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Auditory signs for public transportation – Accessible pleasant smart cities

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ABSTRACT

Public transportation system is a complex organizational structure and includes various kind of vehicles, such as busses, trams, metros/subways/undergrounds, trains etc., planned routes, timetables, stops, ticket counters, etc. Therefore various information, such as departure time, how to get from place A to place B, where to board and leave, selection of the correct vehicles, closing door, etc., is necessary for the users. Because user of the public transportation services must handle with many junctions, staircases, delays, being prevented from boarding due to crowding, cancellation of the service etc. Most of the information are delivered visually. The visual signage alone reduces the accessibility of the public transport for the people who cannot use visual information, such as visually impaired people, the foreign language-speaking tourists, children and reading handicapped persons. In this case, the auditory signs, such as speech messages, earcons, icons, music tunes, are used to inform the users. Their audibility, intelligibility, clarity and correct identification is very important for the users. However, auditory signs can be annoying for the residents. In this study, some accessible pedestrian signals were evaluated their suitability, clarity, intelligibility and annoyance.

Keywords: Auditory signs, Blind, Annoyance
I-INCE Classification of Subject Number: 61

1. INTRODUCTION

Travelling in cities with a visual impairment can be a challenging task. The navigation, the crossing intersections, identification of the road names and the stations, identification of the correct public transportation vehicles are important to get from A to B. However, the technology is developing exponentially and the intelligent solutions can be developed for above-mentioned subjects. Apart from tactile aids, auditory signs with intelligent technologies can be used to support not only visually impaired but also the foreign language-speaking tourists, children and reading handicapped persons. Auditory sign design and evaluation is an important research subject of different publications (1-7). Some researchers developed wearable audio reproduction systems for visually impaired persons (8, 9, 10). In most cases, such kind of technologies will be combined with detection and recognition technologies (9, 11). If the spatial information will be presented, earphones or headphones are mostly used audio reproduction technologies. Particularly mobile devices provides promising new opportunities. In this case, the information will be mostly presented using the loudspeaker of the mobile device. One of

the critical situation, which is reported by visually impaired persons, is the usage of the zebra crossing “continental crosswalk”. In a study, an algorithm was developed to recognize the zebra crossing (ZebraRecognizer, 11). This recognition system was extended with an audio guiding system (10). For the audio guiding, the speech signals and impulsive sounds of short duration were used. If a visually impaired person would like to cross a street and there is no any traffic light at this street, in most cases she or he listen the traffic noise to identify any oncoming vehicle. If it is possible, in some cases, the visually impaired persons try to avoid to cross such kind of streets. In this study, we focus on the situation “crossing an urban traffic intersection with a traffic light”. The accessible pedestrian signals from different countries are introduced at the next section of the paper. We conducted a discussion panel with visually impaired persons and different accessible pedestrian signal solutions were evaluated. At the next section the results of the evaluation and discussion are introduced. Finally we briefly conclude the results of the study.

2. ACCESSIBLE PEDESTRIAN SIGNALS – ACOUSTIC TRAFFIC LIGHTS

Acoustic traffic light signals are important to provide information about the wait/walk situation. In some cases, there is additional locator tone, which inform the user about the location of the traffic light and push button. In different countries, there are different solutions and auditory signs. In some countries, there is only one auditory sign countrywide. In some countries, different auditory signs are used in different parts of the country. In some countries the auditory signs are combined with tactile feedback from the push button.

In Germany, a locator tone, which indicates the traffic light and the push button, is used. The locator sign (L1) is an impulsive sound and sounds like a slow knocking (tack-tack-tack) (Figure 1). The spectral character of the locator sound is not defined in the standard (DIN 32981), the time structure of the impulses, i.e. the frequency of the repetition, is 1,2 Hz. Short-time Fourier transform (STFT)-based spectrogram of the locator sound is shown in Figure. The impulsive sound has at app. 440 Hz (broad band), 880 Hz, 2600 Hz and 3500 Hz tonal components. According to the standard, it should differ strongly from the walking indication tone. A walk indication sign, which is defined in the standard in detail (DIN 32981), is used in Germany. The walk indication sign is a fast beeping sound (WI 1). The frequency of the sound is defined as 880 Hz + 50 Hz (DIN 32981). In most cases, the harmonics of this frequency are audible (Figure 2). The repetition frequency of the beeping signal is 4 Hz ± 0,2 Hz.

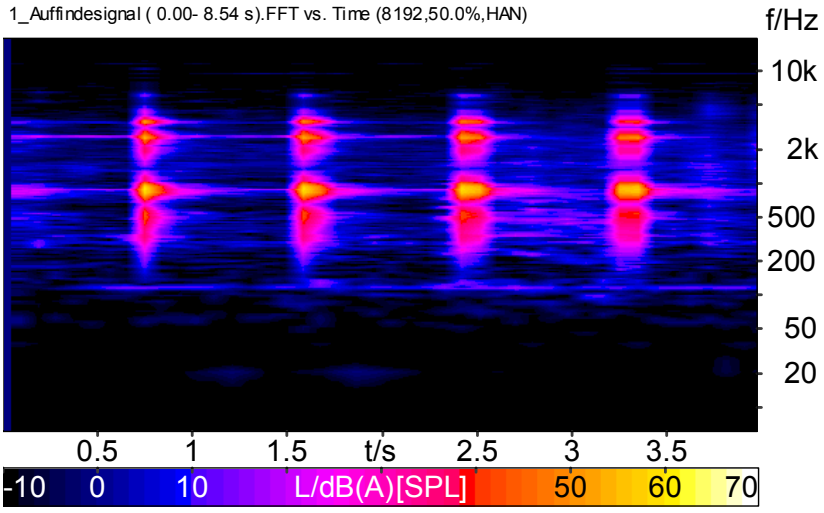

Figure 1 - The STFT-based spectrogram of the locator tone from Germany (L1, recording).

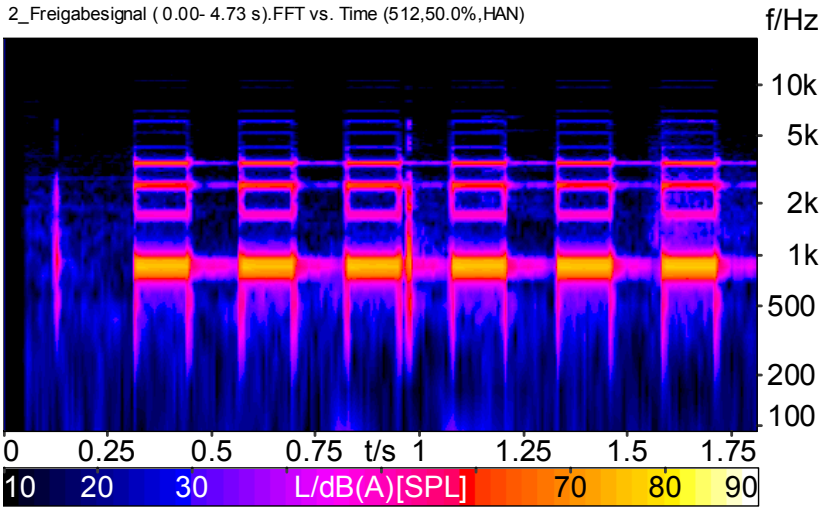

Figure 2 - The STFT-based spectrogram of thewalk indication sign from Germany (WI 1, recording).

In Japan and also in Canada, the imitation of bird songs, such as chirp (WI 2) and cuckoo (WI 3) sounds, are used to indicate the pedestrian can cross the street. In Japan, beforehand, the musical samples, such as Toryanse (children song) and Common Frae the Town (Scottish song) were used. The characteristic frequencies of the chirping of a chick song is about 1.6 kHz – 2.4 kHz and the characteristic frequencies of the cries of cuckoo is 900 and 1100 Hz (Figures 3 and 4). The chirping of a chick is repeated each 2.8 seconds and the cries of cuckoo is repeated each 3 seconds. Furthermore the auditory signs are played from both street sides in different moments, not at the same time. The pause between the sides is about 1.4 – 1.5 seconds.

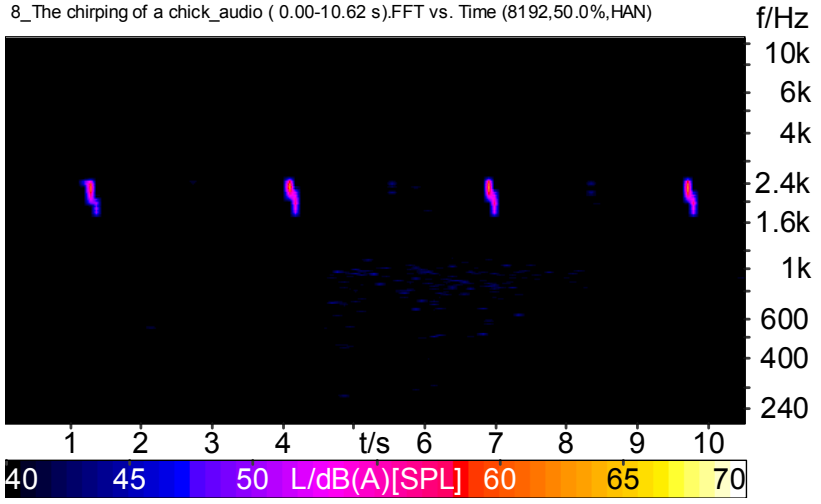

Figure 3 - The STFT-based spectrogram of the walk indication sign "chirping of a chick" from Japan (WI 2, recording).

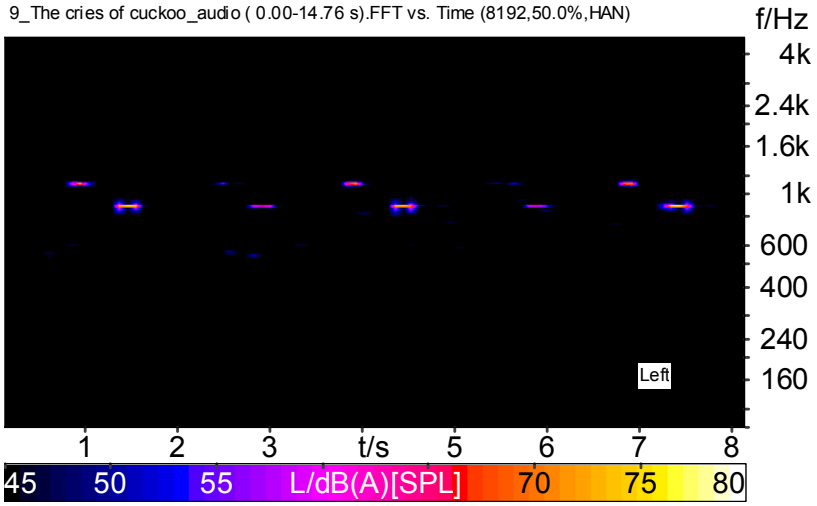

Figure 4 - The STFT-based spectrogram of the walk indication sign "cries of cuckoo" from Japan (WI 3, recording).

3. PANEL DISCUSSION AND EVALUATION

A panel was organized to discuss about the experiences, the expectations and the perception of visually impaired persons regarding the auditory signs for public transportation in general and particularly acoustic traffic lights. 22 visually impaired/blind participants (9 female, 13 male) took part in the panel discussion. Age of the participants varies between 20 and 65 years old. The participants don't have any acoustic background. They were paid for their participation on an hourly basis.

The above-mentioned (section 2) auditory signs were presented to the participants using a Genelec 8040 loudspeaker. The participants were asked to evaluate the suitability of the sounds on a quasi-continuous scale (not at all - 0, slightly - 25, moderately - 50, very - 75, and extremely - 100).

Most of the participants found the locator signal (L1) very suitable for the indication of traffic light location. The mean suitability score of L1 is 66 %. Similar reaction can be seen for the walk indication sign WI 1. The mean suitability score of WI 1 is 59 %. However most of the participants did not found the chirping of a chick suitable as a walking indication sign. The mean suitability score of WI 2 is 11 %. Some of the participants found the cries of cuckoo (WI 3) suitable and some of the participants did not found the cries of cuckoo suitable as a walking indication sign. The mean suitability score of WI 3 is 45 %.

Some comments of the participants are summarized as follows:

- Audible pedestrian signals (APS) are very important for the safe travelling
- Acoustic traffic light signals should clearly indicate the location of the traffic light/push button. The locator sign is necessary.
- Locator and walk signs should differ from each other clearly.
- In USA, some APS systems give information about the name of the street. Some participants found such kind of information very helpful.
- The directional cues regarding crossing can be very useful. Most of the participants found different temporal cues of the crossing sides from Japan example very good.
- The application of the same APS in different cities and countries can make the travelling easier and safer for visually impaired persons.

4. DISCUSSION AND CONCLUSIONS

The panel discussion was conducted in Germany and the participants have long-term experience with German APS system. It is possible that the participants are used to the auditory signs from Germany and therefore they found them more suitable in comparison to further APS from other countries. Most of the participants claim that the bird songs can cause easily recognition mistakes, because some birds in the environment mimic these songs. The acceptance of such kind of bird songs and musical examples was very limited because of the danger of confusion. However, the cuckoo song obtained more approval than chirping. The directional cues regarding crossing from Japan were found as a good solution.

The level of the APS is an important issue regarding both the recognition and the possible annoyance caused to residents. In Germany, the level of APS system is adapted to the traffic background noise. Some participants complained that the adaptation does not function always very well. However, the adaptation is an important and effective issue to increase the recognition and to keep the possible caused annoyance limited. The timbre and the sound quality of APS play also role on the perceived annoyance. Therefore, further investigations are planned with residents to investigate the caused annoyance of different designed APS. Also other auditory signs for the public transportation regarding will be investigated according to the above-mentioned criteria.

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