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Interactive Sonification of Images on Mobile Devices for the Visually Impaired

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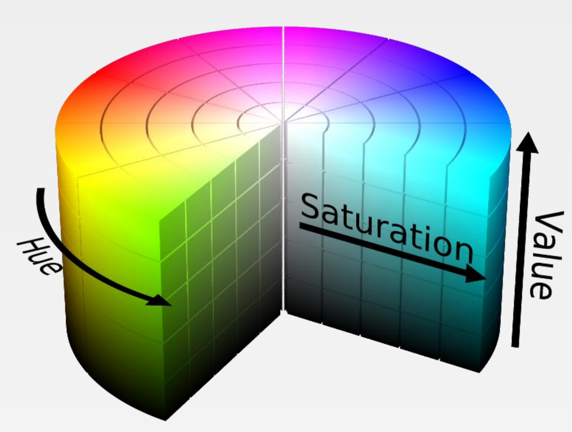
INTERACTIVE SONIFICATION

The project proposes several image sonification algorithms for use on mobile devices in education of blind children. The sonifications use greyscale or HSV color space representation for images and the software is written for all Android devices with large touchscreens.

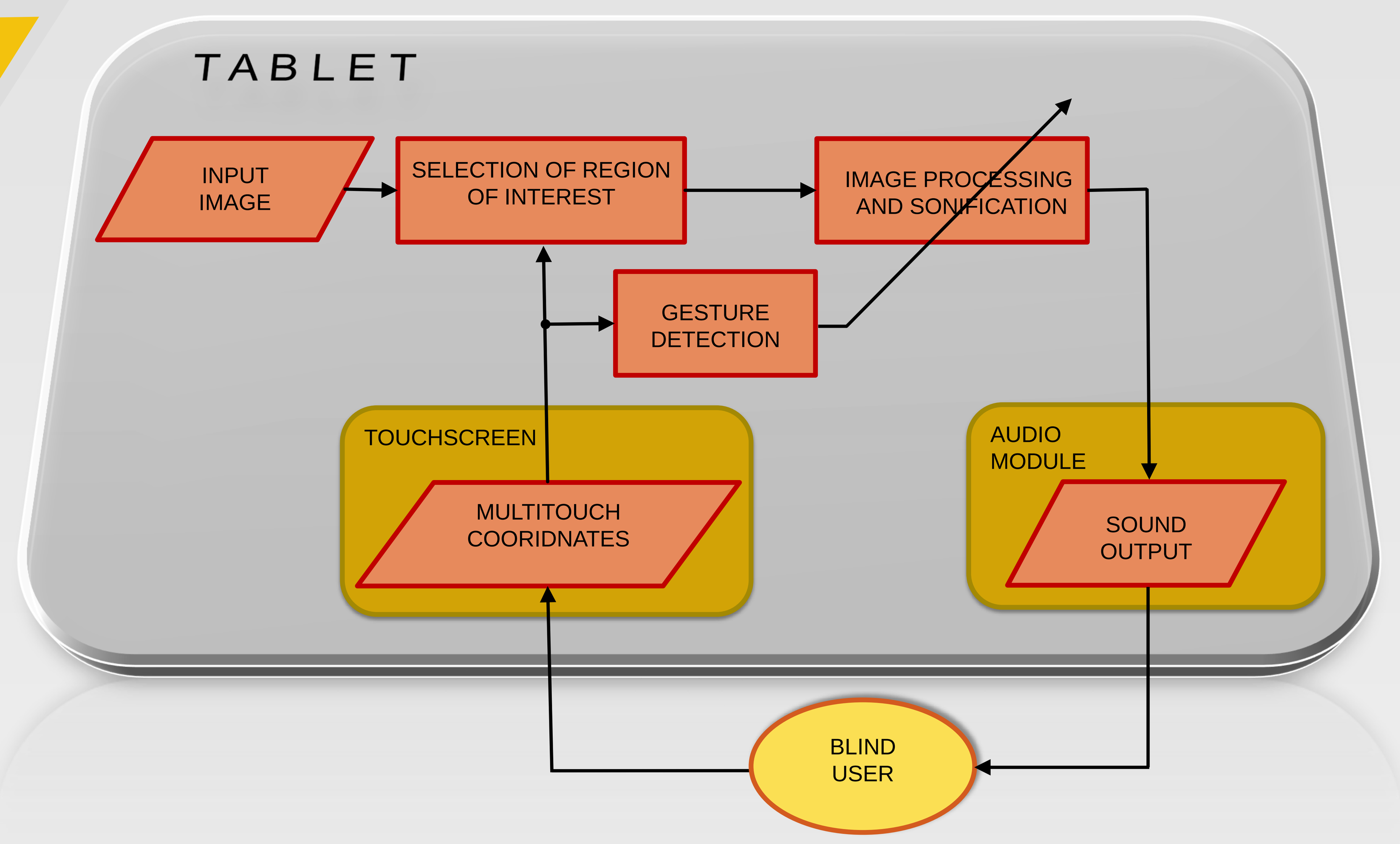
The interactive sonification methods can be divided by:

- Region of interest indicated by touch gestures (one pixel, line or area)
- Image processing filters (the image can be blurred, sharpened or tresholded)
- Color or greyscale images
- Coninuous or looped sonification

$$g_{HSV2}: HSV \to \mathbf{S},\ g_{HSV2}(H,S,V) =$$
$$(s_1^1(f_b/(1+S\cdot c_{21}), V\cdot g_{amp}((H+c_{31})\,\mathrm{mod}1)),$$
$$s_2^1(f_b/(1+S\cdot c_{22}), V\cdot g_{amp}((H+c_{32})\,\mathrm{mod}1)),$$
$$s_3^1(f_b, V\cdot g_{amp}((H+c_{33})\,\mathrm{mod}1)),$$
$$s_4^1(f_b\cdot(1+S\cdot c_{22}), V\cdot g_{amp}((H+c_{34})\,\mathrm{mod}1)),$$
$$s_5^1(f_b\cdot(1+S\cdot c_{21}), V\cdot g_{amp}((H+c_{35})\,\mathrm{mod}1)))$$



The HSV color space is converted to a linear combination of three sound buffers, taking advantage of the circular nature of the hue component. Saturation controls the „cleanness" of the sound and brightness its loudness. The mod1 operation is a „wrap around 1" to keep values in the <0,1) range.



Interactive sonification user feedback loop

THE DEVELOPED SOFTWARE

The proposed synthesis method consists of combining s^n_m parallel sound buffers which make up the sonic space ***S***. Up to 16 buffers are simultaneously played, while their amplitudę and frequency of playback can be independently controlled. This gives a simple and computationally efficient real-time additive synthesis method that runs smoothly on all Android devices.

The developed software not only implements the sonification algorithms, but also allows:

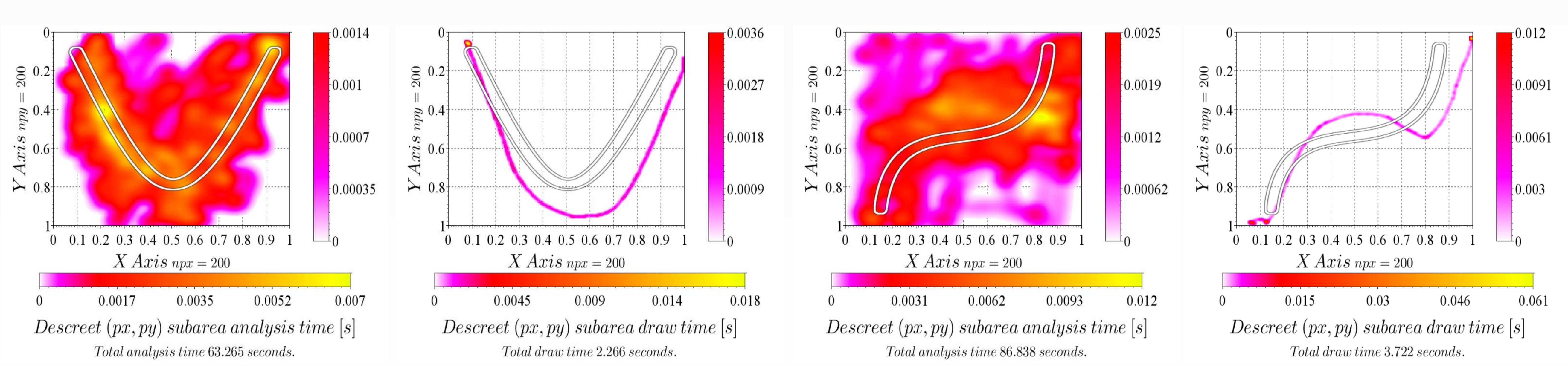
• creation of interactive illustrations or maps, with regions that have descriptions available through text-to-speech sythesis (label regions and text defined in XML files),

• implementation of research tests that present a list of images, questions and task for a user to execeute (e.g. retrace a presented figure)

• tracking of all user gestures and exporting them to a database

CONCLUSION

The presented sonification application was pilot tested with a number of blindfolded and blind subjects. The developed tools are intended to help conduct a larger study with a group of blind school children, which will study if interactive sonification of images and maps could be added to their curriculum.



Sample figure recognition and path retracing experiments.
Heatmaps of a user's gestures (left) and the final retraced path (right)

Custom 3D printed frames allow easier access to menu controls for blind users

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