# A SONIFICATION PROPOSAL FOR SAFE TRAVELS OF BLIND PEOPLE

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## ABSTRACT

Sonification is one of the most natural ways to complete the information perceived by the blind people. Thus, it has been widely applied to create assistive products to help this community in their daily life. In our case, we are working on a mobility device which transforms the depth map of a scene into a set of sounds, comprehensible by the user. Our sonification proposal is based on the opinions of experts and potential users, collected by different interviews which crystallize in the herein explained sonification. This proposal follows the so-called *point transform*, which allows real-time sonification and quite accurate localization of the sound sources. However, some modifications to avoid ambiguous situations are also implemented and explained in this study.

## 1. INTRODUCTION

Sonification is the process in which some information is translated into sounds, formerly to ease the reception, but also for aesthetic or leisure purpose.

We are working on an assistive product called Assistive Product for an Autonomous Travel (APAT) [1], in which a sonification system helps blind people to mentally build a representation of his/her surroundings. For that purpose, we have developed an image processing step, in which two images are processed to obtain the depth map of the scene, by means of stereo vision techniques.

In this manuscript, we propose a novel and still-in-design process sonification code, which tries to surpass the limitations found in the bibliography, regarding this kind of technical aids for the blind community.

## 2. BACKGROUND

Sonification is a technique that has been widely used. The first prototype found sonifying images into sounds was built by Noiszewski, the Elektroftalm in 1897 [2]. Some years later, in 1912, d'Albe built the Exploring Optophone [3].

Since then, many assistive products have been proposed, especially in the last two decades. There are some basic dimensions into which any sonification proposal can be classified:

- Number of channels: Sonification using one channel (monaural emission) or two (stereo or binaural emission).
- Arbitrariness: Some sonification codes exploit the natural direction discrimination capability of the sounds. Others implement arbitrary codes for some parameters of the space, such as vertical position, which are not so well localized. There are some algorithms lying in the middle of these two groups.

We will focus on arbitrary and mixed options (no matter the number of channels, for instance), to summarize them into a few sonification paradigms. We will provide an example of a device implementing each paradigm.

- *Piano transform*: Height is codified as frequency, and horizontal axis as time. The brightness is correlated with the volume. That was d'Albe's choice.
- *Point transform*: Firstly proposed in [4], height is codified as frequency and horizontality as binaural loudness. The volume, again, is related to the brightness.
- *Pitch transform*: Proposed in [5], assigns the frequency to the depth (distance) of a point.
- *Verbal transform*: Extending he concept of arbitrariness, we can find projects as [6] where the surroundings are "read" by a synthetic voice.
- Other proposals: "Click" guiding of a Geiger counter with a radioactive emitter [7].

Regarding what should the light represent, we find 3 options:

- The visual brightness: Directly transforms the image into sounds, as it is done in [4]. This option is called *direct mapping*.
- The depth: The image is processed and only the depth is transformed into sounds.
- Edges: Only the edges are sonified, eliminating the volumes in the sonification process. An example of that transform is described in [8].

## 3. SONIFICATION

### 3.1. Information to be sonified

As said before, we have a depth map (usually called 2.5D image), gray scale, as shown in figure 1.

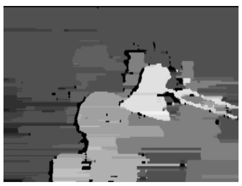

Fig. 1. 2.5D image example.

In this image, the brightness represents the distance of the point to the camera. The whiter a point is, the closer it is.

### 3.2. Sonification code: the Modified Point Transform

We decide to take as baseline the point transform (see section 2) over depth maps, because of the following reasons:

- The system must work in real time to avoid obstacles, so the time cannot be, directly, a variable of each image sonification.
- It uses the binaural properties of the human hearing system, making the training easier and more intuitive.

Important limitations were also found. For instance, this transform cannot differentiate between a volume centered in the image, and two bodies with half volume each, located laterally. Likewise, the volume may change with the ambient noise and, hence, it loses its capability of giving an absolute depth measure.

Thus, a final sonification code has been proposed, with the following characteristics:

- The brightness (the depth) is correlated with the volume, but the range of possible values is discretely split into 6 different sounds (synthetic voice, flute, oboe, trombone and muted trumpet), becoming sharper when the points become closer to help in distance discrimination.
- The lateralization is performed by differences in the loudness and the time of each sound, as it is described since the firsts psychoacoustic studies [9]. To avoid ambiguities, a tremolo is applied to lateral points, taking into account that the closer to a lateral a point is, the deeper is the tremolo.
- Only the nearest pixels (being their bright value higher than 42, in a range of [0,255]) are sonified.
- The vertical axis is codified by means of harmonic musical notes (which perform the CMaj7m chord when all the height levels are excited). However, some simpler profiles have also been proposed, being this last one the most complex. In this maximum level, 16 notes are used for height codification (the CMaj7m chord in 4 octaves). Any Harmonic chord allows the user to perceive music, instead of unpleasant noise.

The sonification is implemented by means of the MIDI standard protocol [10].

## 4. ACKNOWLEDGMENT

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