Automatic Music Composition System to Enjoy Brewing Delicious Coffee

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Abstract. It is important to control the amount of hot water poured and the timing of each operation when brewing coffee by the drip method. Since this is difficult for inexperienced people, some kind of guidance is needed to brew delicious coffee to their liking. We aimed to enable users to enjoy brewing delicious coffee regardless of their coffee brewing knowledge or experience, and proposed a method to automatically generate music to play during coffee brewing. In the demonstration, participants can generate coffee brewing music based on their personal sensibilities, brew coffee while listening to the generated piece and taste it.

Keywords: Coffee Brewing, Music Composition, Symbiotic Evolution

1 Background

The taste of coffee depends not only on the type of bean, its condition, the grinding method, and the temperature of the hot water, but also on the brewing method. There are several brewing methods, such as drip, immersion, and pressurized, but drip is the most popular as an easy way to enjoy delicious coffee. Generally, a small amount of hot water is first poured over all the coffee powder in the dripper to steep it. Then the two processes are repeated, slowly pouring hot water to about halfway up the dripper and waiting for the water to fall into the cup. Because it is difficult for inexperienced people to control the amount of hot water poured and the timing of each operation, some kind of guidance is needed to brew delicious coffee to their liking.

Music is known to have various effects, such as inducing emotions, creating an atmosphere, activating the brain, and enhancing the effects of exercise. However, the impressions and feelings that arise when listening to music are different for each individual, and therefore, the sources distributed to the general public may not be effective for each individual. The way one feels may vary depending on one's mood or situation when listening to music, and one may get bored and want to listen to different music after listening to the same music for a long period of time.

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Table 1. Music structure

Order	Operation	BPM	Part ID	Timbre	No. of bars
1	Lift the kettle	49	a	Marimba	1
2	Aim the spot to pour		b	Marimba	1
3	Pour hot water (1st)		d	Piano	4
4	Wait		f	Bass	5
5	Aim the spot to pour	54	b	Marimba	1
6	Pour hot water (2nd)		e	Piano	5
7	Wait		g	Bass	3
8	Aim the spot to pour		b	Marimba	1
9	Pour hot water (3rd)		e	Piano	5
10	Remove the dripper		c	Marimba	3

In this context, we aimed to enable users to enjoy brewing delicious coffee regardless of their coffee brewing knowledge or experience, and proposed a method to automatically generate music to play during coffee brewing. The following describes the proposed method and the details of the demonstration.

2 Music Composition for Brewing Coffee

2.1 Music Structure

In order to find out the focus of the coffee brewing process, an experiment was conducted with the expert with the Coffee Sommelier Certification and the inexperienced persons. They were instructed to brew coffee freely, and the process was filmed from above, in front of, and to the left of them. Analysis of the videos revealed that the number of pours, the number of spout rotations, and the time required for each operation were important.

In order to guide operations similar to those of the expert, the structure of the music was determined as shown in Table 1. The number of spout rotations in each pouring was equal. Since the first pouring took longer time than the second and third pourings, the tempo is changed after the fourth operation. It is assumed that the spout makes one rotation in one beat. The BPMs are calculated from the average rotation time, and the number of bars required for each operation is determined.

Part a - f are the parts consisting of a piece of music. The same part is assigned to the operation with the same content and the same number of bars. To make it easy to recognize the start and end of the pouring and the end of the waiting process, the timbre of each part should be different. A bell is played on a vibraphone with the key note two octaves higher for one beat to signal the end of each operation. The bell should ring on the beat before the end of pouring, so that the kettle can be returned after the bell rings during pouring.

2.2 Composition Method

The parts a - g are generated by the proposed method, that is based on the composition method adapting to individual sensibilities[2]. The composition flow of the proposed

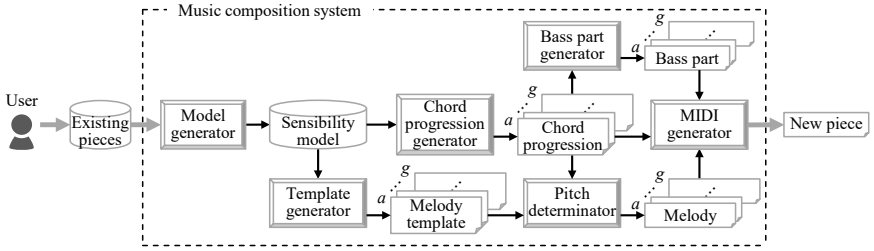


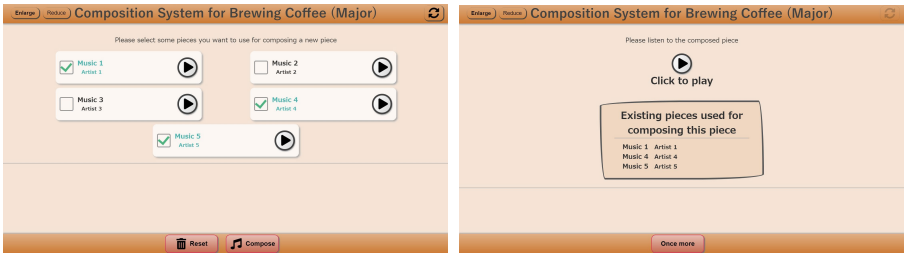
Fig. 1. Composition flow

method is illustrated in Fig. 1. Some existing pieces are needed as the training dataset. The pieces included in the training dataset and the parts generated by the proposed method consists of a chord progression, a melody and a bass part with a 4/4 time signature. The basic duration of a note or rest in a melody is defined as that of a sixteenth note. The basic duration of a chord in a chord progression is defined as that of a quarter note. The bass part is a sequence of eighth notes with the lowest pitch of the chord in the chord progression.

First, existing pieces are specified as the training dataset according to the targeted person's sensibilities, aims, and/or the purpose of the intended composition. Sensibility models for the chord progression and the melody are obtained based on the training dataset. In the next step, chord progressions a - g and melody templates a - g that adapts to the sensibility models and the basic music theory are generated depending on the numbers of bars for the parts a - g. A melody template indicates the time at which each sound in the melody is played, the length of time each sound is played in succession, and the up-and-down stream of the melody line. In other words, a melody template is a melody without the pitch of each note. Subsequently, the pitch of each note in melodies a - g is determined using the melody templates a - g and chord progressions a - g. Finally, bass parts a - g are generated and combined with the chord progressions a - g and melodies a - g to form the parts a - g. Arrange the parts a - g in the order shown in Table 1, set the BPM, add bells, and output in the form of a MIDI file.

Symbiotic evolution[1], an evolutionary computation algorithm that results in a fast, efficient search and prevents convergence to suboptimal solutions, is applied to generate a chord progression and melody template. It is characterized by maintaining two separate populations: a partial solution population, the individuals of which represent partial solutions, and a whole solution population, the individuals of which are combinations of individuals in the partial solution population and represent whole solutions. In the former population, partial solutions that may be components of the optimal whole solution are generated. In the latter population, combinations of the partial solutions that may be the optimal solution are generated.

In generating chord progressions and melody templates, a bar is represented as a partial solution and a part is represented as a whole solution. The fitness of a whole solutionin individual is calculated based on the degree of adaptability to the sensibility models and the basic music theory. The fitness of a partial solution individual is the fitness of the best whole solution individual that refer to the partial solution individual.



(a) Select existing pieces for training (b) Listen to the generated piece

Fig. 2. Screens in the composition system

2.3 Effectivity

Experiments were conducted with three inexperienced people. First, they were instructed on how to brew coffee, then they brewed the coffee at their own pace and tasted the brewed coffee. Next, they selected some pieces as training data according to their own sensibilities. Using the proposed method, a new piece of music was generated for brewing coffee. They brewed the coffee while listening to this piece and tasted the brewed coffee. The total dissolved solids and extraction yield of the brewed coffee were measured, and the values of the second cup were closer to the ideal for all participants. Subjective taste ratings were also higher for the second cup, and listening to the piece while brewing coffee was also well received.

3 Demonstration

In the demonstration, the participants can use the system in which the proposed method is embedded to generate coffee brewing music for themselves based on their personal sensibilities. Examples of the system screen are shown in Fig.2. When they select some pieces for training and press the “Compose” button on the screen of Fig.2(a), the screen of Fig.2(b) will appear in about 10 seconds after passing through the progress indicator screen. The selected pieces are displayed on the screen and they can listen to the generated piece. If they wishes, they can actually brew coffee while listening to the generated piece and taste it.

References

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