

Making Smart Phones Accessible to Braille Users

Authors:

Andrew Wells
Undergrad

Robert Alexander
Undergrad

Maryam Etezzad
Faculty Mentor

Presenters:

Andrew Wells
Undergrad
Chapman University
awells@chapman.edu

Robert Alexander
Undergrad
Chapman University
roalexander@chapman.edu



CHAPMAN
UNIVERSITY



Andrew Wells

- Senior computer engineering major at Chapman University



Robert Alexander

- Junior computer engineering major at Chapman University



Smartphone Haptic Display

- **Smartphones** are an important tool in modern life
 - Primarily a visual medium
 - **Accessibility problem** for the blind and those with vision-impairments
- Small, lower-cost braille-type screen reader
 - 6x6 grid of **piezoelectrically actuated pins**
 - Phone **application**
 - Display text and images

Smartphone Haptic Display

- Research was started as part of a master's thesis by Jason Blood at Weber State
 - Continued by Professor Dhanya Nair [2]
 - Eventually passed on to us

Initial Design

- Smartphone communicated with USB dev controller board, connected to the LED array via I2C

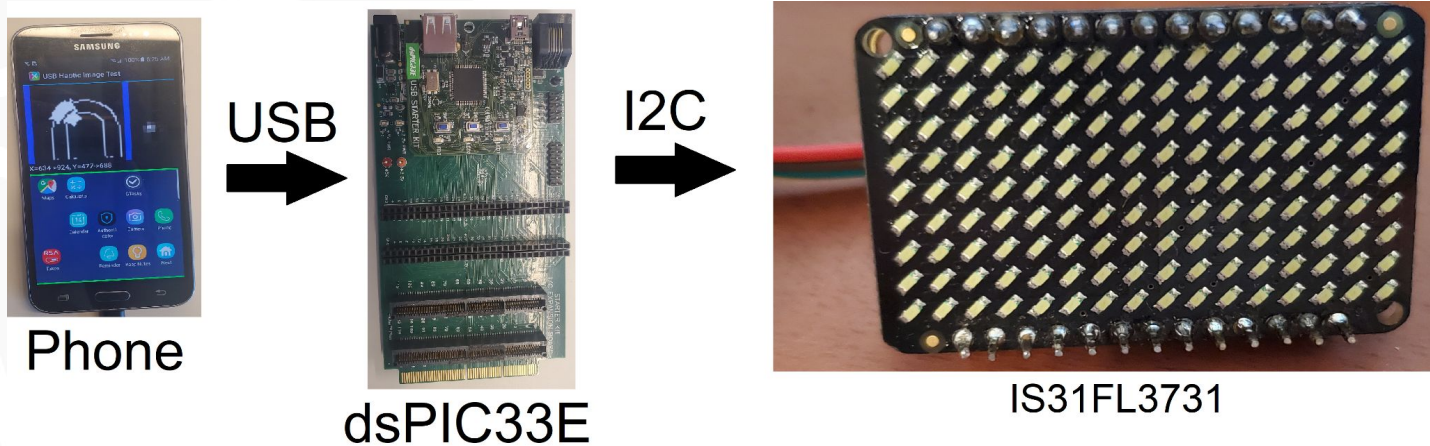


Figure 1: Original Hardware Design and Connection Protocols

Issues

- dsPIC33e (USB dev controller board)
 - Old board not recommended by the manufacturer for new designs
 - Relatively expensive for its feature set
 - We experienced intermittent I2C bus problems
- Similarly, the app contained a significant amount of deprecated code

New Hardware Design

- Phone connects with ESP32 controller over Bluetooth; controller connects to LED array over I2C still
- ESP32 is newer, cheaper
 - More support and available libraries

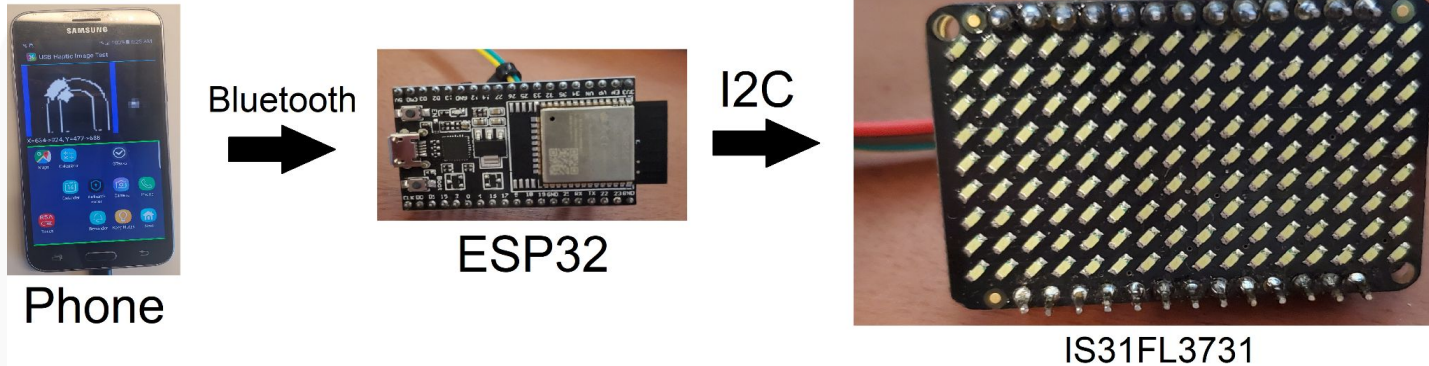


Figure 2: New Hardware Design and Connection Protocols

New App Design

- Demo shapes on the display
- Bluetooth
- Support for current Android
- Serial communication code based on previous code
- MIT App Inventor



Figure 3: New Test App Design in MIT App Inventor

Pin Grid Design

- Designing Mockups
 - Using *Fusion360*, we 3D model the pin grid shapes to test braille
 - Help gauge the effect of the display for the visually impaired
- Deciding next steps
 - Realizing flaws early allows us to effectively redesign for best user experience
 - Get feedback on ways to improve usability

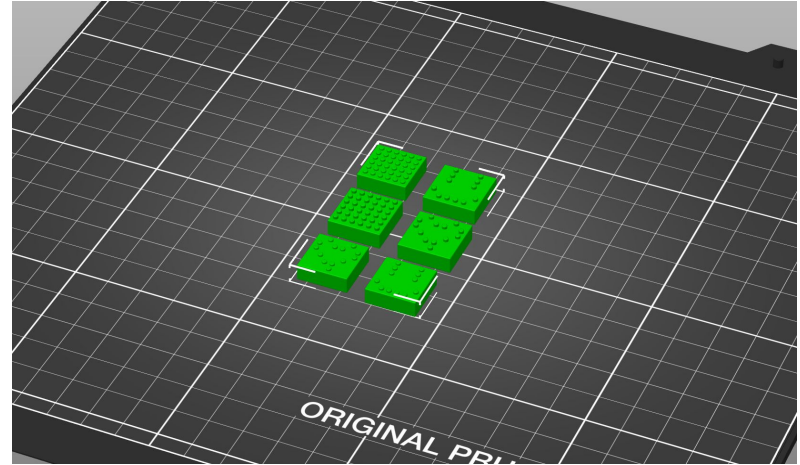


Figure 4: Test Pin Grid Models in PrusaSlicer

Conclusion and Future Work

- Transitioning LED grid to Pin grid
 - Each LED represents a Pin on the grid
- Further testing with the visually impaired
 - Ensuring that even with the pins the user experience is placed first

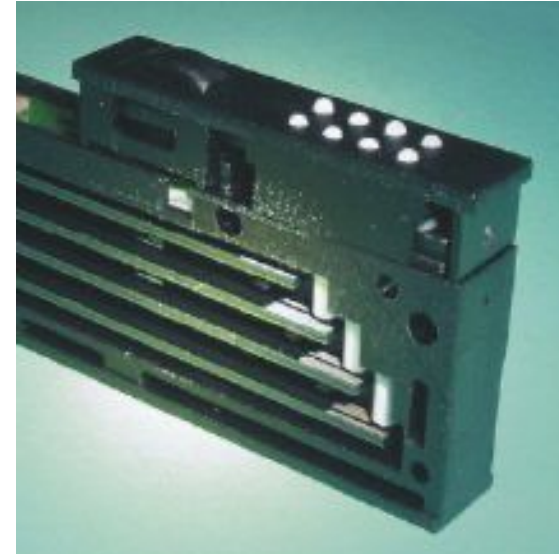


Figure 5: Example Pin Grid

[Braille-modules-with-a-conventional-and-b-novel-vertical-construction_Q640.jpg](#)

Acknowledgements

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