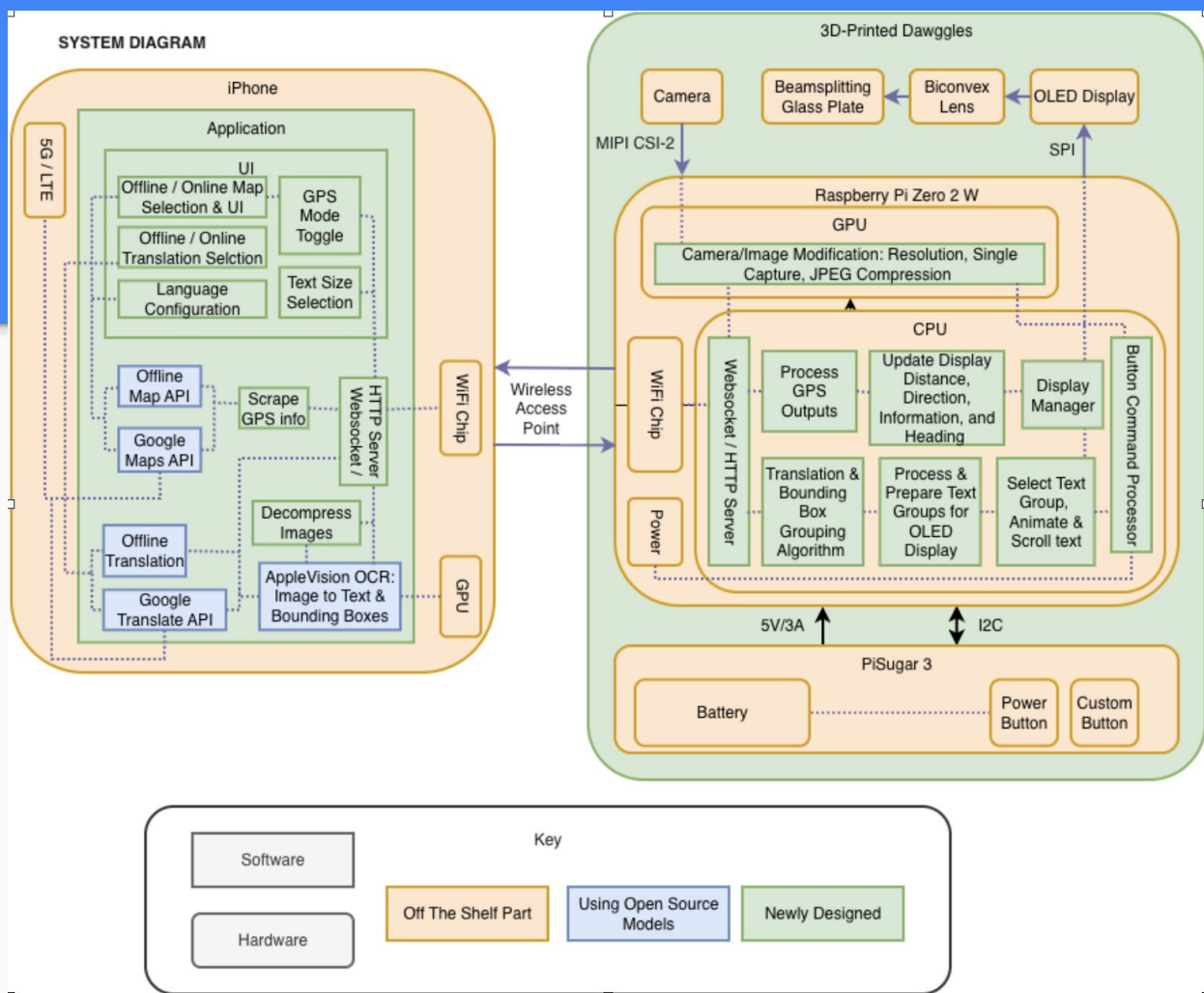
Power

Operating temperature $< 45^{\circ}\text{C}$

Battery life > 1.5 hours

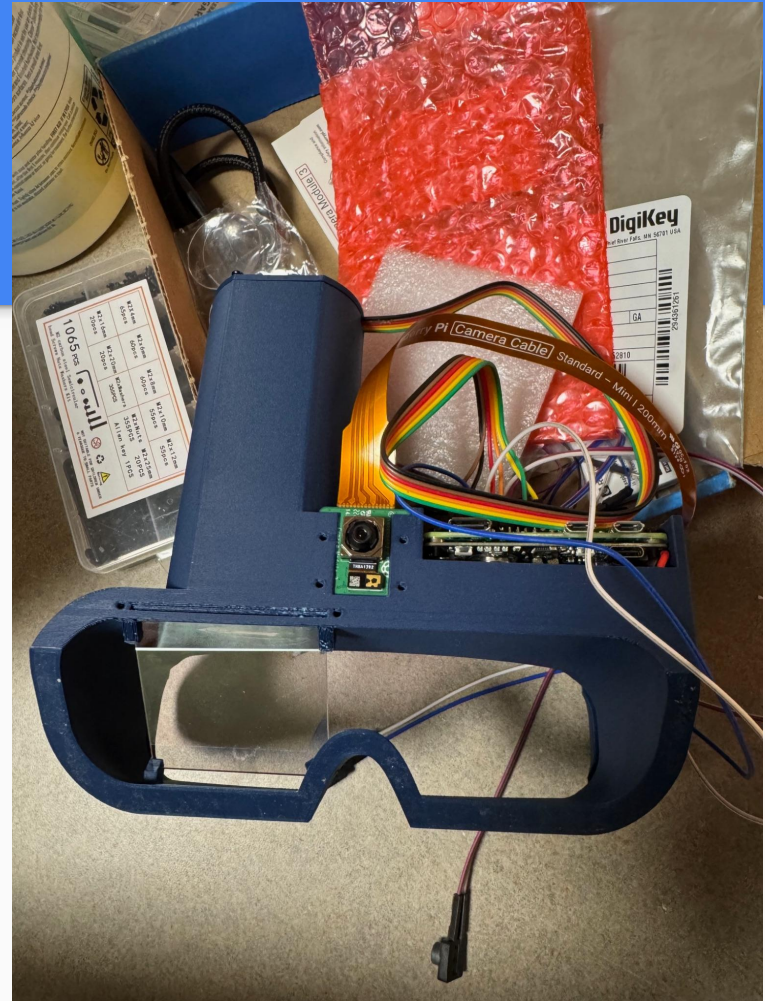
Charge time < 2 hours

Solution approach



Solution Approach

- Biconvex Lens: ~~45mm~~ → 75mm focal length
- Translation: ~~static~~ → live
 - Google Translate API → stretch goal
- Navigation: same (Google Maps)
- Additional Features



Complete Solution

iOS

- Bluetooth Device Pairing and Dawggles AP Connection
- Basic UI for app switching
- Translation:
 - From & To Language Selection
- Navigation:
 - Integrated Google Maps

Goggles

- Basic UI
 - App selection
 - Battery Health
 - WiFi Connection
- Next & Back buttons
 - App scrolling
 - App interfacing

Complete Solution

Demo Walkthrough

1. Download the Dawggles app for iPhone or use our phone
2. Pair the Dawggles
3. Explore the home screen
4. Open the translation app on Dawggles and translate a sign
5. Open the navigation app on Dawggles and get directions
6. ...Open other apps

Test Plans and Pass Criteria

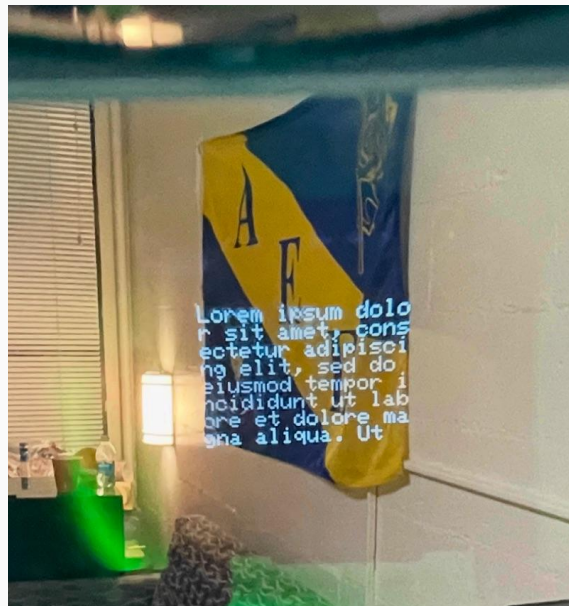
Survey participants in study

- Draw our own signs and translate them to evaluate the translation feature
- Walk around Pittsburgh to evaluate the navigation feature
- Evaluate based on user experience and feedback (if the average of ratings for comfort, easiness, and reliability of dawggles ≥ 3 it is a success)

Verification Results

Lets see if we met our design requirements

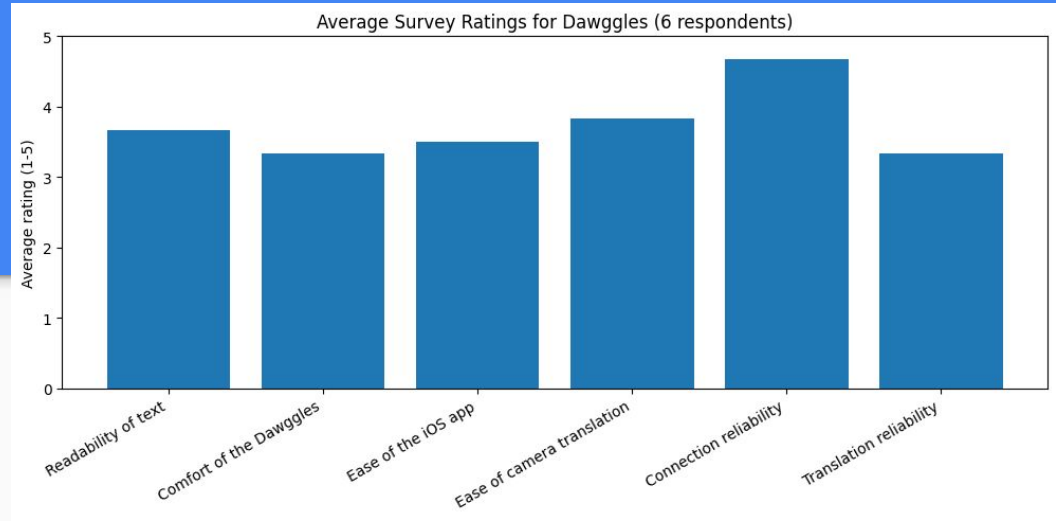
- Characters per line: $\geq 10 \rightarrow \sim 15$
- Characters of text in total: 8 lines $\rightarrow \sim 120$
- Virtual image distance: $> 15 \text{ mm} \rightarrow \sim 25 \text{ mm}$
- Camera resolution: $\geq 640 \times 480 \text{ pixels} \rightarrow \geq 4608 \times 2592 \text{ pixels}$
- Round trip translation time: $< 2 \text{ s} \rightarrow < 1 \text{ s}$
(basically instantaneous to the user)
- Battery life: $> 1.5 \text{ hours} \rightarrow 2 \text{ hours}$
- Charge time: $< 2 \text{ hours} \rightarrow \frac{1}{2} \text{ hour}$



Test, Verification, and Validation

Validation Results

Surveyed 6 people

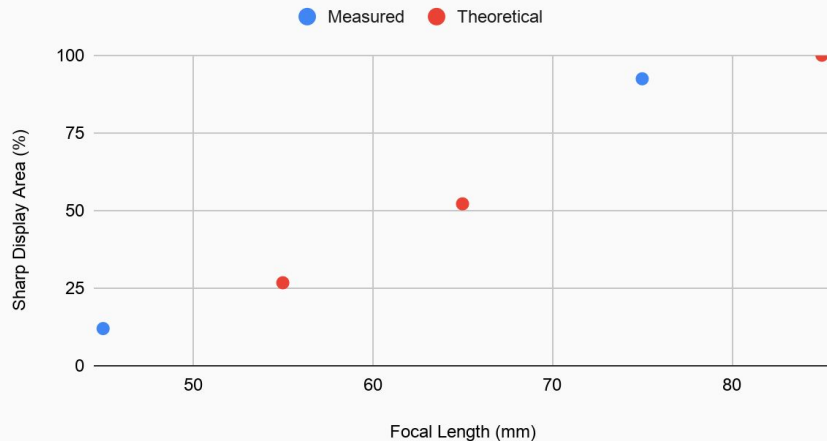


Respondent	Readability of text	Comfort of the Dawggles	Ease of the iOS app	Ease of camera translation	Connection reliability	Translation reliability
P1	3	3	4	3	5	2
P2	5	4	3	4	5	4
P3	4	5	3	3	4	4
P4	3	3	4	5	5	4
P5	4	2	3	4	4	3
P6	3	3	4	4	5	3

Design Trade-Offs & Pareto Analysis

- Trade-off between display quality and height of goggles

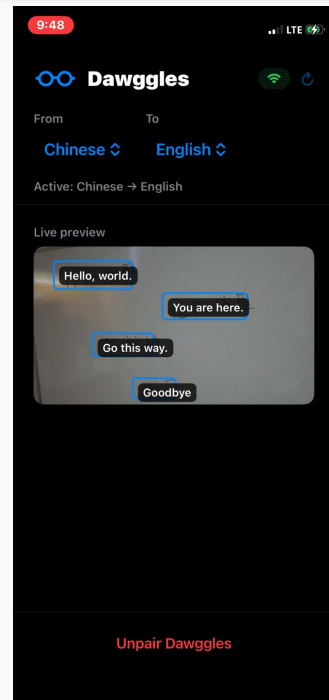
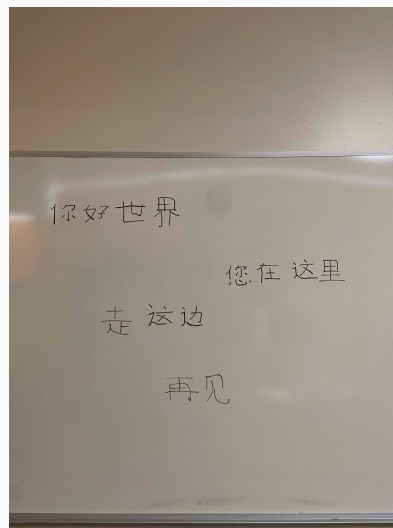
Image Sharpness vs Focal Length Trade-Off



Design Trade-Offs & Pareto Analysis

- Apple Vision VNTxtRecognize
 - Fast: < 75% accuracy, ~30fps
 - Accurate: > 90% accuracy, ~5fps, more intensive

Static	Live
1 frame	~5 sec avg translation → 25 frames
Complex text groupings, UI	One text group, no UI
Sensitive to image quality	More interactive experience



Project Schedule & Remaining Work

- Navigation UI (Aidan)
- Continue surveying (reach 30+ respondents) (David)
- Improve comfortability by adding foam pad (Pat)
- Additional translation testing with large amounts of text (Pat and David)
 - May be necessary to switch between fast vs accurate modes on Apple API

Lessons Learned

- Mechanical takes a lot of time – ongoing process
 - Especially for minor adjustments
- System architecture matters a lot
- Investing time into researching what exists pays off
 - Optics
 - Models
- We convinced ourselves that we are engineers