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Making Images Accessible to the Blind

This essay describes technical aspects of enabling the Blind and the visually Impaired to experiencing images and movies. The proposed technical implementation is based on the a special dots relief array „display“ hardware that is planned to be developed within a currently proposed EC 6th Framework IST Programme Project.

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State-of-the-art

The common type of information that is transferred using tactile devices/materials is text (using Braille). There are also some applications that use static tactile maps (e.g. of museums, train stations, airports, etc.). Some picture books are also available that contain tactile images.

To present images in a tactile way, the image must be simple. Complex images must be reduced and simplified in order to provide meaningful non-overloaded information. By this, static tactile images cannot represent complex scenes such as photos or artwork.

The Display Hardware

A major outcome of the proposed project is a dynamic dot matrix array of the size of a sheet of paper. The dots are moved in the z-direction. By this, images can be represented topologically in 3D „landscapes“. The movements in the z-axis are highly dynamical. Pulsing and vibration is possible as well as fast image alterations in a frame-rate of approximately 2-3 frames per second.

A Sequential Image Presentation Approach

The human's tactile sense is not as accurate as the eye – a conversion of the original image to a greyscale image and a 1 by 1 mapping to the z-axis of the dot array is not sufficient. Image enhancements and simplifications are required in order to present the image information in a way that it can be experienced by the Blind. Nevertheless a reduction of information is not always desired. To solve these problems, it is proposed to present different aspects of the image in a sequential way that can be controlled by the user. By the proposed *Image Aspect Filters (IAF)*, the image is seperated in certain aspects such as edges, brightness, shapes, etc.

The user is able to experience images aspect-wise in a sequential way by freely switching between the most meaningful IAF representations. Besides other filter-specific settings the complexity of the generated filter image can be specified by a scroll wheel.

Since the display hardware is also able to generate vibrations of different strength, this feature can be used as an additional dimension to carry extra information in parallel to the topological representation. By this, image aspects may be combined and presented simultaneously. For Example the combination of object bounds (relief) and motion blur (vibration) is meaningful for images that display movement.

Image Aspect	Information transferred
Edges	Shapes, Objects
Object bounds	A handle to further object access. By this, the object can be zoomed (e.g. by tapping on it)
Colours (selective separation)	Information about scenes (sky, road, lawn, sun, water) and objects (the color of...)
Brightness	Various information about the area of interest, textures, etc.
Contrast	Area of interest, definition of foreground and background, fluffiness of objects and textures, etc.
Image definition (focus)	definition of foreground and background, image depth
Shapes	Simplification of image contents, shapes may also be described by speech synthesis (TTS)
Faces	Positions of persons (and eventually animals) in complex scenes
motion blur	Positions and movement vectors of moving objects
autocorrelation	Detection of homogeneous areas, patterns and textures. The detected pattern tiles may be zoomed or masked out.
Edge/Shape/Object-Correlation	Areas of multiple similar objects. E.g. an image with a traffic jam, trees of an alley, etc.
Scene detection	general image information such as „flat“, „deep“ (in terms of the third dimension) and „nature“, „Landscape“, „Drawing“, „Hand-drawing“, „Artwork“, etc.

Table 1 - Image Aspect Filters for tactile topological image representation

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Colour Representation

While many aspects of an image can be presented in a tactile way, a meaningful presentation of colour is limited. Colour filters may present parts of the image that correspond to a preselected colour – simply by filtering the original image correspondingly. By this, the user is able to locate areas of a certain color such as lawn, sky, trees, etc. While color names such as „Blue“, „light Yellow“, etc. mean nothing to the Blind, sounds represent colors much better. In order to generate sounds that correspond to the color of a certain image area, the image processing algorithms are also able to determine the main colors of a certain area. The determined RGB values will be used to compose a multi-dimensional sound using 3D sound projection, the sound will carry not only simple base color information, but also information about the saturation and the homogenity of the queried image area. The user accesses this facility by tapping on a certain area of interest on the tactile display. Since two-dimensional images are to be represented, the x and the y dimension of the 3D sound interface correspond to the image dimensions. The z-axis may e.g. carry information about the saturation of the requested image area. The sounds may represent the colors.

Experiencing Movies

Due to the nature of moving images, it does not seem to be possible to play tactile representations of movies in real-time. The limitation is not the iSENS Hardware, but the ability of the user to experience the displayed content. Simply slowing down the frame rate or displaying a Snapshot every few seconds would either result in a lengthy „watching“ process or in missing the key scenes. Nevertheless, listening to movies is very popular for the Blind.

The proposed approach lets experience both, scenes (still images) and dynamics by the following modes:

Dynamic Mode
The Dynamic Mode displays the movie in real-time. Only moving objects are displayed - in a very reduced way. The user is able to follow the objects with the fingers or may simply lay both hands flat on the dot array and experience the movement. Certain previously marked objects may be displayed vibrating for easier tracking. The Dynamic Mode can either be stopped manually by the user or is automatically stopped whenever the scene has significantly changed.
Camera movements result in displaying the whole scene in a reduced way. Cuts result in an abrupt change of the image.

Still Mode
Once selected, the image can be experienced by the user as already described above. Additionally the user may select an object to be tracked and „highlighted“ by vibrating in the dynamic mode. In Still Mode, the movie may either continue to run in background (audible) or may be completely stopped.