Technical University of Lodz
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# INTERACTIVE SONIFICATION OF COLOR IMAGES ON MOBILE DEVICES FOR BLIND PERSONS - PRELIMINARY CONCEPTS AND FIRST TESTS

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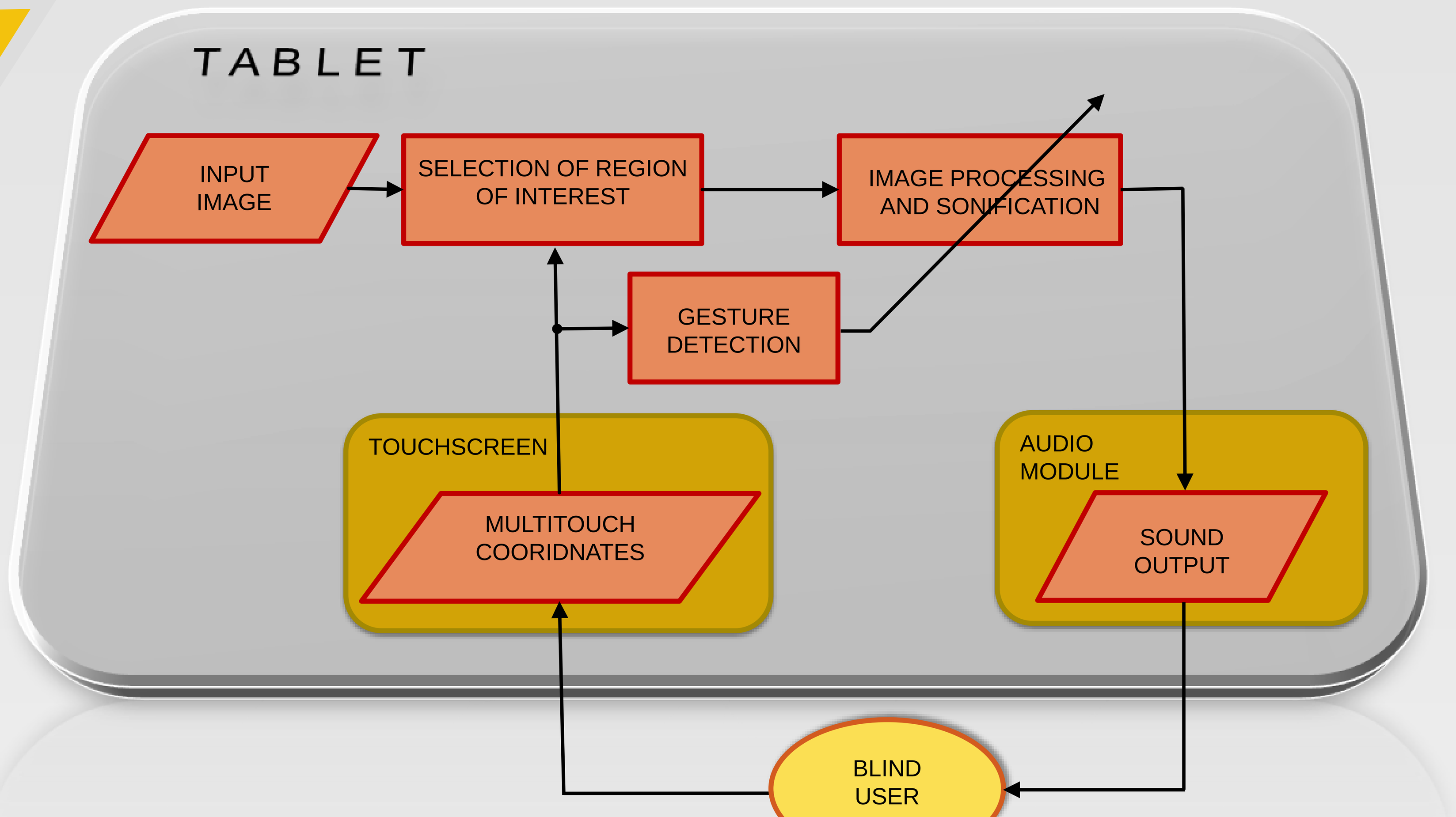
## INTERACTIVE SONIFICATION

An image sonification algorithm for use on mobile devices in education of blind children is proposed. The sonification uses HSV color space representation for images and the software is being written for Android devices with touchscreens.

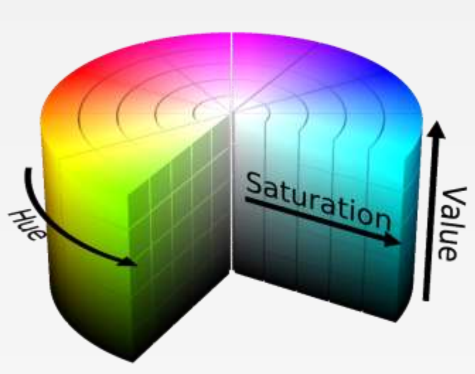
The presented algorithm is part of a larger project in which we propose several methods for interactive sonification where the user indicates with touch the area of the image to sonify. Depending on the selected image content and image processing filters a real-time additive synthesis of several sound buffers is implemented. The presented method sonifies just one pixel directly under the finger, using its HSV values as input to an additive synthesis transform; however, other methods are available for demonstration.

The focus was to create sonfication algorithms that are real-time and not computationally complex, while allowing to clearly distinguish not only brightness, but also the saturation and hue components determining color.




*Interactive sonification user feedback loop*

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




*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.*

## SONIFICATION ALGORITHM

The proposed synthesis method consists of combining $s^n_m$ parallel sound buffers which make up the sonic space ***S***. The ***S*** space is *n* dimensional and each of its elements is defined by the *m*-th buffer contents having unique timbres, the frequency a given buffer will be sampled with $f_{nb}$ and its amplitude scaling $A_n$.

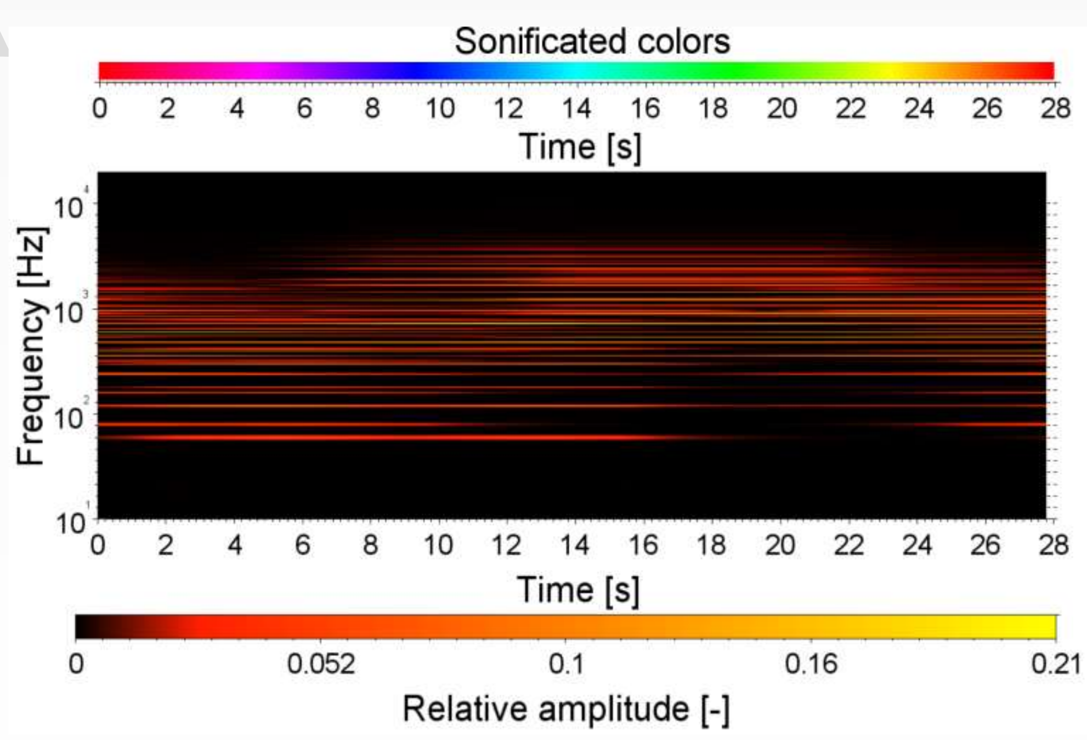
The basic sonification scheme presented in the paper aims to transform the HSV color space to the sonic space ***S*** according to the *g(HSV)* function shown on the left, where: $H,S,V \in <0,1>$, $c_1$, $c_2$ – normalizing coefficients, $f_b$ – audio buffer playback frequency, and the *mod1* operation is a „wrap around 1" to keep values in the $<0,1)$ range.

The transformation assumes generation of three independent sounds of predefined timbres, spaced apart in frequency. The spacing is dependent on the color saturation S, while the hue H shifts the base frequency. The brightness V determines the loudness for all the components.

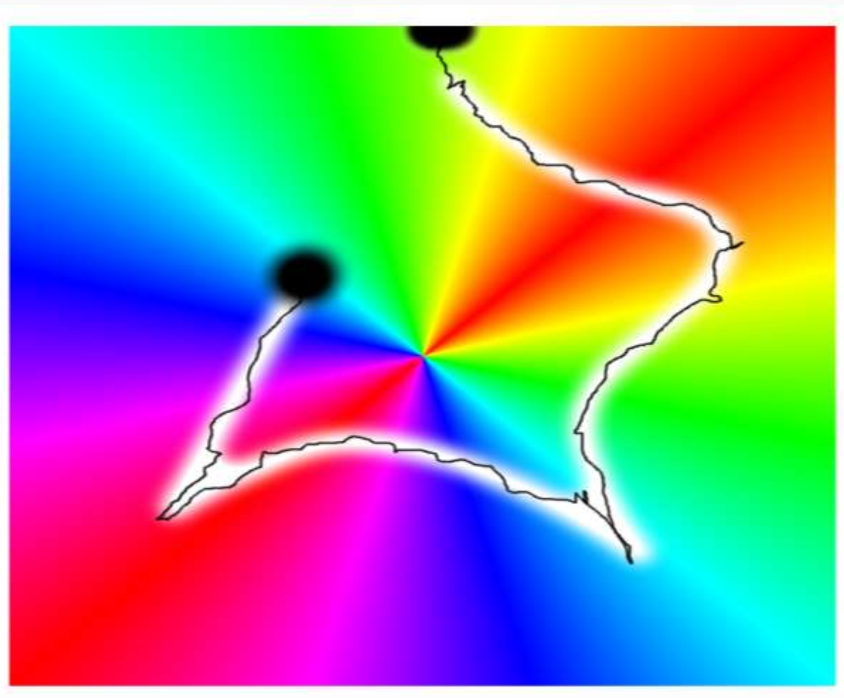
## CONCLUSION

The presented sonification application was pilot tested with four blindfolded and two blind subjects and is the first of a number of approaches proposed in the project. 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.

In the developed interactive sonification tool multiple image filters can be used to enhance an image, examples include color depth limitation, edge detection or Gaussian smoothing. Images loaded into the software can also have supplementary text information in XML files containing labels assigned to image regions, e.g. street names for maps, written descriptions of image content or instructions for educational tasks.




*Spectrogram of the sonification of a continuous color sequence with a constant saturation value (S=1)*



*Sample path-tracking experiment.*

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