In terms of signal processing, sound design is often discussed as time domain or frequency domain. Considerable physical parameters referred to subjective impression are sometimes typical psychoacoustics parameters such as loudness or roughness, or deformation of time signals or frequency contents like harmonic components. In this paper, newly methodology of sound design is presented as "drawing". This drawing method based on time-frequency representation. However, at the process of sound design, sound modification is just drawing on the analytical window. Through this process, effective sound design on white noise is considered and discussed. Keywords: Sound Design, Signal Processing, White Noise, Drawing

1. Introduction

One of sound design techniques could be considered as filtering, which means the way of modification. Sound modifications by filtering are based on frequency domain such as Band Pass-stop filters. However, sound impression can be changed with modification of sound in time domain not only frequency domain. Additionally, such filtering is more based on mathematical numbers, which does not lead instant ideas of sound design. This paper is about to introduce inspirational sound design methods like drawing pictures, it is much easier, more over it is new sound creating way.

2. Basic idea of Filters

2.1 Advantages of Band Pass-stop, High Pass & Low Pass Filters

Acoustical filters were initially developed with the idea of electrical engineering. A band pass-stop filter enables certain frequency to amplify or de-amplify amplitude at certain frequency, which comes from an RLC (a resistor-inductor-capacitor circuit). Because of such historical reason, acoustical filters have great advantages of modifying sounds in frequencies.

![Figure 1: Filters.](image)
2.2 Disadvantages of Band Pass-stop, High Pass & Low Pass Filters

On the other hands, these acoustical filters are always set as frequency so that it is not changed. However, impression of sound is effected by time changes of sounds. Currently order tracking filter such as Vold-Kalman filter can possibly change sound in time domain although usage is limited. If modification is freely made with giving some inspiration, another method should be required.

![Advanced Filters](image1.png)

Figure 2: Advanced Filters.

3. “Drawing” on Time-Frequency domain

3.1 Time-Frequency analysis

Time-frequency analysis compromises signal-processing techniques in both the time and frequency domain simultaneously, using time frequency representation. A signal, as a function of time, could be considered as a presentation with time resolution. At contrast, the Fourier transform of the signal could be considered as a presentation with spectral resolution but without time information. Time-Frequency representation can bridge between those functions of time and frequency, so that it provides a temporal information and spectral information at the same time.

3.2 Sound modification on time-frequency representation

If sound can be modified on time-frequency representation, disadvantage of filtering can be overcome because time frequency representation covers both with time and with frequency information. Additionally, manipulation of such representation will differ from ordinal filtering.

![Time-Frequency representation](image2.png)

Figure 3: Time-Frequency representation.
3.3 Advantage of sound modification on time-frequency representation

Sound modification on time-frequency representation has clear advantages such as modification both in time and frequency domain and inspirational modification.

Since time-frequency representation has both information on time and frequency, sound can be modified in change of time and frequency by the same action.

Additionally, this representation is a kind of picture which shows sound algorithmic waves in color. The picture can provide inspirational modification, which is “drawing” on sound.

4. Examples of “Drawing”

“Drawing” on sound must be the same idea as “Seeing is believing”. Once you experience in drawing and listing to reaction of its sound, people can easily understand how it works and how much advantages of them. Thus, in this section examples are shown and discussed.

4.1 Extraction example – “Bird singing in ocean wave”

Sound wave sample shows a seagull is singing with noise of ocean wave. Time-frequency representation of the sound has noise section and harmonic tones section which changes in time and frequency. (see Figure 3) Extraction of bird singing out of ocean wave noise should be applicable in order just to mark or draw on contours on harmonics. Recent software enables to pick these areas off easily. (see Figure 4)

![Figure 4: Extraction of bird singing from ocean wave by “drawing”.](image)

After manipulation of this extraction, it is possible to modify frequency of extracted sound, namely bird sound, and add back to main ocean wave file. Figure 5 denotes final changes of bird singing in ocean wave.
4.2 Drawing example – “Ultraman”

Since the drawing can become filtering for sound design, it is better to step into drawing on white noise because white noise has all spectrum. It will be a nice study to see how drawing method deforms sounds on white noise, which has equally balanced amplitude in each frequency. For science fiction type sound, the diamond-shape is examined, whose name is given as “ultraman”.

Figure 5: Final sound design of bird singing (manipulation – above, time-frequency representation of modified bird singing – under).

Figure 6: Ultraman – Scientific Fiction type sound
5. Filter shapes from real pictures

The sound design method “Drawing” is based on shapes of figured bitmap, so that any shapes of bitmap can be converted as filter. It enables unique way of sound design.

5.1 Bird noise singing filter

First trial of this section starts from one shape of wave sound applied into another sound. In other words, if drawing shape of one sound is used on white noise, does it sound the same as original one? These hypotheses can arise. When the picture of time-frequency representation is the same, does it sound the same? The answer is yes.

Simple test was conducted for bird singing sound where is examined in previous section.

5.2 Image filter – Yokohama Landmark Tower sound

Bitmap files can be created by image files such as pictures and photos. Of course, photos are not taken for sound design, thus unexpected or unique sound will be shown. However, shapes of harmonic, white noise or frequency change in time are already clearly understood with experiments in previous sessions. Some parts of image filtering may be expected to effect on sound when photo is examined. Photo of Yokohama Landmark Tower is selected because of combination of harmonics and noise part, so the sound results in unique combinations of tones.

![Figure 7: Yokohama Landmark Tower original photo and time-frequency representation.](image)
6. Summary

Sound modifications on time-frequency representation are discussed. A clear advantage over normal filtering is possible to modify sound in time and frequency domain simultaneously. Moreover, filtering shape is convertible to image file such as bitmap. Therefore, only shape of filter can be related to sound image and also the method with photo can be possible to extend way of sound design in the future.

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