An automatic music accompaniment model at nursing homes using VLN's

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Abstract— Eurydice, an automated music accompaniment system, and vertical line notation are used in this research to provide music entertainment in a nursing home. Alzheimer's disease and other forms of dementia may be prevented or treated by regular music listening. Music progression on Eurydice may be achieved using two different tapping methods. A beginner piano student of ours has been asked to play from a VLN sheet music. We've put our system to the test over the last 10 months.

Index Terms— an automatic accompaniment system, vertical line notation, Musicianship senior person.

I.   INTRODUCTION

People over the age of 65 now make up a larger percentage of the population than they did a decade ago. As of October 2019, Japan has a population density of senior people (those over the age of 65) of 28.4 percent. More than any other country, Japan has the highest density of old persons (9.1 percent) [1]. Only the United States and Italy behind Japan in terms of percentage of population, with 23% and 22.4 percent, respectively (22.4 percent). As a result, the importance of preventive medical treatment and dementia prevention will increase in the future. Various computer technologies, such as virtual reality [2] and gaming systems [3,] are used for long-term rehabilitation or prevention.

Music therapy relies on a variety of activities, including singing, laughing, and interacting with others [4], [5]. Physical and mental components are improved and stabilised as a result of this treatment.

Both advancements have a symbiotic influence on each other. Music therapy may also be good for the elderly, according to our research.

"Eurydice," an artificial music accompaniment system, and a score of vertical line notation invented by us were used in this study, as well.

II.   MUSIC ACCOMPAGNMENT SYSTEM

"Eurydice" is a music accompaniment system that we developed [6]. Eurydice's window is seen in Fig. 1. Eurydice executes the accompanying part in accordance with the stated music score, in contrast to improvisation systems like Biles' "GenJam" [7] and Kalonaris' "Dory" [8]. As an SMF (standard MIDI file) contains multitrack music parts, this application predicts where the user would play them.

It is capable of tracking human musical performance, including mistakes on the keyboard, shifts in pace and sudden changes in a score. One finger tapping is all it takes to progress a music performance in Eurydice. [9] Eurydice allows the human to press the erroneous keys and plays the accompanying part in advanced music score position, or discovers the proper music score position and jumps there. Eurydice, on the other hand, chooses to continue the music accompaniment performance to the following notes in the music score if the pitch error is fairly large. As a result, a recording of human music part may be structured as a sequence of very low pitch notes, allowing for the creation of music. Human-playable tones were created by using MIDI note zero zero. Nobody can play the correct pitch since the incredibly low pitch is outside the range of the conventional piano keyboard. Pitch inaccuracies of a significant magnitude are a constant source of frustration. Initially, we added the new track to SMF by hand, but we later developed a software that would automatically add tracks of this kind. Eurydice's window in tapping modes 1 and 2 may be seen in Figure 2. A quarter note in a quarter time signature may be played using "Mode 1," which mirrors the player's tap-based timing. The default mode is mode 1. The player is now free to play whatever key on the music keyboard they like. A melody section must be selected before performing in "mode 2," and the song is constructed by hitting any note in time with the melody beat.
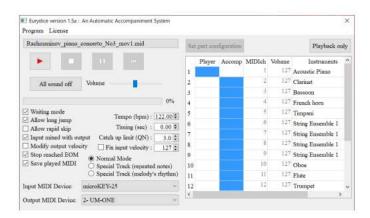

Fig. 1. Eurydice's window (normal mode)

Fig. 2. Eurydice in special playing mode 1 and 2

Vertical line notation (VLN) was established by Agata as a method for teaching piano to beginners in 1985. The vertical axis depicts the passage of time, while its horizontal axis conveys pitch. A circle on a node indicates the position and time of a key to be pressed. Notes added sharp or flat are placed immediately on the black keys in this notation, eliminating the need for accidental markings (or, for example, E expressed as F). Because each node has a finger number associated with it, a player may play more fluidly by correctly using their fingers. It is also helpful to know where the next node is on a branch since it has a blue bar. The VLN score can be read even if a player is unable to read regular staff notation.

III.   OUTLINE OF EXPERIMENTS

More than 30 times, we've stopped by a nursing home near NIT, Kisarazu College. We invited eight people to play the piano on a simple music keyboard (KORG microKEY-25).

- **Tap input like a conductor**

A favourite Japanese pop song was selected for each subject. For the time being, Eurydice is in mode 1. Figure 3 shows how to dial down the music keyboard's loudness while using this tapping mode. Players are able to play any key on their keyboard, and Eurydice modifies its pace accordingly. As a result, the subject acts as a conductor.

Singing has never been easier thanks to our lyric slides. We provided phonetic transcriptions of every Chinese character in kana form.

In addition, we were asked to play "A river sin spring," a Japanese children's song, which is shown in staff notation in Fig. 3. Participants first used mode 1 and then mode 2 tapping. After a few days, the order was overturned in order to examine the order's effect.

In this piece of music, the last note of each phrase may be either prolonged or not. Every four measures, there is a quarter rest. It was important that our test subjects maintain pressure on the key throughout each quarter rest in order to avoid accidental overlapping.
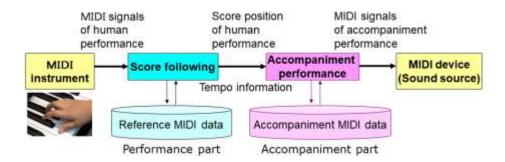
- **Piano solo with VLN score**

As an added bonus, we had a participant S1 play using a VLN score. When it comes to dementia, S1 has a minimal risk. Previously, S1 had to use a computer to do her job; today, she can even use a smartphone!

S1 used Eurydice and the VLN score to play "Tulip" on the piano. This piece of music has a difficult passage. Five fingers may be assigned to C, D, E, and G up to the eighth measure. However, the tenth measure has a pitch a note. The fourth note in the ninth measure and the first note in the tenth measure are the most challenging challenges. The little finger will be used on the fourth note G in the ninth measure if the hand is held up to the eighth measure. In this example, the little finger is used to play the beginning note of measure ten, an A. Pianists avoid using the same finger over and over again in order to generate a high-quality sound and perform fluidly. This means that the player must first move their hand one key to the right in the ninth measure before returning their hand one key to the left in the eleventh.

IV.   EXPERIMENTAL RESULTS

Table I shows the current state of the various issues. Dementia affects a number of students, making it harder for them to recollect information. The upper body movements of each participant

are unaffected, however half of the patients have difficulty walking. This study was the first time any of the participants had ever played the piano before.

Figure 3. System conceptual of Eurydice in the case of special track

As you learn each subject, you may like to listen to some music. Notice how S1 switched up their 15th performance's musical selection.

Each piano performance had its inter-onset interval (IOI) measured. We may use Eq. (1) to get d: Assume that d is an IOI

$$d = o_i - o_{i-1}, \qquad (1)$$

Where I is the note's index number and oi is its onset time when the key is pushed, as seen in the figure. Chords are performed within 33 microseconds of each other when there are a large number of notes in them. By looking aside or checking the playing style as they go, the subject's IOI grows. To remove outliers, we used Eq. (2) to compute the IOI's value range:

$$33[msec] < d < 2 \times d_a, \qquad (2)$$

da is the average IOI value, which is computed once outliers have been eliminated from the data set. Comparatively, the S1 and S3 performances are stable. S4's music piece has a slow tempo and a tendency to change. Lower IOIs are the outcome of a greater volume of performances. The piano prowess of the subject is said to have developed over time. To begin with, the users were afraid to look at the keyboard. Participants become more eager to attend as the number of performances increased.

Additionally, we calculated the average of the difference between the present and previous IOIs, known as df

$$\bar{d}_f = \frac{1}{I} \sum_i \{d_i - d_{i-1}\}, \qquad (3)$$
.

In this case, I represents the number of decimal places. Even in everyday life, S5's chronic condition caused him to sometimes cease moving, and he even stopped playing the piano unexpectedly. As a result, the S5's average IOI is rising. Nevertheless, lately, the cessation of movement during performance has steadily diminished. Other subjects have comparatively minimal change in pace. We assume that since each subject performs a well-known song, they can readily convey the tempo's atmosphere.

TABLE I STATUS OF SUBJECTS.

Subject	Sex	Age	Degree of care	Preexisting illness
S1	male	83	Need support 2	cerebral infarction
S2	female	82	Need care 1	dementia (use of stick)
S3	female	87	Need care 2	
S4	female	87	Need care 2	(use of stick)
S5	male	79	Need care 5	cerebral infarction (use of wheelchair)
S6	female	86	Need care 3	angina (use of wheelchair)
S7	male	76	Need care 3	moderate intellectual disability
S8	male	80	Need care 3	dementia, diabetes

All of the participants have performed two tapping styles of "A river in spring." The number of times "A river in spring" was correctly and incorrectly played. While in the first situation, the subject immediately switched from mode 1 to mode 2, in the second case, the subject switched from mode 2 back to mode 1. Take into account that halting the show mid-way is a result of this.

The incorrect position has a negligible amount of bias. However, in the first and second verses, the errors are most apparent in the first phrase and in the fourth phrases. Subjects made an error in their performance of the last note of the first phrase, which they noticed and corrected in the next phrase. It is probable that note duration will grow since the last note of the fourth phrase is also the final note of each verse, generating a cadence.

TABLE II   THE MUSIC LISTED WAS PLAYED ONE AT A TIME ON THE 15th PERFOMANCE, S1 USED A DIFFERENT PIECE OF MUSIC.

Subject	Name of music piece
S_1	Triumphal March from "Aida" (by Verdi)
	I want to go somewhere far away
S_2	A river in spring
S_3	Twilight time in Yokohama
S_4	Yagiri's ferry
S_5	Fellow traveler
S_6	The inland sea bride (Seto-no hanayome)
S_7	Osaka autumn shower
S_8	Thank You Again Today, Night Fog

Playing on tapping mode 1 was first thought to be more convenient since the motion on mode 1 is similar to playing a favourite music and it is just necessary to maintain the same tapping action, resulting in less mistakes than on mode 2. For Mode 2, pupils must be able to keep up with the melody's tempo and know where they are in relation to the rest of the piece. Although we expected to find problems like sound expansion in mode 1 and unnecessary tapping in mode 2, we were wrong. Mode 1 was considered more difficult by some participants. The length of the prelude note was not mistakenly extended on mode 1 for any of the themes, on the other hand. Because the prelude was an instrumental piece rather than a song, we feel that the participants correctly recognised it.

It was common to hear individuals say, "This is my first time playing the piano" or "I can't play the piano." However, if proper direction is given about key press time, they may perform without flaws. There is hence a possibility that subjects may play without the assistance of human employees if a system for providing such suggestions is built.

VLN scores seem to be safe and beneficial when used on the elderly. The VLN score is commonly acknowledged as suitable for use with children because of its simplicity of

understanding and reading. VLN scores may be useful for students wishing to be nursery school teachers, for example. Therefore, students of any age may use the VLN score.

V.   CONCLUSION

The Eurydice automated music accompaniment system and a score in vertical line notation (VLN) are used in this study to show the use of music entertainment for elderly people in nursing homes (VLN). Subjects and staff alike have expressed their appreciation for our musical entertainment. A lot of practise and exposure to the piano has helped the kids improve their piano skills.

A modest system like Raspberry Pi 4 will be developed in the future and will be installed in the facility so that subjects may play at any time. In addition, we believe that training music educators and community volunteers is essential. The method will also assist other organisations and people, such as future nursery school teachers.

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