MUSIC THERAPY WITH A LARGE-SCALE MIDI CONTROLLER USING A MAT SWITCH

PACS: 43.75.-z

Niikawa, Takuya; Yamagishi, Kazuaki; Onishi, Eri; Kawachi, Ryosuke; Minato, Kotaro; Yoshihara, Tatsuo; Terayama, Naoya

1Division of Biomedical Engineering, Graduate School of Biomedical Engineering, Osaka Electro-Communication University, 1130-70 Kiyotaki Shijo-Nawate, Osaka 575-0063, Japan; taku@isc.osakac.ac.jp
2Occupational Therapy (Night Course), Osaka Isen, 1-10-3 Oyodonaka Kita-ku, Osaka 531-0076, Japan
3Department of Bioinformatics and Genomics, Graduate School of Information Science, Nara Institute of Science and Technology, 8916-5 Takayama Ikoma, Nara 630-0192, Japan
4Joint Institute for Advanced Multimedia Studies, Osaka Electro-Communication University, 1130-70 Kiyotaki Shijo-Nawate, Osaka 575-0063, Japan

ABSTRACT
When expression disturbance and motor dysfunction are severe, participation in musical activities such as singing and playing instruments is difficult. In this study, by constructing a large-scale MIDI controller operable by depressing a mat switch with a foot or a wheel of a wheelchair, we propose a new music therapy available for the physically challenged. This system comprises a mat switch 500 mm x 700 mm in size with an operation load of 100 N, an A/D converter, a PC, and a MIDI device. Signal output from the mat switch was converted to a variety of MIDI signals by the PC, and sent to the MIDI device. By depressing 10 mat switches arranged in a matrix shape, users can control all elements operable by the MIDI signals. The status of the mat switches, whether depressed or not, is projected onto the wall by a projector and can be confirmed visually. In this study, we confirmed that users were able to control music sounds, song volume, and sound notes and scales by depressing the mat switch with a foot or a wheel of a wheelchair, and that the music therapy program we established was feasible.

INTRODUCTION
Music influences our feelings and emotions, and brings pleasure to our life. In medical practice, the power of music has long been applied for physical/mental care through music therapy[1]-[6]. In music therapy, there are two methods: passive and active. In passive music therapy, it is generally expected to obtain catharsis by listening to music. On the other hand, in active music therapy, there are a number of methods to actively utilize the power of music by singing school songs and playing instruments. It is known that this method provides a variety of benefits, such as an improvement in physical functions and the opportunity to participate in the community in addition to the effects obtained from passive music therapy.

However, when it is difficult to sing songs or play some instruments due to physical dysfunctions, it is not easy to engage in active music therapy. The goal of this study was to provide a new method for music therapy so that both healthy subjects and the physically challenged could enjoy the power of music.

This study aimed to construct an active music-listening system that would realize new music potential, where factors involved in passive music therapy to listen to music and those in active music therapy to control music were combined with a large-scale MIDI controller. The MIDI controller developed in this study used several mat switches and users were able to play or control music by pressing down them with their foot or a wheelchair.
OVERVIEW OF THE SYSTEM
This system comprised several mat switches 500 mm x 700 mm in size that would respond to a pressure of 100 N, an A/D converter, a PC, and a MIDI device. As a precondition, users of this system had to be able to move to wherever they wanted, or to have a device to do so. Signals were created by pressing down the mat switches, arranged in a two-dimensional matrix, with a foot or an electric wheelchair, and the signals were input to the signal processing PC to create MIDI signals, which were in turn output to the MIDI instrument (music sound creating PC) to control or play music. The system structure is shown in Figure 1.

Users could manipulate all controllable factors by MIDI signals, such as the volume of music and songs, music arrangement, and a music scale by freely pressing down a number of mat switches. For example, when the system was set to control the volume of music parts (such as violins, cellos, and trumpets) by pressing down the mat switches, it would be possible to behave like a hypothetical orchestra conductor. To let the users know which mat switch was pressed down, the switch condition was projected on the wall with an indicator. The overview of the system is shown in Figure 2.
SIGNAL PROCESSING WITH AN ELECTRIC WHEELCHAIR

This system was designed to control music by pressing down the mat switches. When users pressed down the mat switches with an electric wheelchair, they sometimes had trouble in controlling the system because the front and rear wheels unintentionally pressed down the switch in a row. To avoid inputting consecutive signals by pressing down the mat switch with one wheel followed by another wheel, an appropriate interval for signal sampling was calculated from the wheelbase of the electric wheelchair and the moving speed.

Since the wheelbase of the electric wheelchair used in this study was 0.46 m and the moving speed was 0.33 m/s, the sampling interval was set as 1.4 s.

EXAMPLE OF MUSIC CONTROL PROGRAMS

An example of music control programs available in this system is shown as follows.

Basic music control

Music parts played in the same tempo were allocated to the mat switches placed in a two-dimensional matrix, and the volume was controlled by pressing down an arbitrary mat switch. According to this method, users could create music as they liked and construct an environment for active music listening. Furthermore, it was possible to control music with high flexibility by changing music sounds and providing various sound effects. The actual control of music is shown in Figure 3.

Playing in concert

A single music note in a different music scale was allocated to each mat switch. One mat switch was assigned to one user, and all participants played one music song cooperatively. Music sounds could be selected from those available by the MIDI device, and a number of variations...
were possible. Needless to say, it was possible to play music in concert to a certain degree of complexity by allocating not only a single note but also effect sounds and chords. The actual playing in concert is shown in Figure 4.

Figure 4.-Playing in concert

A music game as card game “the concentration”
A variety of music phrases were allocated to mat switches in advance. The system was set to produce sounds by one push-down of the mat switch and silence them by another pressing-down. The question master made sounds by randomly pressing down several mat switches in a manner where answerers could not see them. Answerers pressed down the mat switches and silenced the sounds completely in the game. In other words, this mimicked card game “the concentration”. More details are as follows.

1) An answerer was given one minute to check out which music phrases were allocated to which mat switches placed in a two-dimensional matrix.

2) While the answerer was blindfolded, the question master made sounds by pressing down arbitrary mat switches.

3) The answerer pressed down mat switches to completely silence the sounds within the time limit. When mat switches were pressed down incorrectly, more sounds would be heard and the difficulty would be increased.

MUSIC CONTROL EXPERIMENT
With this system, an experiment to control with an electric wheelchair was carried out. In more detail, music parts played at the same tempo were allocated to 10 mat switches placed in a two-dimensional matrix, and the subjects were asked to control the volume by freely pressing down
the mat switches and construct music of their own. The subjects comprised 40 males and females from 11 to 75 years old, and they were asked to answer the survey as a free comment after they controlled the system. The results of the survey are shown in a circle chart in Figure 5.

As a result, 67% of subjects had favourable opinions, and most of them were related to the joy of controlling music freely. On the other hand, negative opinions accounted for 8% of subjects, and the majority was related to the poor control by an electric wheelchair. One reason for this may be because none of the subjects used an electric wheelchair on a daily basis. We are planning to ask the physically challenged to use this system and further develop this system.

CONCLUSIONS
In this study, we proposed a new music therapy with a large-scale MIDI controller operable by both healthy subjects and the physically challenged. In addition, we asked them to operate the MIDI controller and confirmed that usability of the system was good in general. We are planning to construct a variety of music therapy programs with this system and investigate their efficacy.
ACKNOWLEDGEMENTS
This research was partly supported by the Ministry of Education, Culture, Sports, Science and Technology in Japan under the Grant-in-Aid Scientific Research No. 17700465.