***Glitch Sounds Based on Image Manipulation***

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**Abstract**
Glitch art is the art that makes use of image, video, and sound errors (glitches) intentionally generated by destroying digital data or physically manipulating electronic devices. Such glitch art is interesting in that it expresses unpredictable and accidental beauty. As part of our research into glitch sound creation methods and effects, we tried to create glitch sounds based on image manipulation. Specifically, glitches are generated in audio data using Photoshop image editing software. Audio data cannot normally even be loaded into image editing software, but by using RAW as the audio data format, we made this possible and applied audio processing such as copy, cut & paste, and gradation to the audio data to generate glitches. Our goal is to generate glitched sounds not by random methods but by sophisticated methods based on legitimate manipulations of images, which have different dimensions from those of audio. This research enables the user to enjoy the generation and appreciation of glitch sounds from the perspective of images.

Keywords: Glitch Sound, Image Processing, Photoshop

## Introduction

Glitch art is the art that makes use of image, video, and sound errors (glitches) intentionally generated by destroying digital data or physically manipulating electronic devices. This type of glitch art has been produced along with the emergence of new media. It began with works that utilized glitches in television and video game consoles and gradually developed into a genre of music under the name of "glitch music. Glitch art, which expresses unpredictable and accidental beauty, has an appeal that cannot be found in the beauty of predestined harmony, and this is what attracts many people to it. Glitch art also dares to introduce imperfection into art, and in finding beauty in imperfection, it brings a different perspective from classical artworks that aim for perfect beauty, and it can be said that it expands the range of appreciation of art in general.

As part of our research into glitch sound creation methods and effects, we tried to create glitch sounds based on image manipulation. Specifically, glitches were generated in audio data using the Photoshop image editing software. Audio data cannot normally even be loaded into image editing software, but we made this possible by using RAW as the audio data format and then applying image processing such as copy, cut & paste, and gradation to the audio data to generate the glitching. Our goal is to generate glitched sounds not by random methods but by sophisticated methods based on legitimate manipulations of images, which have different dimensions from those of audio. This research enables glitch sounds to be generated and appreciated from the perspective of images.

The paper is organized as follows: Section 2 describes the background of this study on glitch art. Section 3 describes the goals and basic approach of this study. Section 4 describes the experiments conducted in this study and a discussion of the results, and Section 5 describes related studies. Finally, Section 6 concludes the paper.

## Research Background

### Glitch Art

A glitch is an error (defect) in images, video, sound, etc., caused by destroying digital data or malfunctioning TVs, game consoles, etc. Such accidental beauty brought about by glitches has a charm that cannot be found in the beauty of predestined harmony. The accidental beauty brought about by such glitches has a charm that cannot be found in the beauty of predestined harmony, and pioneers' attempts to utilize it in art have come to be accepted as glitch art over the years. The first pioneering work of glitch art is Nam June Paik's "Magnet TV. This was a work in which the distortion of the TV image was changed by moving a powerful magnet placed on top of the TV (Kellein et al., 1993). Jamie Fenton and Raul Zaritsky's 1978 video work "Digital TV Dinner" is a recorded video of glitches generated by manipulating a Bally Astrocade video game machine from Bally Manufacturing (Betancourt, 2015).

Glitch art is now not limited to works that utilize glitches in TV and video game consoles, but has developed into a genre of music under the name of glitch music. The German electronic music group OVAL (Popp, 2022) is cited as a pioneer in the field of glitch music, and a music festival under the name GLITCH (Festival, 2014) has been held annually since 2014.

Theoretical research on glitch art has also been conducted, with Rosa Menkman proposing to use information theory to understand glitch art as a specific genre of contemporary art (Menkman, 2011). In 2010, Rosa Menkman et al. organized an international conference on glitching, GLI.T/CH (McCormack, 2010), and research on glitch art has been presented at the international conference evomusart, held annually since 2011 (Machado et al., 2013).

## The Methods of Glitch Art

Various tutorials on glitch art production are available online (Temkin, 2009; Stearns, 2013). Michael Betancourt categorizes the techniques used to create glitch art as follows (Betancourt, 2016):

- Data Manipulation: Alter the data in a file to cause glitches
- Misalignment: Open a file in another application
- Hardware Failure: Cause a machine to malfunction and produce sound or video
- Misregistration: Physical noise in analog media
- Distortion: Create physical distortion with magnets, etc.

Note that these techniques do not always work. For example, when data is destroyed by data manipulation, glitches may or may not occur depending on the result. Such coincidences are undoubtedly a factor in the appeal of glitch art, but glitches in glitch art are necessarily limited to those that can be recognized by human sensory organs such as sight and sound.

## Research Goals and Basic Approaches

### Research Goals

In this study, our goals are as follows:

- Creation of glitch sounds using elegant techniques
- To express art through the cross-disciplinary manipulation of sound and color (light)

We seek not only to create glitches, but also to pursue the beauty of the method itself. Even if we can see accidental beauty in a method that cannot be reproduced, there is no beauty in a method that cannot be created again as a technique. On the other hand, a method that produces the same result no matter when, where, or by whom would deny the beauty of chance, which is the charm of glitch art.

Elegant methods in this study mean a unified method based on a certain form. This is in no way contradictory to the five techniques listed in the previous section. For example, taking data manipulation techniques as an example is achieved by systematically organizing and unifying data manipulation methods. Specifically, rules are defined in advance regarding which parts of data are to be destroyed, how much, etc. However, not all of these rules are completely defined. In this way, the chance nature of glitch art is preserved.

We have also worked on the colorization of sound (Amano, 2018). Drawing on this knowledge, this study aims to create a transversal artistic expression that spans sound and color. Sound and color have something in common. Specifically, both have the property of being waves. Color is a reflection of light, and light and sound are sinusoidal waves with different frequencies. Waves in sound represent timbre, and waves in light represent color. In other words, both can be represented and processed as waveform data. Sounds that cannot be recognized by the human auditory sense can be visually recognized if they are represented as waveform data.

**Basic Approaches**

The basic approach of this study is as follows:

- Glitch technique: A combination of misalignment and data manipulation
- Preprocessing: Transformation of audio data (preparation for misalignment)
- Image processing: Application of image processing operations to the audio data
- Confirmation: Confirmation of glitching effects using audio playback software

First, the glitching technique uses a combination of misalignment and data manipulation. Specifically, audio data is loaded into image processing software and data manipulation is performed. To do this, the audio data must first be converted. This is because audio data usually cannot even be loaded into image editing software. There are several audio data formats, including MP3 (MPEG-1 Audio Layer-3) (Jonathan, 2012), WAV (RIFF waveform Audio Format) (IBM Corp. et al., 1991), and AIFF (Audio Interchange File Format) (Apple Computer Inc, 1989). Audio data in these formats are structured according to a specific data structure and cannot be read by image editing software in their original state. Therefore, the format of these images is converted to RAW (Raw Image Format) (Fraser, 2004) format (Figure 1). RAW format data refers to unprocessed image data from a digital camera, etc., and RAW images are the "raw" image data from which images such as JPEG are generated. This kind of RAW format data is a format that does not strongly depend on specific applications.

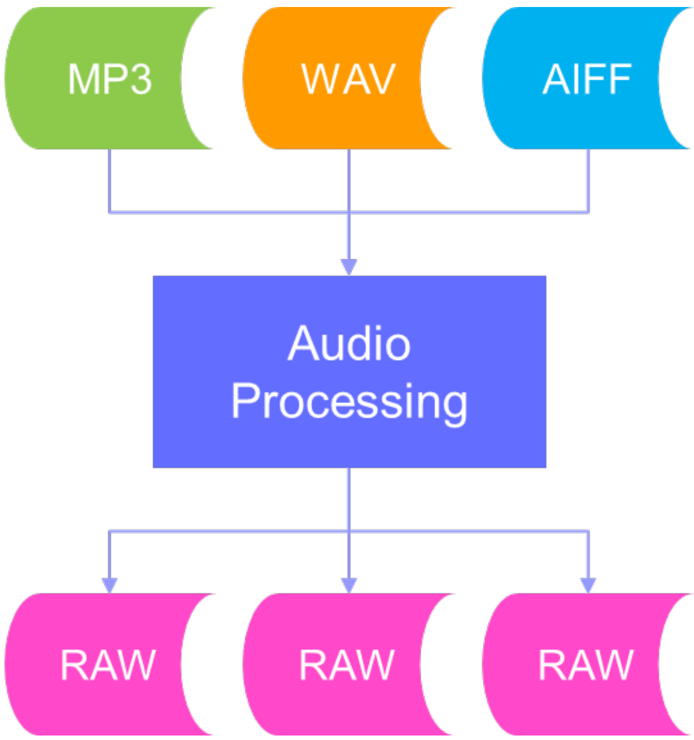

Figure 1: Pre-process: audio file conversion.

Next, the audio data converted to RAW format is loaded into image editing software for data manipulation. Data manipulation here refers to various basic operations and effect operations on image data, such as the following:

- Basic operations: copy, cut, cut & paste, enlargement, reduction, rotation, etc.
- Effect operations: black-and-white conversion, blurring, filtering, gradation, etc.

When audio data converted to RAW format is loaded into image editing software, it is still audio data. At this point, misalignment has already occurred, but if no operation is performed, the original data will remain unchanged and no glitching can be expected to occur.

Therefore, the image processing operations provided by image editing software are applied to the audio data (Figure 2). In other words, applying image processing to audio data that is not image data destroys the audio data and causes glitches. Image editing software cannot recognize whether the loaded data is audio data or image data, but only applies the specified image processing to the data. Although applying color manipulations to audio data is essentially meaningless, it is intended to destroy the audio data and cause glitches to occur. In this study, we consider it an elegant method to treat audio data as if it were image data. This is because image processing operations in image editing software are not random processes, but typical processes for image data that have been refined by many people over many years.

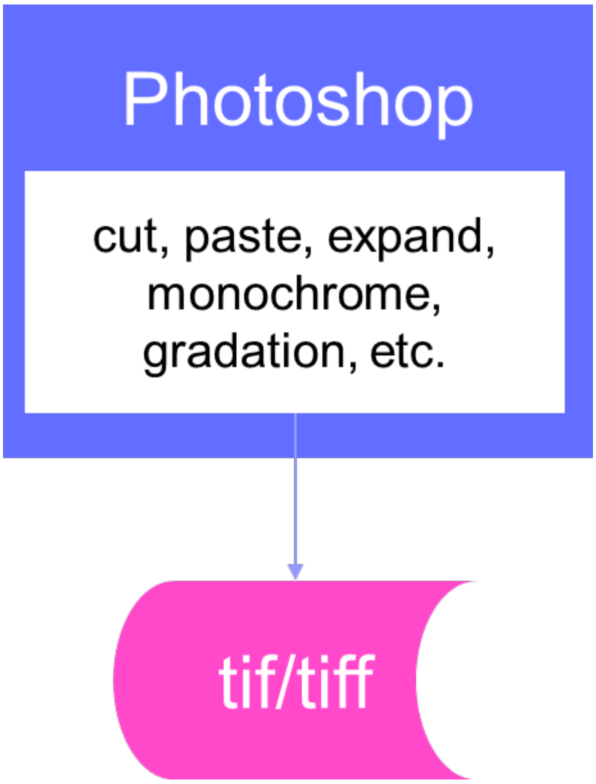


Figure 2: Image processing.

After the image processing operation, the TIFF (Tag Image File Format) (Adobe Developers Association, 1992) format should be specified when saving the file. The extension of a TIFF file is tif or tiff. After the above process, check the occurrence and effect of glitches using audio playback software. This is because image editing software is not an audio playback software and does not have such a function, so it is not possible to check for glitches.

## Experiments and Discussions

In this study, experiments were conducted to create actual glitch sounds based on the approach described in the previous section. The following is a step-by-step description of the experiments and results.

## Pre-process

First, the audio data used in this study was Waltz of the Flowers from Tchaikovsky's The Nutcracker. The following is the waveform data displayed when the audio data is loaded into the audio editing software Audacity (John et al., 2012), (Figure 3).

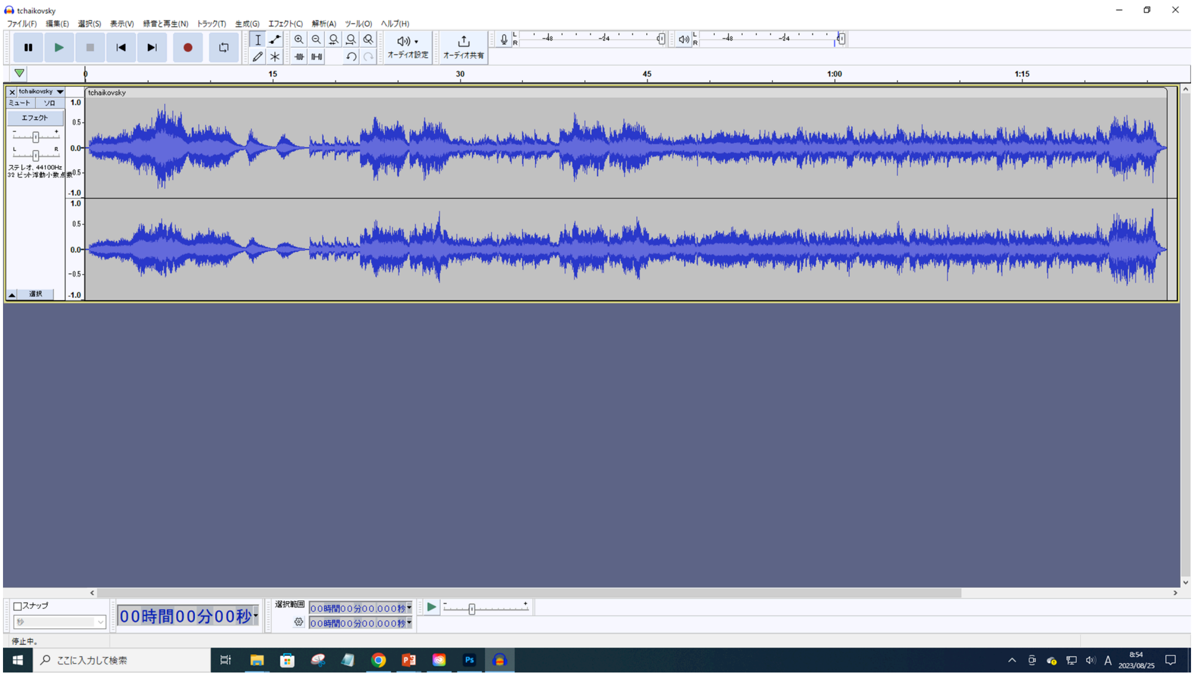


Figure 3: Original audio data.

Because this audio data was in MP3 format, it was saved (exported) as a new RAW format file in Audacity. The following options are specified:

- File extension: .raw
- File type: Other uncompressed file
- Header: RAW (header-less)
- Encoding: U-Law

Next, the audio data converted to RAW format is loaded into image editing software. In this study, Photoshop (Laskevitch, 2023) was used as the image editing software.

Figure 4 shows the image display when the original audio data (Figure 3) is loaded into Photoshop. The image is now ready to be processed.

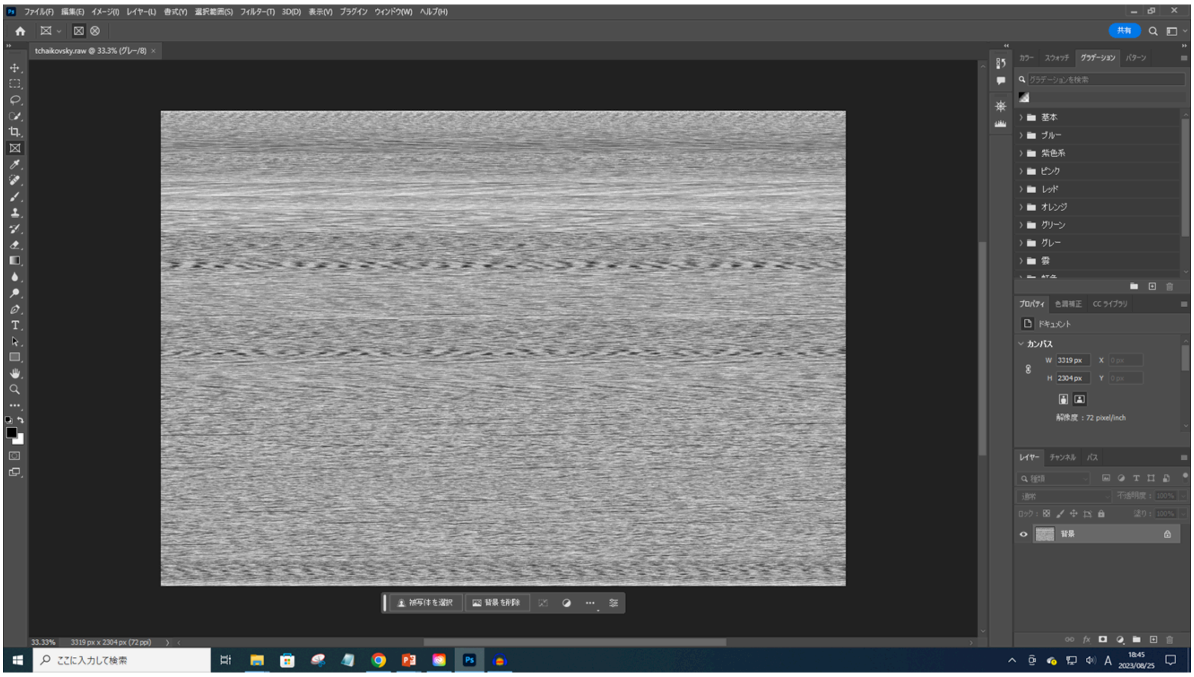

Figure 4: Image of Original Audio Data.

**Image Processing**

In this study, we experimented with the application of some image processing techniques, but for reasons of space limitation, we will limit our discussion to the following four typical processes:

- Cut: Cutting out image data
- Cut & Paste: Reduction and pasting of cropped image data
- Gradation: Gradual change of color tones

***Cut Operation***

Cutting is a basic image processing operation to cut out unnecessary areas. In this study, a rectangular cut operation was intentionally performed on the above image (Figure 4) from the center of the image (Figure 5). Although this operation does not make sense for editing audio data, it is a basic image-processing operation. We verified what kind of glitchy sounds are generated by applying this kind of image processing to audio data.

To check the glitch sound in Figure 5, it is first necessary to save the image data of Figure 5. As mentioned above, TIFF must be specified as the saving format. The following options are required for the TIFF format:

- Image compression: None
- Pixel order: Interleaved
- Byte order: IBM PC
- Layer compression: RLE

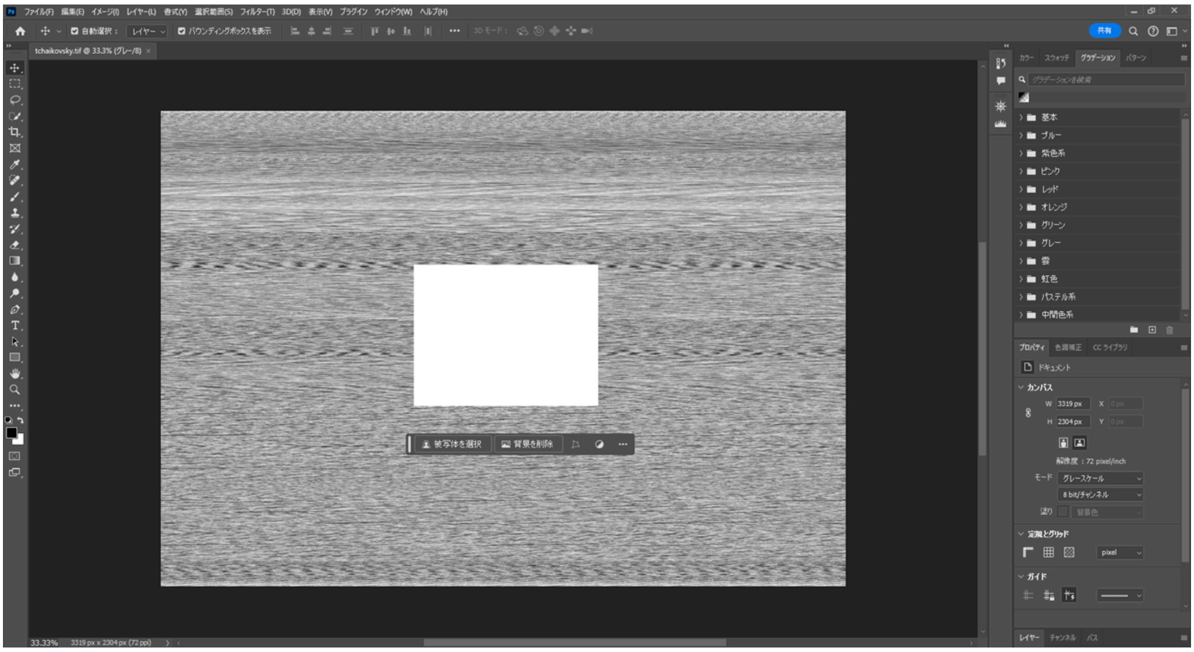

Figure 5: Image Date applied Cut Operation.

The audio data saved in TIFF format as described above is loaded again into Audacity for playback. This data is originally audio data, but because it has been edited in Photoshop, it cannot be loaded into Audacity like normal audio data. Therefore, select "Import" from the File menu and specify "Import Raw Data" when importing to Audacity. In addition, specify the following options:

- Encoding: U-Law
- Byte order: Big Endian
- Channel: 1 channel

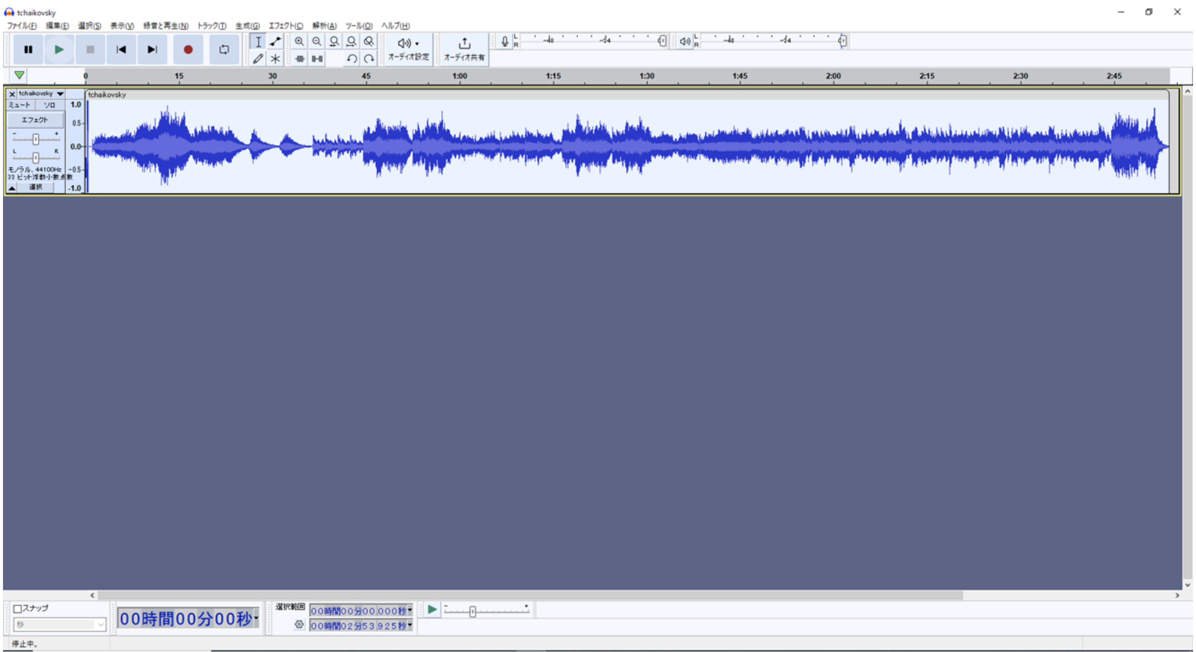

Figure 6: Glitch sound based on the cut operation.

Figure 6 shows the waveform data when the rectangle was cropped from audio data in Photoshop is loaded into Audacity. At first glance, there does not appear to be much difference from the original audio data (Figure 3), except that the stereo is now mono. However, when this audio data is played back, the location of the glitch becomes aurally apparent. The occurrence of these glitched sounds is localized, reflecting the fact that the cut operation was localized.

### *Cut & Paste Operation*

Cut-and-paste is another basic image-processing operation that cuts a part of an image and pastes it. In this study, the data in Figure 5 was intentionally cut from the center of the image, and the cut rectangle was scaled down and pasted to the cut area (Figure 8). This is also a basic image processing operation, although it does not make sense in terms of editing audio data. We verified what kind of glitchy sounds are generated by applying this kind of image processing to audio data.

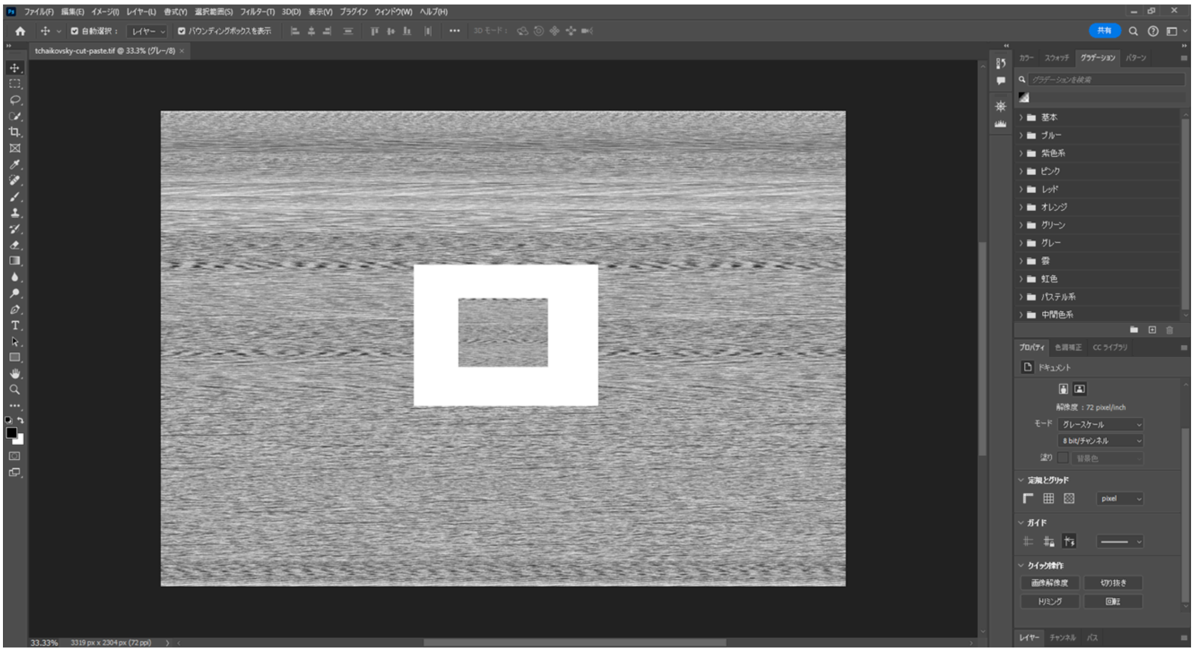

Figure 7: Image date applied cut & paste operation.

The procedure for checking the glitch sound in Figure 7 has been described above and is omitted here. Figure 8 shows the waveform data when audio data that was cut and pasted in Photoshop was loaded into Audacity.

From a visual standpoint, the waveform data in Figure 8 differs significantly from both the original audio data waveform (Figure 3) and the waveform (Figure 6) of the audio data with the cut operation. First, the two parallel tracks are now in series, and the waveform of the cut-only audio data also differs significantly in some areas. When this audio data is played back, glitchy noise-like sounds are present only in some parts, which is the same as in the case of the cut audio data, but the glitchy sounds are clearly different. This is thought to be because the effect of the paste is expressed as glitches.

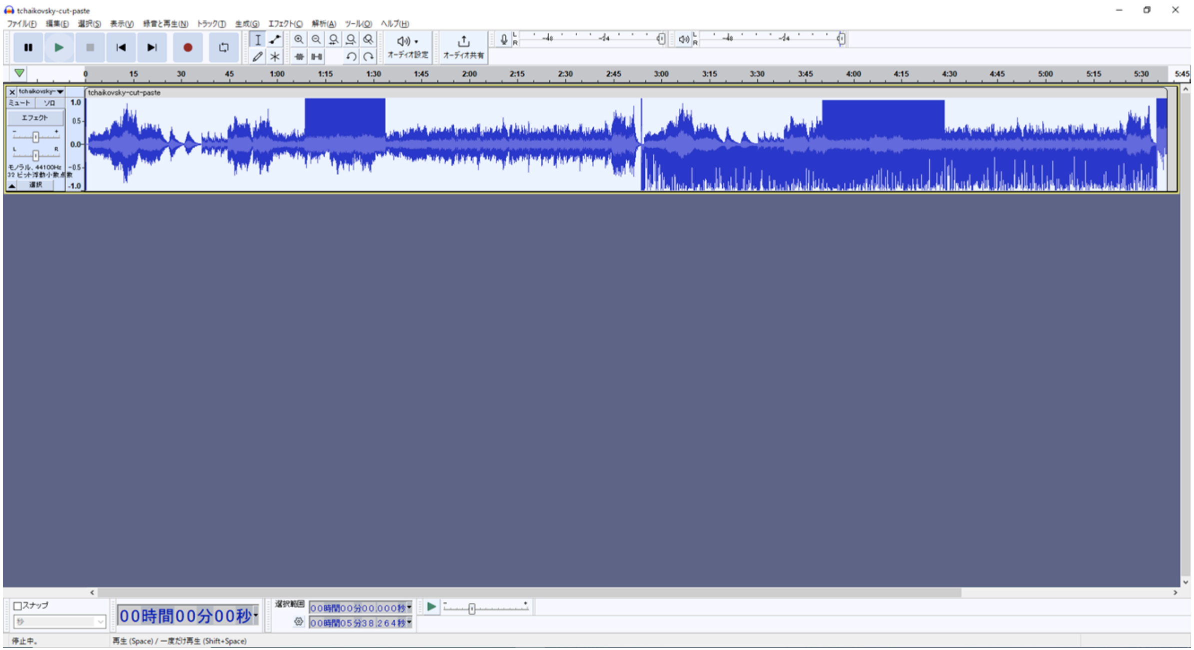

Figure 8: Wave date applied cut & paste operation.

***Gradation Operation***

The gradient is an expression in which colors and textures change continuously and step by step in an image and is known as an effect operation in image processing. In this study, gradient operations were applied to the original audio data image (Figure 3) (Figure 9). This is also a common effect operation in image processing, although it does not make sense as an editing of audio data. We verified what kind of glitchy sounds are generated by applying such image processing to the audio data.

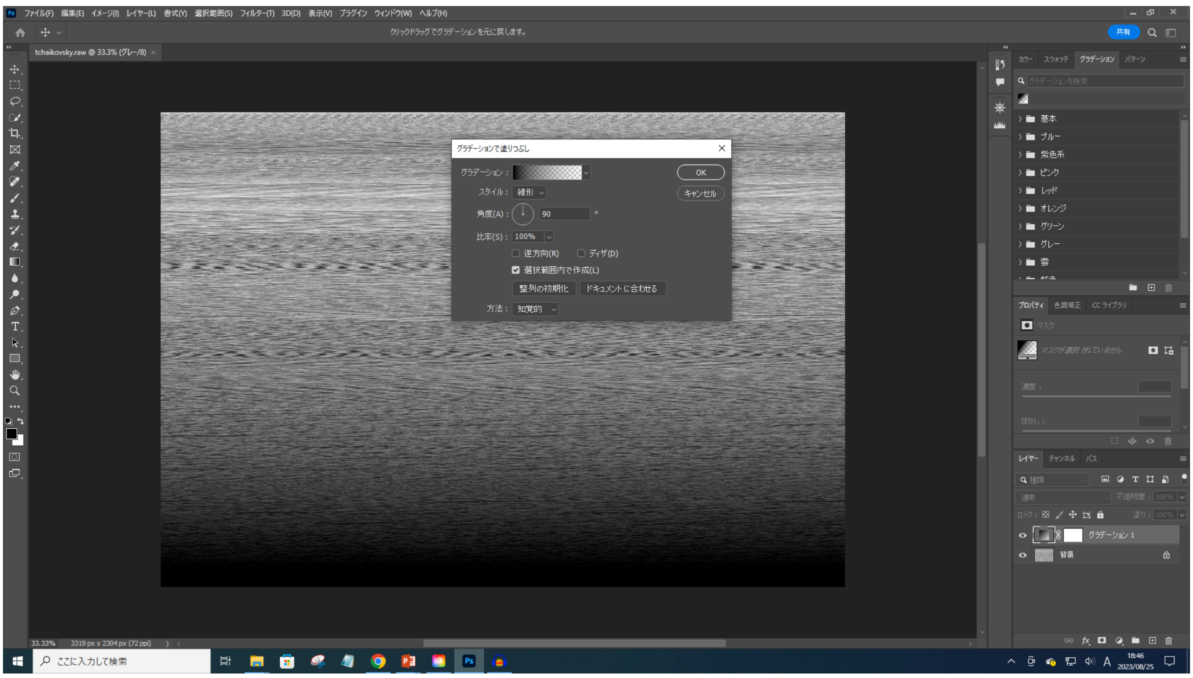

Figure 9: Image date applied gradation operation.

It should be noted that the gradient operation was applied to the entire image, not to local image editing operations such as the cut and cut-and-paste operations described above. Specifically, we specified the following options for gradient operations in Photoshop:

- Gradation pattern: dark to light tone
- Gradation style: linear
- Angle: 90 degrees
- Ratio: 100 percent

Figure 10 shows the waveform data when the gradient-processed audio data is loaded into Audacity.

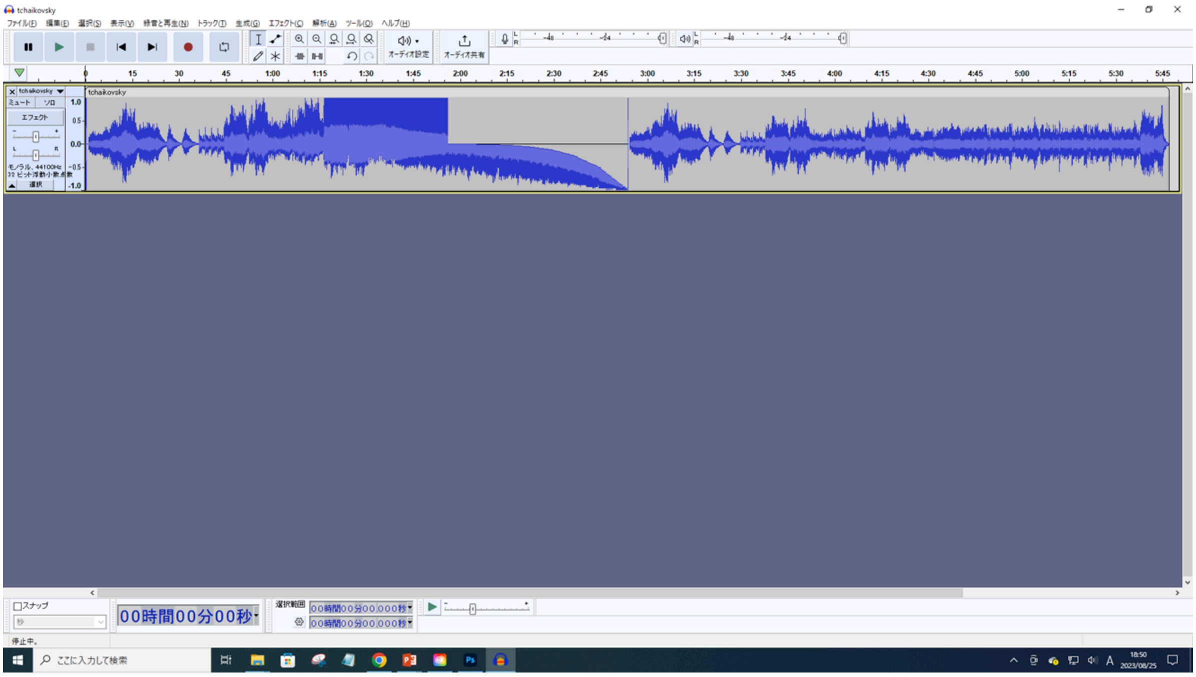


Figure 10: Wave date applied gradation operation.

From a visual standpoint, the waveform data in Figure 10 differs significantly from the original audio data waveform (Figure 3), the cut operation (Figure 6), and the cut-and-paste operation (Figure 8). The waveform of the cut-and-paste operation is similar to that of the cut-and-paste operation in that the two parallel tracks are now in series, but other than that, they differ from each other in every respect. When this audio data is played back, a noisy glitchy sound is heard throughout. The volume was gradually decreased, and the effect of the gradient could be felt aurally. This clearly indicates that the effect of the gradient is manifested in the form of glitches.

## Discussions

Summarizing the results of the experiments described in the previous section, we can insist that the audio data to which image processing was applied produced a glitching effect that reflected the image processing. In the case of the cut operation, a local glitching effect reminiscent of the cut operation was obtained, and in the case of the cut-and-paste operation, a glitching effect reminiscent of paste was obtained in addition to the local glitching effect. In the case of the gradient effect operation, glitching effects were applied to the entire image, including gradual muffling, again reminiscent of gradients. Of course, it is impossible to say whether this is true in all cases without conducting exhaustive experiments, but the results of the current experiments seem to be generally consistent with such a conclusion. From the above, we can conclude that the method we have tried in this research is the elegant method we have been aiming for, i.e., a method that can generate glitched sounds that reflect the original image processing through an established operation called image processing.

However, this approach is not without its drawbacks. For example, there are the following problems:

- Glitchy sounds are not generated properly depending on the operation's coverage.
- The occurrence of glitches cannot be confirmed in real-time.

First, when applying image processing, it is necessary to pay attention to the scope of the application. Each original audio data has its own unique format, even when converted to RAW or TIF format. If the original audio data is destroyed, it will not be recognized as audio data before the glitch sounds. For example, if the start of a file is deleted by a cut operation, the header information is deleted and is not recognized as audio data. However, when effects are applied to the entire file, such as gradients, some cases work well and others do not, and more exhaustive experimentation is needed to determine what operations to apply and where to apply them. However, since the problem cannot be visually confirmed from an image display of the audio data, this experimentation is a trial-and-error process.

Furthermore, the effects of applying image processing cannot be confirmed in real-time. To check the glitching effect, as described before section, it is necessary to select "Save As" from Photoshop's File menu, specify the options in TIF format, and save the file. Only after these operations can the audio be played back using audio playback or editing software. This is a rather complicated process.

However, we are positive about the fact that the range of applications of image processing has to be determined by visual estimation and trial and error. This is where the beauty of chance, which is the charm of glitch art, can be expected to emerge. In other words, it is up to the user to decide where in the audio data to apply image processing, and we believe that there remains room for the beauty of chance. We believe that it is better to leave this part of the process as it is to make glitch art an art form.

**Related Work**

The use of glitching in art is not new, and glitching is already recognized as a form of expression in art. There have been attempts to use glitch sounds for quite some time: Luigi Russolo built a mechanical noise generator in the early 1900s (Luciano, 2012); Michael Pinder created glitch sounds through the intentional misuse of the Mellotron (Fabbri, 2017); and the Mellotron (Mellotron) was developed in the 1960s as an analog playback device. Christian Marclay is creating sound collages using damaged vinyl records (Christian, 2023). Yasunao Tone intentionally scratches the surface of CDs to create distortion (Yasunao et al., 2008). The above examples are examples of glitch sound generation using a physical medium.

There are also research and artwork that are completely opposite to this research. That is, they have been researched generating glitch art by applying audio processing to image data using Audacity. We also have been trying to do it, but it is not original to us. However, our goal is to express art by manipulating color (light) and sound in a cross-disciplinary manner, and our research also includes the reversible interconversion of glitch art images and glitch sounds.

Other techniques include data moshing, which causes errors during video playback, and research has been conducted on its effects and methods (Ito et al., 2014). An installation work of glitches using live coding (Fuego, 2022) has also been produced. This work is very interesting because it includes not only sound and images but also glitches with physical devices. Although not competing with this research, there is an attempt to use glitch art in contemporary dance (Jürgens, 2020). This is very interesting because it uses glitched art based on errors in sensors that acquire dance motions as images for mixed reality.

The differences between these glitch artworks and this research are as follows:

- Manipulating (controlling) audio glitches based on image processing
- Intentionally triggering glitches that match image processing operations or effects

In other words, the trigger for the glitch is the image processing, which generates the glitch in the audio data while enjoying the effect applied to the image.

Another unique aspect of this research is the generation of regular glitches. This is related to the generation of glitches that are matched to image processing. In other words, generating glitches that match a specific image processing can be described as expressing the audibility of the image processing in terms of glitches. This is one of the goals of this research.

## Conclusion

In this study, we tried to apply image manipulation using the Photoshop image processing software to audio data to generate glitch sounds elegantly. From the experimental results, it was confirmed that glitching effects corresponding to image processing can be introduced into audio data.

However, there are many issues to be addressed in this research. The following points will be studied in the future:

- Application of various image-processing operations and complex image-processing operations
- Technical investigation of the relationship between image processing operations and glitching effects
- Identification of the causes of cases where glitch sounds cannot be generated

The experiments conducted in this study were limited to the application of relatively simple image processing operations (cut, cut-and-paste, gradient, etc.). In the future, we plan to experiment with the application of more image processing operations (e.g., enlargement, reduction, rotation, monochrome transformation, blurring, filtering, etc.), as well as their combined application. For example, we will investigate the glitching effect of applying a rotation operation after an enlargement operation, or a blurring operation after a monochrome transformation operation, and so on.

The relationship between image processing operations and glitching effects will also be investigated technically. In this study, we found only sensory similarities between the two. Technical clarification of this issue will be conducted. In addition, we also aim to clarify the causes of cases where glitch sounds cannot be generated from a technical point of view.

## References


Adobe Developers Association. (1992). TIFF Revision 6.0, Retrieved from https://download.osgeo.org/libtiff/doc/TIFF6.pdf

Amano, N. (2018). Wearable Music: Generation of Costumes from Music and Generative Art and Wearing Them by 3-Way Projectors, International Journal of Humanities and Social Sciences, Vol. 12, No. 12, pp.1-7, World Academy of Science, Engineering and Technology.

Apple Computer Inc. (1989). Audio Interchange File Format: "AIFF", Retrieved from https://www-mmsp.ece.mcgill.ca/Documents/AudioFormats/AIFF/Docs/AIFF-1.3.pdf

Betancourt, M. (2016). Glitch Art in Theory and Practice: Critical Failures and Post-Digital Aesthetics. New York and London, Routledge.

Betancourt, M. (2015). The Invention of Glitch Video: Digital TV Dinner (1978), Retrieved from https://www.michaelbetancourt.com/pdf/Betancourt_TheInventionofGlitchVideo.pdf

Christian, M., Jean, P. C. (ed.). (2023). Christian Marclay, Jrp Ringier Kunstverlag Ag.

Fabbri, F. (2017). "Binaurality, Stereophony, and Popular Music in the 1960s and 1970s". In Merrill, Julia (ed.). Popular Music Studies Today: Proceedings of the International Association for the Study of Popular Music 2017. Springer Fachmedien Wiesbaden.

Festival, G. (2014). GLITCH Festival Official Website, Retrieved from https://www.glitchfestival.com

Fraser, B. (2004). Understanding Digital Raw Capture, Retrieved from https://www.adobe.com/digitalimag/pdfs/understanding_digitalrawcapture.pdf

Fuego, D. F., Naoto Hieda, N. (2022). Witchcraft at Livecodera, Retrieved from https://www.youtube.com/watch?v=XyUGDKd3lME

IBM Corp., Microsoft Corp. (1991). Multimedia Programming Interface and Data Specifications1.0, Retrieved from https://www-mmsp.ece.mcgill.ca/Documents/AudioFormats/WAVE/WAVE.html

Ito, Y., Stone, C., Yamada, M., Miyazaki, S. (2014). Datamoshing Technique for Video Art Pro-duction, The Journal of the Society for Art and Science, Vol.13, No.3, pp.154-168. doi: 10.3756/artsci.13.154

John, S. R., Greg, B., Jay, B. (2012). Audacity 101: The Unofficial Audacity Tutorial & Step By Step Guide, South Carolina, CreateSpace Independent Publishing Platform.

Jonathan, S. (2012). MP3: The Meaning of a Format (Sign, Storage, Transmission). Durham & London, Duke University Press.

Jürgens, S., Correia, N. N., Masu, R. (2020). Designing Glitch Procedures and Visualisation Work-flows for Markerless Live Motion Capture of Contemporary Dance. MOCO '20: the 7th International Conference on Movement and Computing, pp.1-8. doi: 10.1145/3401956.3404225

Kellein, T., Stooss, T. (1993). Nam June Paik: Video Time, Video Space. New York, Harry N Abrams Inc.

Laskevitch, S. (2023). Adobe Photoshop, 2nd Edition: A Complete Course and Compendium of Features (Course and Compendium, 6), California, Rocky Nook.

Luciano, C. (2012). Luigi Russolo, Futurist: Noise, Visual Arts, and the Occult, California, University of California Press.

Machado, P., McDermott, J., Carballal, A. (eds). (2013). Evolving Glitch Art, Evolutionary and Biologically Inspired Music, Sound, Art and Design. EvoMUSART 2013. Lecture Notes in Computer Science, vol 7834. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-36955-1_10

McCormack, T. (2010). Code Eroded: At GLI.TC/H, Retrieved from https://rhizome.org/editorial/2010/oct/13/code-eroded-at-glitch/

Menkman, R. (2011). The Glitch Moment(um), Institute of Network Cultures, No. 04, networkcultures.org, Retrieved from http://networkcultures.org/_uploads/NN%234_RosaMenkman.pdf

Popp, M. (2022). OVAL Official Website, Retrieved from https://www.popppopppopp.com

Stearns, P. (2013). Glitch Art Resources, Retrieved from https://phillipstearns.wordpress.com/glitch-art-resources/

Temkin, D. (2009). Glitch Tutorials, Retrieved from https://danieltemkin.com/Tutorials

Yasunao, T., Kim C. (2008). Yasunao Tone: Noise Media Language (Critical Ear), Errnat Bodies Pr.

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