McSig - A Multimodal Collaborative Handwriting Trainer for Visually-Impaired People

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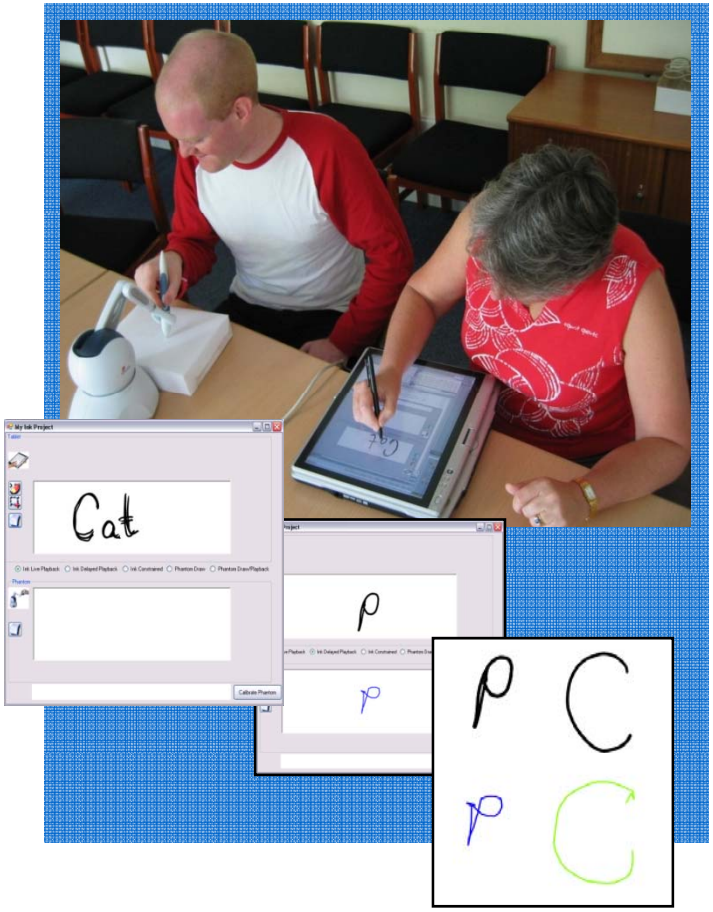
Peter Reid –
Current work



Outline

- Haptics Basics
- Rationale
  - Why is writing important for a VI person
  - Why is a difficult thing to train
- How can we train users to draw a letter shape
  - One solution – haptic trajectory playback
  - How good are people at recalling a trajectory they’ve been dragged through
- McSig

Haptic ~ Touch

- Haptics interact with the user via the sense of touch by applying forces, vibrations and/or motions to the user.
- Generally in a 3D space – this is not touch screen type technology which is sensing pressure on a flat 2D interface

- Forces make it harder for the user to move the device in a particular direction
- Vibrations simulate the feedback from real objects
- Movements are used to rehearse the user's required action.

Devices

Phantom Premium

~ $40,000

Phantom Omni ~ $4,000

dAb was introduced at SIGGRAPH 2001 in a paper by [Baxter 2001]

New – cheap device

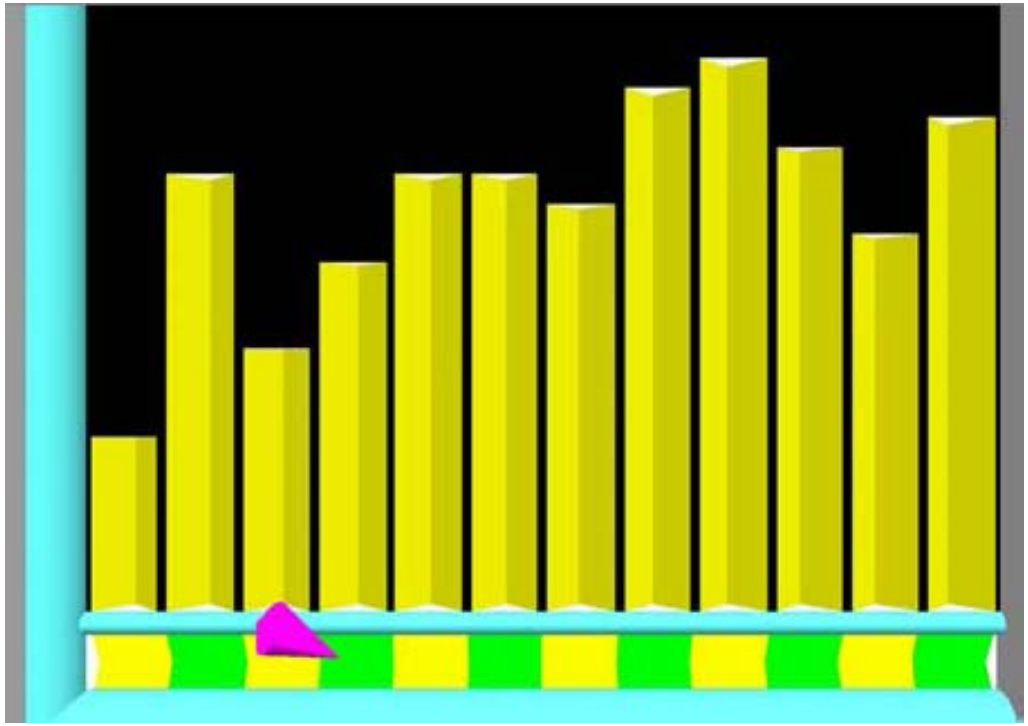
- $189 US
- Promoted as
  a games device

- Movie clips from Novint

- http://www.novint.com/novintfalcon.htm

Related work

Haptic Cow – Sarah Bailey (Glasgow)

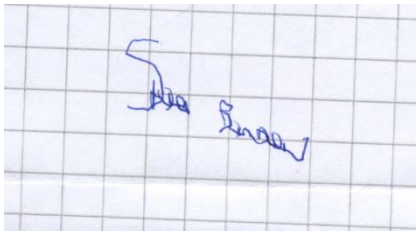


SoundBar System. Bars are represented as recessed grooves, the SoundBar is located below the bars. When a segment of the SoundBar is touched with the PHANTOM (represented by the cone shaped object), a note proportional to the height of the bar immediately above is played.

McGookin and Brewster (2006), SoundBar: exploiting multiple views in multimodal graph browsing,NordiCHI '06

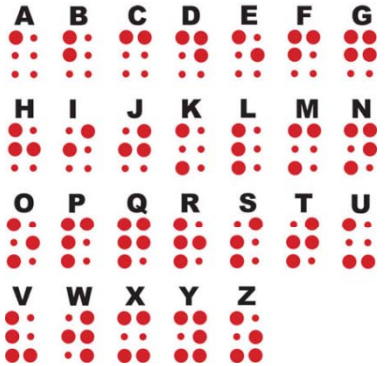
Why do Visually Impaired People Need to Write ?

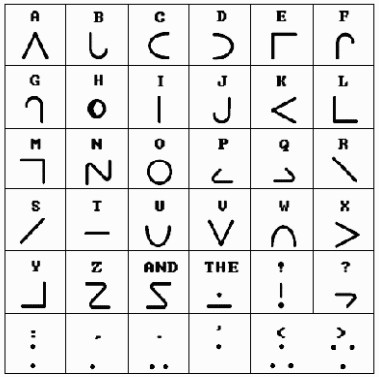
- Signature
  - Difficult without visual feedback
  - Important for Job Applications, Legal documents etc.
  - One participant described her signature as *'resembling the meanderings of an inebriated fly'*
- More general problem with spatial data
  - Presenting
  - Creating



Traditional Accessible Technologies

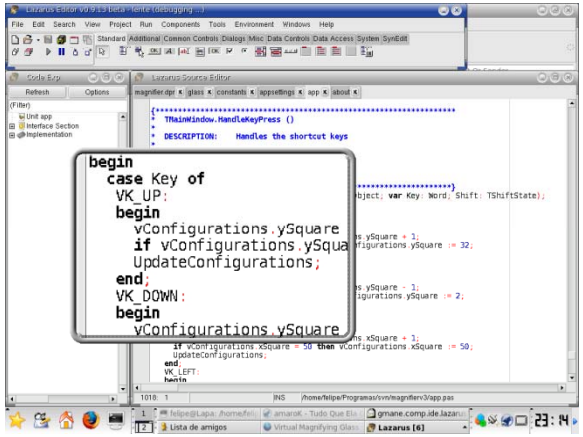
- Text information
  - Tactile
    - Coded representations - Braille, Moon etc.
    - Optacon
  - Audiobooks
- Spatial data
  - Raised Paper
  - Dutch drawing boards





Accessible Computing

- Magnifiers
  - Need some sight
- Screen Readers
  - Read text from the screen
  - Not good for non-text information
- Dynamic Braille
- Non-Text or spatial data is very difficult to present non-visually
  - Maps, charts, graphs, diagrams, web pages

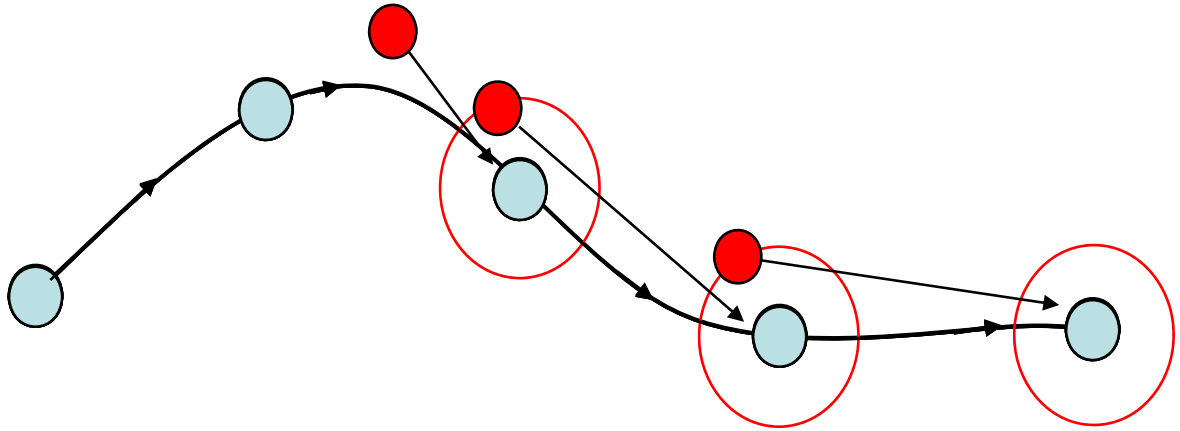


Force Feedback as an Accessibility Aid

- Guidance
  - Force effects on widgets
  - collaboration
- How can force feedback be used to convey spatial data
- Related work
  - Feygin (2002) – Haptic vs haptic visual playback
  - Oakley (2003) – Collaborative playback
  - Baillie (2007) – Training veterinary students
- Our research question
  - Can trajectory playback techniques be used to communicate shape and trajectory information to visually impaired people ?

Haptic Guidance

- Playback Controller
  - PID a standard control engineering algorithm
  - Minimise error between cursor position & target position
- Trajectory split into sample positions
- The user is dragged through a close approximation of the path



McSig: Multimodal, collaborative handwriting and signature training tool

- Haptic guidance and audio feedback
  - Based on Andy's previous work
- Teacher and student work synchronously on shared representation sat next to each other
- Teacher guides the student to learn letter shapes using words and actions
- Student holds PHANTOM Omni pen, teacher uses touchscreen
  - Teacher can move student's pen around the character shape
- Audio feedback as shape is drawn
  - Left/right movements: pan, up/down movements: pitch

McSig – system design

- Simulate standard school learning scenario
- Teacher can choose collaborative or free drawing mode
- Collaborative *Playback* mode: student dragged through shape as it is drawn by teacher
- Free *Stencil* mode: teacher draws letter which is used as a stencil, then student explores it
  - Can reduce constraining forces as student gets more experienced

McSig – first evaluation

- 1 blind adult
- Feedback key to learning
- Fully virtual display was poor
- Added Dutch drawing board – shape is raised on the paper
- Can be felt with other hand

Formative testing

- 4 visually impaired adults (3 blind, 1 partially sighted)
- Started with playback mode and then moved on to stencil
- Finally drew the letter unsupported
- Stencil mode hard to use
  - Strengthened forces for shapes to give clearer path
    - Problem with Omni
- Audio feedback useful to some, teacher descriptions most useful
- Omni pen difficult to hold, plus pressing button whilst drawing tricky
  - Users not used to holding pens
  - Gave some pen training before main study

McSig evaluation

- Could McSig improve handwriting performance?
- Task designed with teachers
  - Some children almost no handwriting skills, some have good skills
  - 4 characters chosen after discussion with teachers
    - o, c, a, d, e
- Participants
  - 8 children 11-17 years old, read Braille, no other major disabilities
  - 3 partially sighted, 5 blind
- 4 stage study
    - Familiarization with McSig, then for each letter:
      - Pre-test
      - McSig training
      - Post-test

Familiarization and Pre-test

- Participants could feel setup, PHANTOM, mat, PC
- Spatial orientation
- Drew circle, horizontal and vertical lines
- Practised with the pen
- In pre-test got participants to draw each letter as best they could
  - Some unable to draw one or more of them

McSig Training and Post-test

- After pre-test teacher showed participant how to draw letter in Playback mode
  - Synchronous audio/haptic feedback
  - Experimenter wrote shape on screen, child felt it with PHANTOM and scored line on tactile sheet
  - Number of repeats based on child's confidence
- Post-test
  - Got participants to draw character using McSig but with no feedback
  - If participant could not draw it we trained and tested again
- Time-out after 20 mins
  - Stopped earlier if all letters done

Results – partially-sighted children

- Participants
  - All could read enlarged print
  - All had deteriorating sight but had learned to write when sight was better
  - Did not write now as sight too bad
- Familiarized very quickly, could all do circle, horizontal and vertical lines no problem
- One participant all our letters in the pre-test

Pre Post

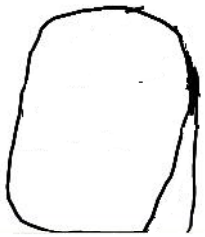
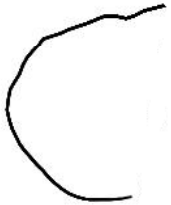
Results – partially-sighted children

- One did a normal ‘e’ but did it the wrong way around
- Participants had eyes close to drawing surface but did not feel drawing surface with non-dominant hand
  - Wanted to use their sight
- All trained quickly and did all letters correctly in post-test
  - Completed within 20 mins
- Politely interested but not captivated

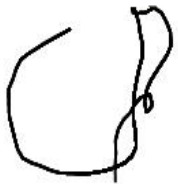
Results – blind children

- Participants
  - 5 totally blind
  - One lost her sight at 3 years, others blind from birth
- Familiarization took much longer
  - Pressure on pen – too much/too little
- Interacted with drawing space very differently
  - Non-dominant hand for orientation in space
- All but one could draw circle and lines
- Before and after examples

“Mae”

“Mae” Age 14	**o**	**c**	**a**	**d**	**e**
Pre-test		Unable to do	Unable to do	Out of time	Out of time
Post-test				Out of time	Out of time

“Sue”

“Sue” Age 19	**o**	**c**	**a**	**d**	**e**
Pre-test	No data		Unable to do	Skipped	Unable to do
Post-test	No data			Skipped	

“Tam”

“Tam” Age 13	**o**	**c**	**a**	**d**	**e**
Pre-test		Unable to do	 In his name	Unable to do	Out of time
Post-test					Out of time

“Nik”

“Nik” Age 11	**o**	**c**	**a**	**d**	**e**
Pre-test		 Formed backwards		Unable to do	Out of time
Post-test					Out of time

“Ann”

“Ann” Age 17 Sight till 2-3yrs	o	c	a	d	e
Pre-test		Unable to do	In name		Unable to do
Post-test					

Results – blind children

- Skills varied a lot
  - Some knew letters in their names
- Mae couldn't create a circle in pre-test and knew no letter shapes
  - Did 2 rounds of training on 'c' and 3 on 'a' before she felt she could remember them
  - We timed out at 20 mins
  - Did well in post-test – 'o', 'c' and 'a'
- Ann (sight for 2-3yrs) could do an 'o' and 'a' in pre-test
  - Learned the others quickly
  - Scaled letters accurately
    - Training letters were around 6cm
    - She drew them at 1cm in post-test

Results – blind children

- Sue could do ‘c’, ‘a’ and ‘e’ in post-test
- Nik and Tam showed general improvements
- Suggests McSig could help them learn
- They were all very interested and expressed excitement at using the tool
  - Motivating for learning?

Discussion

- Results suggest that McSig could help children to learn
  - Especially blind children
  - A self-teaching tool would be very useful for learning at home
    - Even more challenging to design
    - How do you get input to computer when both hands busy on PHANTOM/drawing surface?
    - Voice is in theory possible but recognition rates would need to be fantastic!
- Why didn’t stencil mode work?
  - No physical representation of the letter
  - Better PHANTOM?

Current Work

- Cursive handwriting and signatures
  - Support move from single letters to cursive
  - A signature can be created and then practised to keep it consistent over time
- Wider context
  - Could be used in any application where the teacher wants to guide student
    - Geometry, 2D and 3D shapes
    - Charts and graphs
    - Beacons?

Conclusions

- Hard for visually-impaired people to learn to handwrite
  - Signatures difficult to learn and keep consistent
  - Required for important aspects of life
- McSig: a collaborative tool that allows a teacher to guide a student to handwrite letter shapes
  - Dynamic haptic and audio feedback
- Can improve handwriting in 20 minute session
  - All blind students learned at least 2 new letters
  - Enjoyed the experience
- Now working on longer-term study to see how learning develops over time

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Demo Time!