

Research Article

The Design and Implementation of the Matching Method of Chimes Dance and Music for Growth of Edible Mushrooms Based on Hevner Music Emotion Model

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Abstract: This study aims to investigate the synchronization mechanism for music and dance in the production encouragement system of edible fungus. The synchronization between the music and dance may significantly influence the stimulating effect on the growth of edible fungus. However, very limited work has been done to address this issue. To deal with the synchronization problem of music and dance, the Hevner music emotion model based on adjective circle is proposed in this study to achieve matching mechanism of audio streams and video. By doing so, the proposed algorithm can improve the synchronization between the music and dance. In emotion driven model with the theoretical basis of Hevner emotion ring, the music matches to the dance successfully, which can not only provide matching method for chimes-driven dance editing system, but will also provide a simple and feasible matching pattern for any other applications.

Keywords: Edible fungus, music, production encouragement, synchronization

INTRODUCTION

Acoustic encouragement technology has been applied to many agriculture food applications. Literature review indicates that by listening to music the plants can increase production output and improve the production quality (Hou *et al.*, 2009, 2010; Spillan, 1991). There are some researches addressing on the production promotion of bacteria and other micro-organisms (Robrish *et al.*, 1976; Xiao, 1991) and their findings suggest that the different frequencies of sound waves have different influence on microbial breeding time (Li *et al.*, 2008). Up to date, the music audio has already been applied to edible fungus production in Japan (Han, 2006) to reduce the cultivation time. It reported that a well matching of music and dance can greatly improve the encourage effects for edible fungus production. However, how to synchronize the music and dance for the edible fungus is still a big challenge in this field. As virtual human technology has become more sophisticated, virtual humans have been widely used in engineering, virtual meetings, interaction, monitoring, virtual environments, games, training, education, military training, design and maintenance of products and other fields. With the rapid development of virtual reality technology, the establishment of an ideal, integrated virtual people in a virtual environment has gradually become a new direction in the study of musical-stimulated growth of edible mushrooms. However, little work has been done to deal with this issue, especially for the synchronization problem of

music and dance in production promotion of edible fungus.

In order to investigate the synchronization problem of music and dance in production promotion of edible fungus, this study proposed a new method based on the Hevner music emotion model to well match the music and dance. A comprehensive design and implementation algorithm have been established.

MATERIALS AND METHODS

In the characteristics of music there are many aspects related to the emotions expressed in music, including beat and melody in complex characteristics, musical styles and emotional connotations in overall characteristics. However, the direct impact on the emotional response to music is mainly tonality, which refers to the 24 major and minor. There is a correspondence of non full map between different tonalities and emotions expressed. For instance, G major is bright; D minor is sad and strong; C major is resplendent; E flat major is solemn, with opaque concentration; C minor is a dark and intense; D major is brilliant, dazzling like a beam of sunlight.

Emotional expressions through music tonality are mostly sentimental and fuzzy and more critically, interwoven parts exist in many descriptions for tonal emotions, which makes it difficult to distinguish them with a clear definition. For example, the resplendent emotional attributes represented in C major and the brilliant tonality represented in D major both have sub-

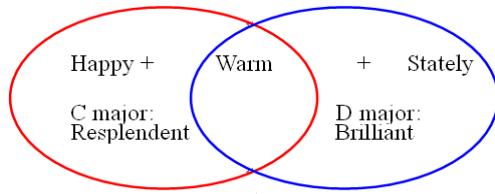


Fig. 1: The overlap of emotional descriptions with different tonalities

attributes that represent warm, as shown in Fig. 1. This method of emotional description cannot be classified in the digitized approach and must be further split to obtain indecomposable music element. According to the most widely recognized Hevner glossary, we convert the vaguely defined tonal emotions to eight major emotional categories, each including many emotional sub items, which will be specifically described in more details later. Thus, the final description of the emotional attributes of each music section and sub section in music/action script file is the amendment to tonality based on Hevner glossary.

Because the Poser act database was established with Hevner emotion entry as a standard to classify the habitual actions in the original chimes dance library, as shown in Fig. 2, it is easy to correspond to the generated music/action script file. For each sub-section in the script file, we retrieve in the corresponding classified Poser library according to its emotional attribute. As actions with the same emotional attributes are under the same emotion child directory, there may be more than one action that is in line with the sub-section search condition; actions with the highest matching rate can be identified by invoking the action

correlation module. By repeating the retrieval process, the action sequence matching emotion driven model corresponding to the music/action script is finally achieved. Figure 3 shows the action sequence matching emotion driven model.

RESULTS AND DISCUSSION

Music and movement synchronization control model in multimedia system: After acquiring the action sequences corresponding to MIDI source music through the system, the next step is to build a real-time multimedia playback system to combine the two and display it. As a real-time system, how to synchronize audio stream and video stream has become the primary question. During music playback, if the system cannot display the action or action sequence corresponding to the music section in specific section, then it is considered as real-time system synchronization failure or even a failure of the whole audio-based dance editing system, because the corresponding relationship between music and action cannot be demonstrated.

To describe the synchronization control method, we first give a formalized definition to the elements of media information involved in the output and provide the multimedia output synchronization control model as shown in Fig. 4.

Assuming multimedia information streams output contains two kinds of media information (as audio and video signal synchronization is mainly discussed in the present system) with variable t representing time. Using $F = (f_1, f_2)$ as an expected output function,

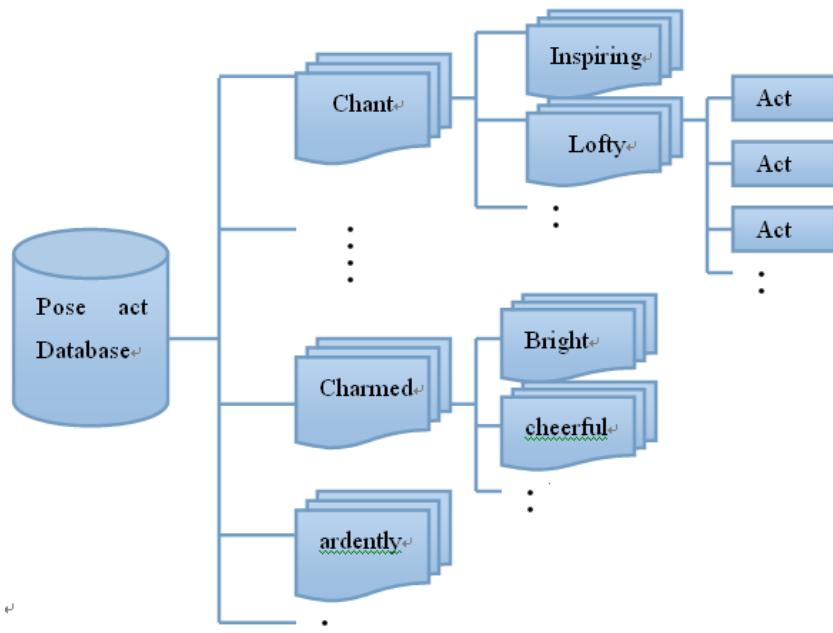


Fig. 2: Dance association

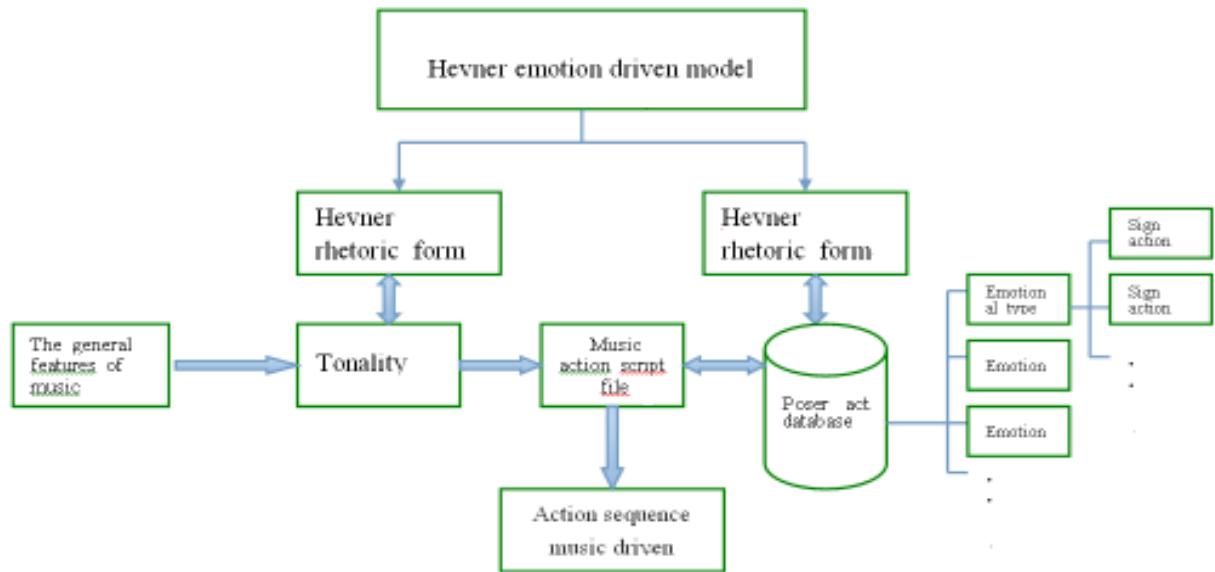


Fig. 3: Hevner emotion driven model with music matching action sequence

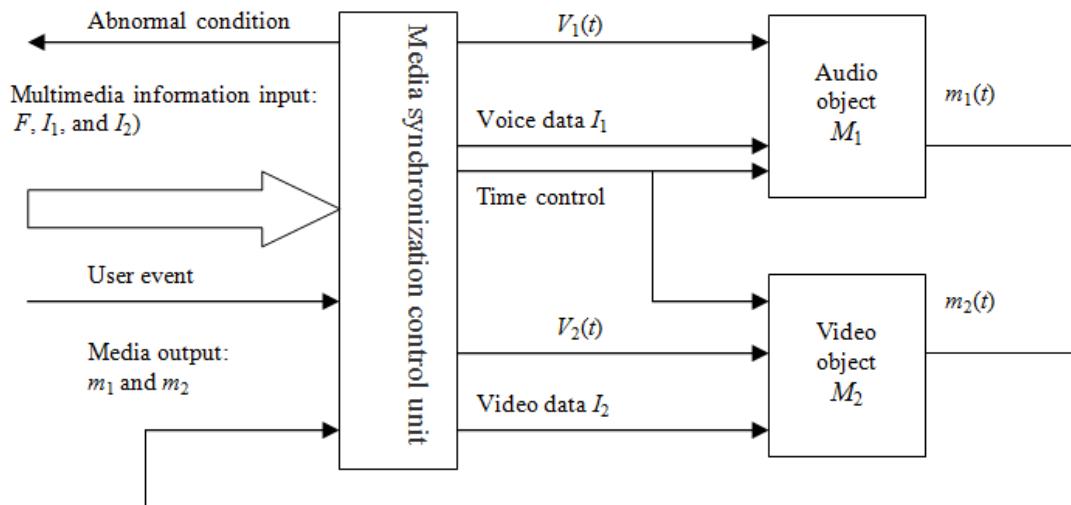


Fig. 4: Music and movement synchronization control model

stream function should be based on the information such as the types and features of media, user requirements and so on. $f_1 = f_1(t)$ represents the expected output function of audio signal, which refers to the position audio media information should play to at the time of t ; $f_2 = f_2(t)$ represents the expected output function of video signal, which shows the position video media information should play to at the time of t . F is part of the input media synchronization control unit information, describing the temporal relationship between output audio and video media. F and output multimedia data stream I_1 and I_2 constitute I , the multimedia input stream of synchronization control unit. In Fig. 4 I_1 and I_2 represents two output media data streams that the synchronization control unit separate from multimedia input information I . V (v_1, v_2)

represents output speed required by each media control object, where v_1 represents the desired output speed of audio signal and v_2 represents the desired output speed of video signal. The output state function $M = (m_1, m_2)$ in synchronization control unit indicates the current position of the media output, where m_1 represents the current position of audio signal output and m_2 represents the current position of video signal output. Generally, M is the function of input data stream I , playback speed V and time t , i.e., $M = M(I, V, t)$. As shown in Fig. 4, the output state function M is also the input of synchronization control unit, which helps to generate the media output speed.

Media synchronization control unit in multimedia system: In the model of Fig. 4 the, the synchronization

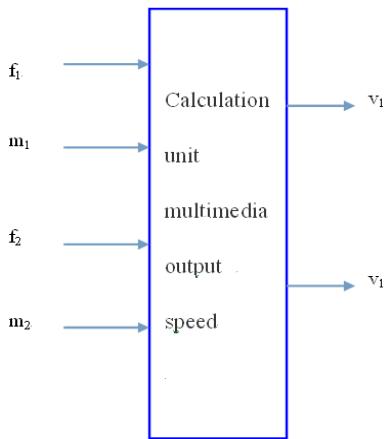


Fig. 5: Speed calculation unit

control unit is the central component. Its core content is to separate the expected output functions of various media from the multimedia input information I and media output speed is generated through operation. Its internal structure design is shown in Fig. 5.

The working mechanism and operation process of the media synchronization control unit are as follows:

- Separating the expected output function $F = (f_1, f_2)$ from the input information.
- Indicating various media output timing relationships respectively according to the expected output function and accepting the output status $M = (m_1, m_2)$.
- Generating the output speed v_1 and v_2 required by each media control object, which is the core of the synchronization control mechanism. By calculating output speed required by various media to maintain synchronization, the realization of synchronization can be ensured by controlling the output speed.

Output speed V should be related to expected output function F , output state function M and input information stream I , i.e., $V = V(F, M, I)$. In practice, however, it is simplified in order to reduce the computational complexity, which assumes that the media output speed is not very relevant to the content (in this method, we only discuss the output speed to control various media rather than synchronization by changing the output content, hence this assumption is feasible). The output speed at the moment is only relevant to the expected output function and output state function, thus the following function is obtained:

$$V = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} v_1(F, M) \\ v_2(F, M) \end{bmatrix} \quad (1)$$

Therefore, if $v_1(1) = \frac{df_1(1)}{dt}$, then $m_1(t) = \int_0^t v_1(t) dx + i_1(t)$. Wherein $i_1(t)$ represents a very small error, which is the error between the actual output position

and the expected output position of the audio signal. Since $f_1(t) = \int_0^t v_1(t) dx$, the error between the actual output and the expected output is $i_1(t) = m_1(t) - f_1(t)$ and we can get the following calculation:

$$\left\{ \begin{array}{l} v_1(t) = \frac{df_1(t)}{dt} \\ v_2(t) = \frac{df_2(t)}{dt} + c_2 * i_1(t) + d_2 * (m_2 - f_2) \end{array} \right\} \quad (2)$$

where, c_2 and d_2 are constants for adjustment.

The ultimate objective to propose media synchronization control model is to make the actual output function consistent with the expected output function to achieve the optimal synchronization. Nevertheless, because of the assumption that the media output speed and content are irrelevant while actually they are, the actual output and the expected output functions are not completely consistent; there must be an error, e.g., $i_1(t)$. By controlling the output speed of various media, the output and the expected targets are as close as possible, which controls the error within the affordable range. It should be noted here that with the accumulation of this type of error in the segment, when the accumulated error is large enough it will affect the synchronization effect. Accordingly, it is necessary to use a synchronization control method by sections to eliminate the accumulated error within a section.

After following the above three steps, the media synchronization control unit can realize intersection synchronization by controlling the respective output speed of various media to meet the timing relationship between them.

The realization of music and movement synchronization control model: Music and movement synchronization matching model uses several traditional synchronization model and secondary synchronization model as reference. The synchronized matching model proposed in this study ensures the integrity and continuity of audio and video signals with small computational complexity. Figure 6 shows a flow chart of the synchronization matching model.

The first step to synchronize music and movement is to initialize audio and video objects, corresponding to the system operation is to call MCI_OPEN_PARMS to set parameters of MCI media player class, including MIDI and AVI playback parameters.

The clock used by the control unit of the system is the time type division used in audio analysis. After reading in a MIDI section the continuous divisions are recorded and what triggers the audio and video is the expiration of the division timer, when the reference position should be reset to wait for the next section and movement to reach position. During the synchronization process of audio and video, the following two kinds of coordination for the inconsistency of music and movement duration can be provided:

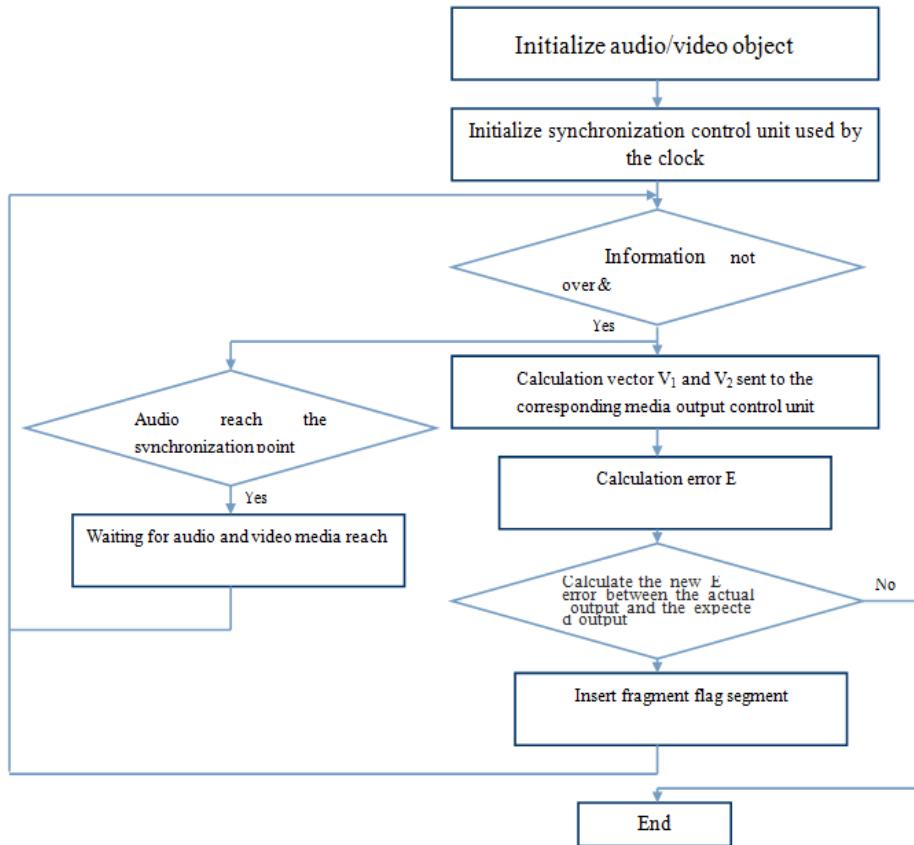


Fig. 6: Calculation of music and movement synchronization control model

The basic approach: Master-slave relationship is not established. If any audio and video stream has ended, re-read the next round of audio and video content after the end of another media stream.

Music-driven approach: With MIDI audio stream as a benchmark, synchronize the two by adjusting the frame rate of key frame animation design based action.

The system default synchronization is the basic approach; reading and playing MIDI audio section successively and displaying actions in two formats (BVH/AVI) until the end are functions that will be implemented by the system.

CONCLUSION

The synchronization between the music and dance may significantly influence the stimulating effect on the growth of edible fungus. Focused on the correspondence between audio section and video sequence, this study has proposed the emotion driven model that uses Hevner emotion ring to maintain the music-dance relationship. After studying the correspondence between the audio stream and video stream, we proposed a music and dance synchronization matching model in a prototype system and the algorithm flow of the model. Hence, acceptable

synchronization between the music and dance could be achieved to full play the music role in the stimulation of the growth of edible fungus.

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