DigiBraille

Team A4
Becky Button,
Joshna Iyengar,
Zeynep Ozkaya

The Problem: Current technologies for blind people do not allow for easily accessible printed braille for simple everyday use.

Braille display and computer

Text to speech

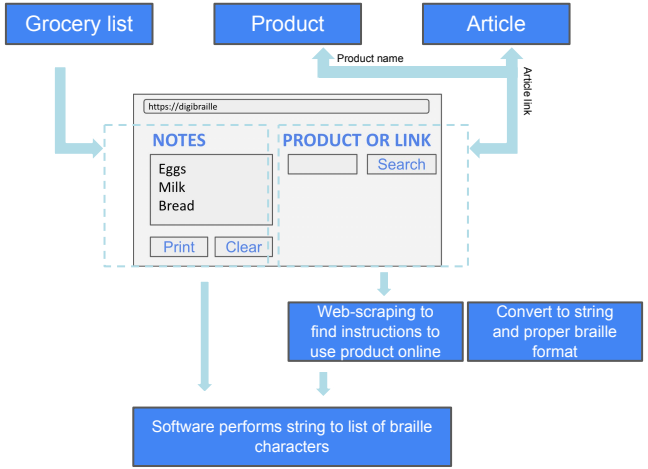
Commercial braille printer

Use Case

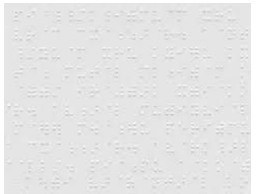
- **Problem focus**: Give blind users fast access to printed information (recipes, lists, articles etc.)
- **Solution**: Design a web app that allows blind users to input notes or a product they want to use, find the instructions for using the product, and print it out in braille with an embosser
- ECE Areas
  - **Device Sciences**: creating a braille embosser using electromagnetic induction
  - **Software Systems**: frontend development for user input, web-scraping to find recipe, storing and sending signals to embosser

User-Defined Input

Ex: user wants to print . . .



Output:



Use Case Requirements

User Needs

- Increased access to printed information
- Increased accessibility needs met by allowing users to use phone instead of paper
- Allow users to read braille recipes by physically embossing a recipe with braille requirements

Device Needs

- Portability and weight
- Accommodates proper paper type
- Cost – Under $100
- Speed
  - Users can't feel limited by the time it takes the device to print
- Accuracy
- Power management

Technical Challenges – Software

- Web-scraping algorithm should take 2s (~20 pages)
- UI on website should be able to interface with braille displays as per Apple Software Kit Accessibility Guidelines on a phone
- Direction finding algorithm must be accurate
    - Keywords from user must be helpful
    - Direction must be from reputable sources
    - Algorithm must distinguish between title, ingredients, and steps
- Database
    - Keeps track of product requests in a cache system so that more popular requests can be more easily sent

Technical Challenges – Hardware

- Braille embossing should take 1 character per second
- Solenoids must not generate more than 5.5 W
- Device should cost ~$100 based on component prices and speed of printing
- Device should be able to work for 8.5x11 paper and emboss with the proper braille dimensions for a 25x32 character page
- Device should be 11 in. length, 11 in. width, and 5 in. height

Measurement Range	**Maximum to Minimum (mm)**
Dot base diameter	1.5-1.6
Distance between two dots in the same cell	2.3-2.5
Distance between corresponding dots in adjacent cells	6.1-7.6
Dot height	.6-.9
Distance between corresponding dots from one cell directly below	10.0-10.2

https://brailleauthority.org/size-and-spacing-braille-characters#:~:text=1%20The%20nominal%20height%20of,0.057%20inches%20%5B1.44%20mm%5D.

Solution Approach

Front-end web application

User inputs recipe/note using **phone** and braille display

Front-end web app

Back-end web-scraping algorithm

Web scraping using python libraries to find recipe based on user input

Convert recipe to proper Braille format.

Braille embosser

Plot Braille characters using g-code based controller like a RAMPS board

Use solenoid and motor system to emboss recipe into braille printer

Solution Approach - Software

- Front-end
  - Create Apple Accessibility Guideline compatible **html code with javascript**
  - Host the html as a web-app on CMU server
- Back-end
  - Use **Python** library Requests to handle post html requests
  - Use Python library Search to query and find the best website
  - Use Python libraries such as **lxml** and **dictionaries** as a data structure to help create a file from external websites

Why use a web app instead of a text message service?

With a web-app, we can have more control over button spacing and functionality, making it more simple to use than a text message service.

Solution Approach - Hardware

- **Solenoid embossing system**
  - 6 5V push-pull solenoid circuit will be used to emboss the 6 dot characters
  - Solenoid system will be moved linearly along the page using X/Y plotter system
- **X/Y plotter**
  - Use RAMPS board, Stepper Motors, Stepper Motor Drivers, Limit Switches to operate solenoids per braille character
- **Communication between hardware and software**
  - Python will output RAMPS compatible g-code file

Why solenoids?

How does it compare to commercial printers?

Why 25x32 characters?

More difficult to control position with motors; piezoelectric material is out of budget.

Cheaper than commercial printers while not compromising speed. Also allows users to print from phone.

8.5x11 in. paper fits 32 characters per line, which is more convenient to carry around than the more conventional 40 character page.

Testing, Verification, Metrics

UI Testing	Software Testing	Hardware Testing
• Have blind user test website using braille display or Accessibility Features • Have sighted user test website using Accessibility Features • Make tests following Apple Accessibility programming guide for OSX and use Apple's debugger • Test usability on a phone	• Test accuracy with 100 most popular products • Check webpage to file to data struct conversions • Check title accuracy with search • Check ingredient accuracy with webpage • Check recipe step accuracy with webpage including separation of steps	• Test gcode instructions with plain motor and device • Test software sending signal to move motors • Test software sending signal for each solenoid • LT Spice simulations for solenoid system • Test power control and embossing capabilities of 6 solenoid system

Testing, Verification, Metrics

Becky	Joshna	Zeynep
Hardware – create a x/y plotter that utilizes a standard plotting system and design of solenoid system for embossing that maximizes speed and minimizes power consumption	**Software systems –** setting up web-app server and framework, web-scraping for finding and simplifying instructions, storing notes or website info in data structure, translating characters to 2 sets of 3 signals, communicating signals and location of next character to embosser	**Hardware** - design solenoid system for embossing that maximizes speed and minimizes power consumption **Frontend Development** - create a platform for **phone** that allows user to input list/recipe/article that is compatible with current accessibility platforms

Schedule

DigiBraille

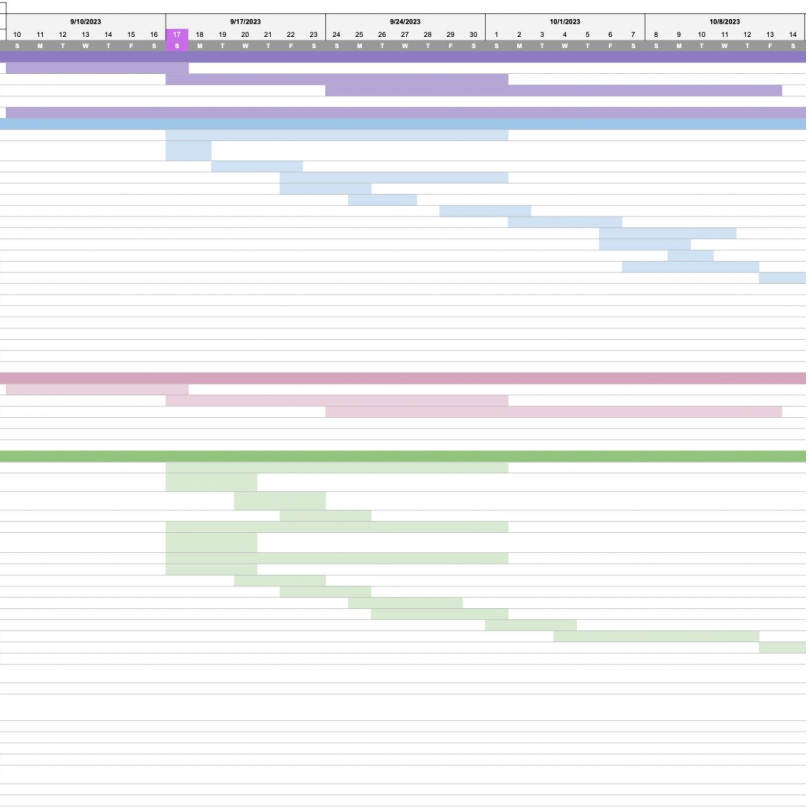
18-500 ECE Design

Becky Button, Joshna Iyengar, Zeynep Odkaya

Project Start: 9/11/2023

Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	DAYS	END
Course Deadlines					
Proposal Presentation	All	WORKING	9/10/23	7	9/17/23
Design Presentation	All	NOT STARTED	9/17/23	14	10/1/23
Design Report	All	NOT STARTED	9/24/23	19	10/13/23
Final Presentation	All	NOT STARTED	11/19/23	14	12/3/23
Slack	All	WORKING	9/10/23	84	12/3/23
Front-end Software					
Initial design	Zeynep	WORKING	9/17/23	14	10/1/23
Website mock-up and usability research	Zeynep	WORKING	9/17/23	1	9/18/23
Finalize web app workflow	Zeynep	NOT STARTED	9/19/23	3	9/22/23
Build basic framework	Joshna	NOT STARTED	9/22/23	9	10/1/23
Set up server	Joshna	NOT STARTED	9/22/23	3	9/25/23
Incorporate notes feature	Joshna	NOT STARTED	9/25/23	2	9/27/23
Incorporate recipe finding feature	Joshna	NOT STARTED	9/29/23	3	10/2/23
Slack	Zeynep	NOT STARTED	10/2/23	4	10/6/23
Testing and improivng	Zeynep	NOT STARTED	10/6/23	5	10/11/23
Test with apple's accessiblity feature	Zeynep	NOT STARTED	10/6/23	3	10/9/23
User testing	Zeynep	NOT STARTED	10/9/23	1	10/10/23
Incorporate changes	Zeynep	NOT STARTED	10/7/23	5	10/12/23
Slack	Zeynep	NOT STARTED	10/13/23	8	10/21/23
Integrate with back-end	Zeynep	NOT STARTED	10/22/23	2	10/24/23
Refine	Zeynep	NOT STARTED	10/25/23	5	10/30/23
Testing and improivng	Zeynep	NOT STARTED	10/30/23	7	11/6/23
Test with apple's accessiblity feature	Zeynep	NOT STARTED	10/30/23	3	11/2/23
User testing	Zeynep	NOT STARTED	11/2/23	1	11/3/23
Incorporate changes and refine	Zeynep	NOT STARTED	11/3/23	7	11/10/23
Slack/Thanksgiving	Zeynep	NOT STARTED	11/10/23	17	11/27/23
Final integration and refinement	Zeynep	NOT STARTED	11/27/23	6	12/3/23
Back-end Software					
web-scraping for kraft mac n cheese	Joshna	WORKING	9/10/23	7	9/17/23
testing and improivng webscraping	Joshna	NOT STARTED	9/17/23	14	10/1/23
convert string to braille characters	Joshna	NOT STARTED	9/24/23	19	10/13/23
test string to braille		NOT STARTED			
create gcode file with movements	Joshna	NOT STARTED	11/19/23	12	12/1/23
test braille to gcode		NOT STARTED			
Hardware Systems					
Design Solenoid System	Becky/Zeynep	WORKING	9/17/23	14	10/1/23
Initial Ciruit Design for 3 solenoid embossing system	Becky/Zeynep	WORKING	9/17/23	3	9/20/23
Simulations in LT Spice to test power limitations	Becky/Zeynep	NOT STARTED	9/20/23	3	9/23/23
Refine and adjust initial design	Becky/Zeynep	NOT STARTED	9/22/23	3	9/25/23
Design print heads	Becky	NOT STARTED	9/17/23	14	10/1/23
CAD embosser "print head" prototypes (1 vs 2 vs 3 vs 6)	Becky	NOT STARTED	9/17/23	3	9/20/23
Design x/y plotter	Becky	NOT STARTED	9/17/23	14	10/1/23
CAD x/ty plotting system	Becky	NOT STARTED	9/17/23	3	9/20/23
Task	Becky	NOT STARTED	9/20/23	3	9/23/23
Task	Becky	NOT STARTED	9/22/23	3	9/25/23
Combine solenoid and plotter designs	Becky/Zeynep	NOT STARTED	9/25/23	4	9/29/23
Design control circuit	Becky	NOT STARTED	9/26/23	5	10/1/23
Slack	Becky/Zeynep	NOT STARTED	10/1/23	3	10/4/23
Refine initial designs	Becky/Zeynep	NOT STARTED	10/4/23	8	10/12/23
Slack	Becky/Zeynep	NOT STARTED	10/13/23	8	10/21/23
Begin prototyping of system	Becky/Zeynep	NOT STARTED	10/21/23	3	10/24/23
Fabricate and test print head prototypes	Becky	NOT STARTED	10/24/23	3	10/27/23
Fabricate enclosure	Becky/Zeynep	NOT STARTED	10/27/23	3	10/30/23
Fabricate and assemble parts of x/y plotting system	Becky	NOT STARTED	10/30/23	3	11/2/23
Test x/y plotting system	Becky/Zeynep	NOT STARTED	11/2/23	4	11/6/23
Stress testing	Becky/Zeynep	NOT STARTED	11/2/23	4	11/6/23
Revisions and demo preparation	Becky/Zeynep	NOT STARTED	11/4/23	12	11/16/23
Begin integration	Becky/Zeynep	NOT STARTED	11/16/23	6	11/22/23
Design system to communicate w hardware via wifi	Becky/Zeynep	NOT STARTED	11/20/23	7	11/27/23
Slack/Thanksgiving	Becky/Zeynep	NOT STARTED	11/22/23	5	11/27/23
Final integration and refinement	Becky/Zeynep	NOT STARTED	11/27/23	6	12/3/23



Conclusions

Our proposal:

- Uses a website on a phone which is more convenient for blind people than a laptop
- Has a solenoid based embosser which makes the device more affordable and thus accessible
- Allows users to directly connect to the embosser from their phone

This device is useful and needed by the blind community and provides blind users with access to printed information at their fingertips!