Multimodal Graphics for Blind and Visually Impaired Students

NSF Grant 1644538: Perceptual and Implementation Strategies for Knowledge Acquisition of Digital Tactile Graphics for Blind and Visually Impaired Students

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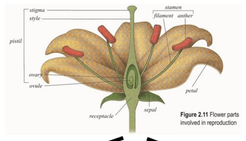
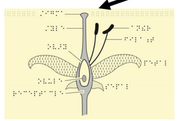
Motivation

- Pressing Challenge for Students with Blindness or Visual Impairments: **Graphical Access**



Traditional Media

Digital Media



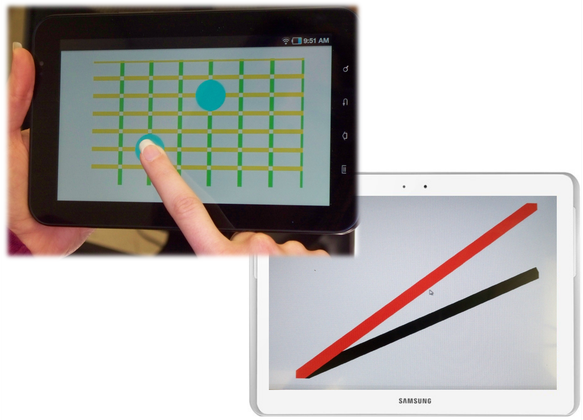
"Figure 2.11 Flower parts involved in reproduction. The flower pistil consists of the stigma, style, and ovary. The stamen consists of the anther and filament."

Image from BANA Guidelines (2018) http://www.brailleauthority.org/tg/web-manual/u3parts-of-flower.html

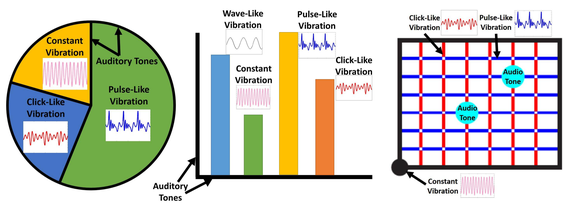
- **Growing Problem:** Educational Content is rapidly moving to digital formats

Overarching Goal

- Create accessible digital graphics using multimodal feedback on touchscreens

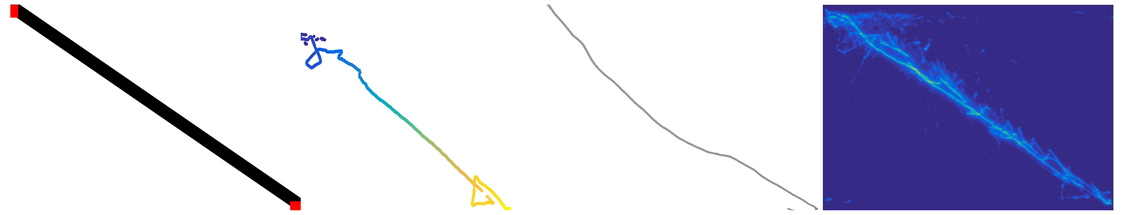


- Useful in interpreting **graphs** [1], **maps** [2], grids [3], and for **panning and zooming** on touchscreens [4][5].



Linear Line Following

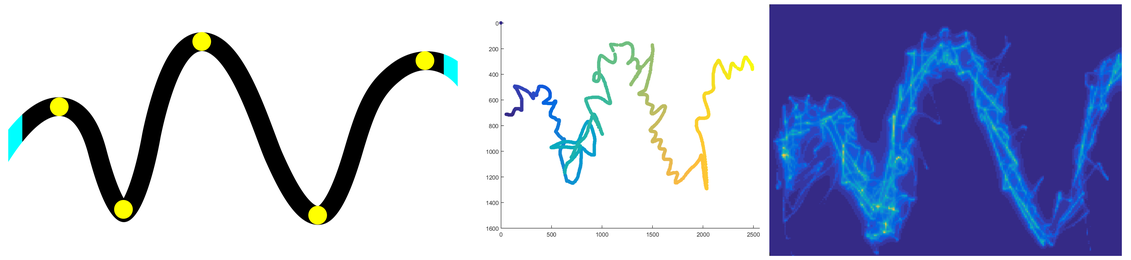
- **Can users follow straight lines on a flat, smooth, touchscreen surface?**



- **Bordered Lines:** Highest Accuracy (90%); Smallest Deviation (11-12 mm)
- **Solid Vibration Lines:** 81% Accuracy; 14.5 mm Deviation
- **Solid Auditory Lines:** 81% Accuracy; 13.5 mm Deviation

Non-Linear Line Following

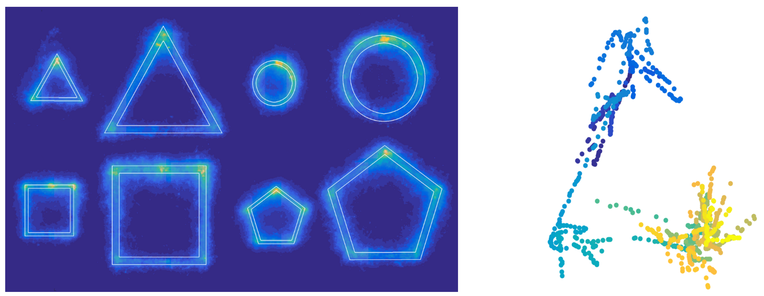
- **How to promote more accurate following of curves and deviations in lines?**



- Auditory Inflection Points:
  - **Improved** average deviations - 1 point: 7-8 mm; 3 point: 7-9 mm
- **No difference** between the 2 cases – User preference is important!

Shape Identification

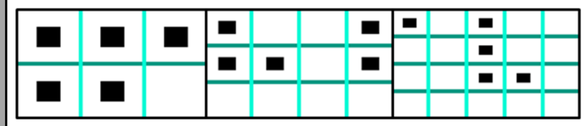
- **Can basic shapes be identified [6]?**



- **Identification Accuracy: >78%**
  - **Pentagon was poor – 47%.**
- Exploration Strategies: Circling of Vertices or Junctions and Anchoring
- Necessary to signify vertices

Effect of Screen Size

- **Impact of Screen Size on Simple Pattern Matching Task**



- **Tablet-sized** devices more useful in situations where the **accuracy** of the interpretation of the graphic is important.
- **Phone-sized** screens afford comparable accuracy, but are **quicker** to explore.

Guidelines and Framework

- **Optimal vibrotactile line width: 4 mm**
- **Gap width between vibrotactile lines: 4 mm**
- **Borders around lines encourage finer tracing but solid lines are sufficient**
- **Inflection Points or Points of Interest (Vertices) should be represented with a different cue (ideally a different modality)**
- **Physical Reference Markers on the Screen Border promote better navigation and enable kinesthetic referencing**
- **A Read-Aloud Textual Background Description is helpful at the onset of exploration for context**

MORE TO COME!

Acknowledgements

- We acknowledge the National Science Foundation for supporting this work (Grant #1644538).

References

[1] Klatzky, Giudice, Bennett, & Loomis, 2014
[2] Poppinga, Magnusson, Pielot, & Rassmus-Gröhn, 2011
[3] Gorlewicz et al, 2014
[4-5] Palani & Giudice, 2017, 2016
[6] Tennison & Gorlewicz, 2016

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