SURF-IT Final Report: A Preliminary Study in Making Comics Accessible to Visually Impaired Persons

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1 Motivation

Access to graphical content remains limited to a person with a severe visually impairment. Graphics are most commonly transcribed into braille or audio, removing the reader's input into the interpretation. Visual images that are converted to a tactile images can be done either through inexpensive manual methods (using craft tools), or using more expensive automatic tactile image embossers or PAIF heaters and swell paper. At present, the only text-image conversion available is for semi-automated conversion of abstract diagrams (histograms, flow charts, etc.).

1.1 Comics

Comics are an unstudied media for accessibility with unique challenges:

- Text and images mingle.
- Images are fantastical.
- Text is confined to small areas.

That said, they also have a wide variance of complexity, from simple stick figures to science fiction landscapes. Also, the mixture of text and image allows for additional information than either alone.

2 Conversion

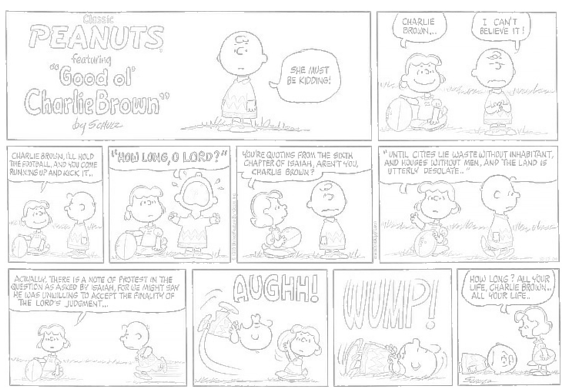
Evidence indicates that the tactile modality alone is insufficient to make up for the spatial information gained in the visual modality (Dulin & Hatwell, 2006 and James, et al., 2001). As such a multimodal audio-tactile design was created to allow additional information. For this study, a manually-controlled pipeline was generated, splitting the work into image processing and audio overlaying.[1]

2.1 Image Processing

2.1.1 Reduction to 20dpi and Grayscale

As the braille embosser can only emboss at 20 dots-per-inch, the first step is to reduce the image to the appropriate dpi. As the embosser embosses at heights relative to color intensity, color images are reduced to grayscale.

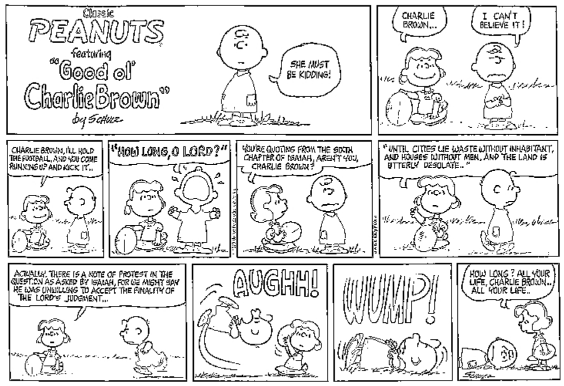
2.1.2 Edge Detection



An edge detection algorithm finds the edges of image highlight them in the image. Laplace was found more effective with simpler comics while Difference of Gaussians worked better on the more complex ones. In addition, Sobel, 2x2, Roberts, and Prewitt compass algorithms were looked at.

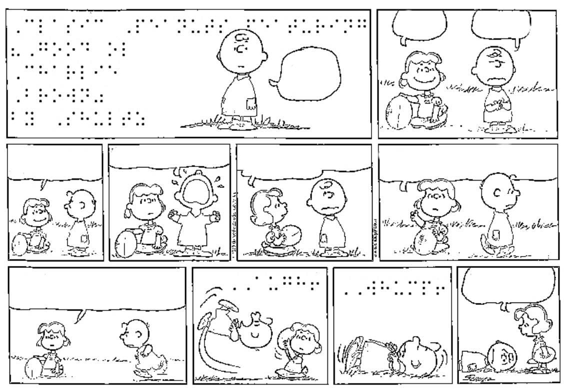
[1]The images shown here are manipulated from a 2004 *Peanuts* cartoon and are copyright Charles M. Shultz. The manipulations done are under fair use for scholarly research purposes.

2.1.3 Black and White Color Reduction



As literature indicates that contours are more easily recognized tactilely, we reduce the color to 1-bit. Black portions of the image are embossed while white portions remain untouched.

2.1.4 Text Conversion



The original print text is removed from the image and a braille overlay is added atop the image. The image is then ready for embossing.

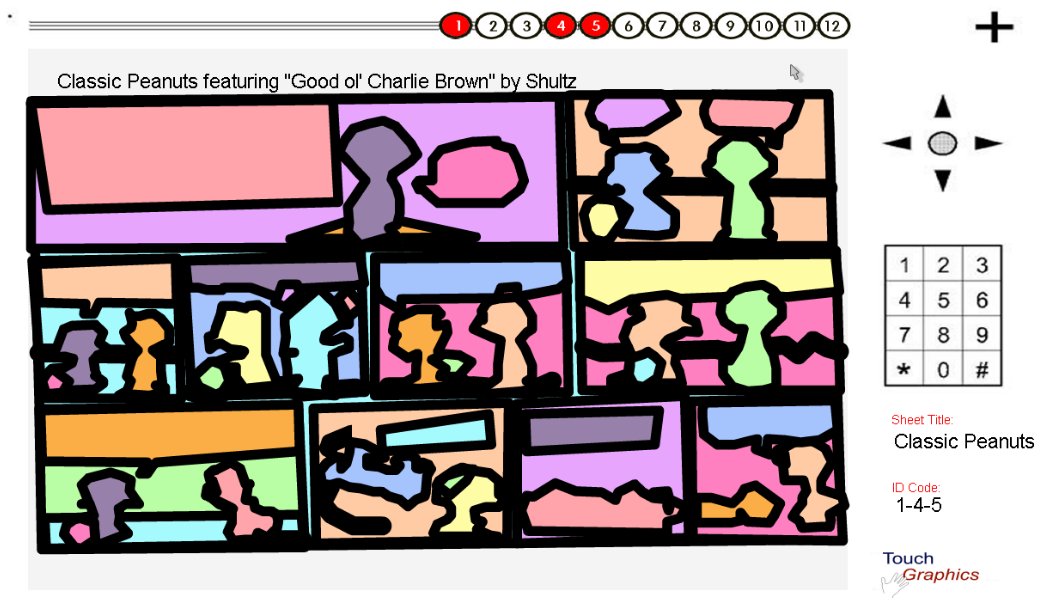
2.2 Touch Tactile Tablet

The Touch Tactile Tablet (TTT) is a large, touch screen input created by Touch Graphics[2]. Designed for visually impaired users, TTT links audio data to areas of the touch screen's surface.

2.2.1 Mounting Image

Tactile images are mounted to sheets that are formated to work with the TTTT. It should be noted that the workspace for the TTT is smaller than indicated on the sheets.

2.2.2 Authoring Tool



The TTT authoring tool allows the user to add audio to different regions. To do so, the author must mark the vertices of each region manually and either type for text-to-speech or include an audio file. There is an option to record audio in the TTT, but the volume remains very quiet using this.

Layers of information for regions can be used to allow a more details, if the user may need it. Yet, with overlapping regions, only the audio information for the top region can be accessed.

[2]http://www.touchgraphics.com/

3 Conclusions

3.1 Tactile Modality

Positives

Images that were more complex than those found in the literature were able to be converted. [3]. This indicates that more complex images can be converted, which could allow for more diversity in information and style.

Negatives

With the tactile images, there was some disconnect between characters and their speech bubbles. In addition, there was some issue with general story continuity. The background, foreground, and braille would overlap, making it more difficult to deduce.

Future Work

The conversion done thus far allowed for edges to remain within characters. Reducing these characters even further to simpler silhouettes may prove more beneficial. In addition,recognition may be improved using a PAIF machine and swell paper and should be tested.

3.2 Audio Modality

Positives

The additional information greatly compensated for the reduction of visual feedback and allowed for the traditional summary transcription. The use of a top-down approach to labeling prevented excessive information, found when doing bottom-up. Top-down involves processing from contextual features (person, building, etc.); bottom-up labels sensory input (red, bumpy, etc.).

Audio provided an alternative to braille for filling in speech bubbles. As such, there was less excess texture and braille overlapping background.

Negatives

The author is restrained to a much smaller area than a normal braille sheet when working with the TTT, reducing the size of possible images. The included voice is very difficult to understand, making it necessary to record informatioProcess started

Future Work

The TTT was only partially satisfactory, and it may be worth exploring changing it out for a standard graphics tablet or touch screen.

[3] Compare to Harder & Rainer, 2002; Jayant et al., 2007; Krufka & Barner, 2006; Krufka & Barner, 2006; and Ladner et al., 2006

4 References

DULIN, D., AND HATELL, Y. 2006. The Effects of Visual Experience and Training in Raised-Line Materials on the Mental Spatial Imagery of Blind Persons. *Journal of Visual Impairment & Blindness 100(7)*, 414-424.

Studies the effects of experience with textual images with congeniality blind, late blind, and sighted participants. The study found that experience with tactile images and onset of blindness are both factors with deducing tactile spatial imagery.

HAMANN, S.E. 1996. Implicit Memory in the Tactile Modality: Evidence From Braille Stem Completion in the Blind. *Journal of Visual Impairment & Blindness 96(10)*, 711-723.

Priming of braille terms with severely visually impaired individuals. Results indicate that there is implicit memory in tactile sensory perception.

HARDER, A., AND RAINER, M. 2002. The Target-Route Map: Evaluating Its Usability for Visually Impaired Persons. *Psychological Science 7(5)*, 284-288.

Creation and evaluation of tactile maps where the route is a larger scale to surrounding areas. Findings indicate that the enlarged scale improved recollection of the route and details of it.

JAMES, T.W., HUMPHREY, G.K., GATI, J.S., SERVOS, P., MENON, R.S., AND GOODALE, M.A. 2001. Haptic study of three-dimensional objects activates extrastriate visual areas *Neuropsychologia 40(10)*, 1706-1714.

fMRI-based study comparing parts of the brain activated by visual and tactile sensory input. There is overlap in some of the regions, but there are also distinct regions for the modalities.

JAYANT, C., RENZELMANN M., WEN, D., KRISNANDI, S., LADNER, R., AND COMDEN, D. 2007. Automated Tactile Graphics Translation: In the Field. In *Proceedings of the 9th International ACM SIGACCESS Conference on Computers and Accessibility*, Tempe, AZ, USA, October 2007. ACM, New York, NY, 75-82.

Review of the University of Washington's Tactile Graphic Project, a semi-automated system to convert diagrams,

KRUFKA, S.E., AND BARNER, K.E. 2006. A user study on tactile graphic generation methods. *Behaviour & Information Technology 25(4)*, 297-311.

Uses a braille tactile image embosser and compares recognition of various styles of embossing. With a braille embosser, they found subjects were best at identifying contoured images than embossed or partially-embossed ones.

KRUFKA, S.E., BARNER, K.E., AND AYSAL, T.C. 2007. Visual to Tactile Conversion of Vector Graphics. *IEEE Transactions on Neural Systems and Rehabilitation Engineering 15(2)*, 310-321.

The algorithms used for the study above.

LADNER, R.E., IVORY, M.Y., RAO R., BURGSTAHLER, S., COMDEN, D., HAHN, S., RENZELMANN M., KRISNANDI S., RAMASAMY, M., AND SLABOSKY B., MARTIN A., LACENSKI A., OLSEN S., GROCE D. 2005. Automating Tactile Graphics Translation. In *Proceedings of the 7th international ACM SIGACCESS conference on Computers and accessibility*, Baltimore, MD, USA, 2005. ACM, New York, NY, 150-157.

Introduces Tactile Graphics Project and provides information on current tactile image conversion practices.

PASQUALOTTO, A., AND NEWELL, F.N. 2007. The role of visual experience on the representation and updating of novel haptic scenes. *Brain and Cognition 94(3)*, 146-155.

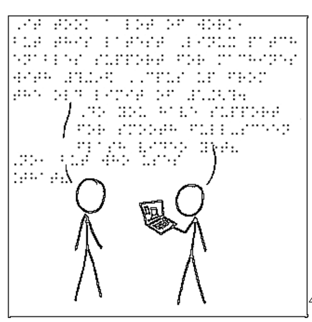
Study of haptic recognition of 3D scenes in congenitally blind, late blind, and sighted subjects. In order of skills for this task: late blind, blindfolded sighted, and finally congenitally blind.

5 Appendix

5.1 Comics Used

The images below have been manipulated to varying degrees using the technique described above. This was done under fair use for scholarly research purposes.

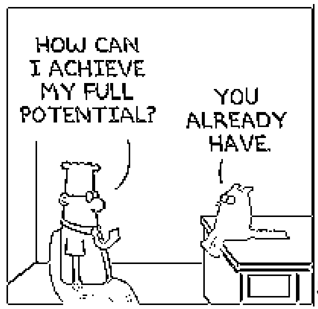
XKCD


[4]

A black and white, stick figure webcomic, this is by far the simplest work used and was most successful in being converted. *XKCD* is also text-heavy compared to many comics.

[4]2009 *XKCD* cartoon, copyright Randall Munroe

Dilbert



[5]

A black and white or color cartoon, *Dilbert* has minimal background. During the conversion process, furniture would melt with characters and the animal characters lost many of their distinguishing shapes.

Peanuts

Peanuts are a black and white or color cartoon, featuring background and various characters. The backgrounds were difficult to separate from characters, but the individual characters remained distinct.

Fantastic Four and X-Men

[6]

Fantastic Four and *X-Men* feature more fantastical characters and more detailed backgrounds. There are group character images and characters drawn very small. At this level of complexity, the conversion process had mixed results with some panels accessible and others undistinct.

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[5] 2007 *Dilbert* cartoon, copyright Scott Adams

[6] 2005 *Marvel Age Fantastic Four Tales 1* and 2004 *Uncanny X-Men 448* comic books, copyright Marvel Comics

Fullmetal Alchemist


[7]

A Japanese manga, *Fullmetal Alchemist* is black and white but includes textures. Characters are often overlapping one another. Panels will include characters talking while the image is of scenery or different characters. This manga was successful 1-2 panels for every 6.

Superman, no. 1

[8]

The first *Superman* comic from 1938 has a large about of inking compared to modern comics and has had some deterioration over time. At this level of noise, only a tiny fraction of panels were successfully converted.

6 Acknowledgements

UCSC SURF-IT Research Experiences for Undergraduates Site, NSF grant CNS-0732604

[7]2001 *Fullmetal Alchemist* manga, copyright Hiromu Arakawa

[8]1938 *Detective Comics*, copyright DC Comics