Validating the Proposed Framework for Visualising Music Mood Using Visual Texture

Adzira Husain[1(✉)], Mohd Fairuz Shiratuddin[2], and Kok Wai Wong[2]

[1] School of Creative Industry Management and Performing Arts, Universiti Utara Malaysia, Changlun, Malaysia
adzira@uum.edu.my

[2] Discipline of Information Technology, Media and Communications, College of Arts, Business, Law and Social Sciences, Murdoch University, Perth, Australia

Abstract. There are several ways to search for songs in an online music library. A few types of visual variables to represent music information such as colour, position, shape, size, and visual texture have been explored in Music Information Retrieval (MIR). However, from a comprehensive literature review, there is no research focusing explicitly on the use of visual texture for browsing music. In this research, we define visual texture as an image of texture designed using the drawing application. In this paper, a framework for visualising music mood using visual texture is proposed. This proposed framework can be used by designers or software developers to select suitable visual elements when designing a clear and understandable visual texture to represent specific music moods in the music application. This research offers a new way of browsing digital music collection and assisting the music listener community to discover new song especially in mood category. To validate the framework, usability testing was conducted. This paper presents the process of developing and validating the proposed framework.

Keywords: Human-Computer Interaction · Information visualization · Music browsing · Music mood · Music information retrieval · Usability testing · Visual texture

1 Introduction

In the conventional way of displaying a music collection in most music library, the song titles were represented in a text list (see Fig. 1). An end-user or music listener will browse or scroll through this text list and select which song to play. However, this method of browsing is insufficient to maintain an overview of the music collection. Moreover, the traditional browsing method is not effective in response to the escalating growth of music collections [1]. As a result, music listeners will search for the same artist they are familiar with and will not be able to discover new and interesting songs available in their music collection. Therefore, Information Visualisation or InfoVis is a promising option for representing musical metadata [2, 3].

Z. Lv and H. Song (Eds.): INTETAIN 2021, LNICST 429, pp. 142–160, 2022.
https://doi.org/10.1007/978-3-030-99188-3_9

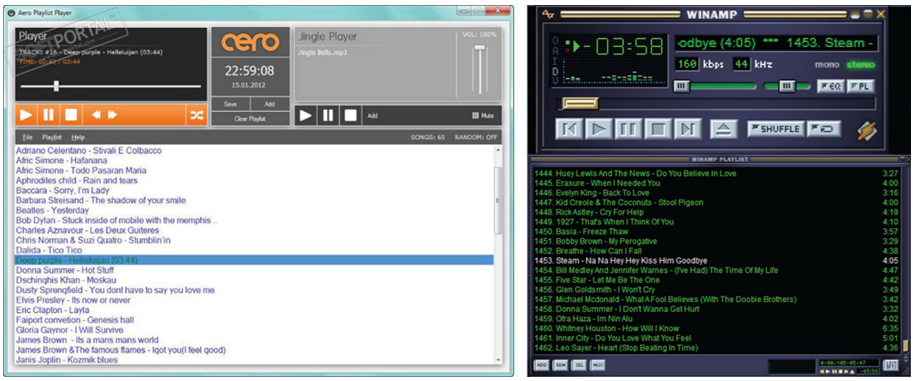

Fig. 1. The conventional way of displaying a music collection

InfoVis is a multidisciplinary research field that encompasses a wide range of areas, including computer graphics, cognitive psychology, and Human-Computer Interaction (HCI). Data images and structures are created toward assisting the exploration, performance of the specific task, analysis, and decision making [4]. Also, InfoVis is often evaluated as a tool that can support the performance of a certain task [5].

Previously, music users listened to music by browsing through the song title or artist's name list. Nevertheless, nowadays, the music segment that has become popular among music enthusiast is mood. Hence, mood has been identified as essential criteria in organising their music collection [6, 7].

In the MIR research field, various types of visual forms such as album cover, avatar, and mood picture have been introduced to represent mood.

Table 1. Related research and the type of visual variable used.

Related works	Visual variable
Moodo dataset [9]	Colour
Moodplay [7]	Colour, position
myMoodplay [1]	Colour, value, shape
Songrium [10]	Shape, size, position
Mood Pictures [11]	Pictures

Table 1 shows several related works that have explored visual variables in their research. Previous research has used other visual variables to associate music metadata, but they have not focused explicitly on textures [3, 8]. The look and feel of a surface are called texture. It can be classified into two types that are, tactile and visual textures. A tactile texture, also known as an actual texture, is the feature of a surface that can be touched and felt. A visual texture is the texture designed using a drawing application, scanned from actual textures, or photographed.

In consumer studies, ceramic art, textile design, and user interface research have discovered that texture has an emotional relationship to human moods [12, 13]. Still, until this research is carried out, visual texture has not been used to represent the music mood category in an online music library. Therefore, a framework for visualising music mood using visual texture is proposed.

In this paper, we proposed a framework for visualising music mood using visual texture. This framework can be used by designers or software developers to select suitable visual elements when designing a clear and understandable visual texture to represent specific music moods in the music application. A usability test was conducted to validate the framework. The process of developing and validating the proposed framework was presented in the next section.

2 Research Methodology

In HCI methodology, this research employed a User-Centered Design (UCD) science research method. The UCD has been identified as a multidisciplinary design method. This is based on the active participation of users towards improving the knowledge on user and task specification and the iteration of design and evaluation. [14]. Design science research has become popular methodology in multiple fields such as information system [15–17], Human-Computer Interaction (HCI) [18, 19], instructional design and technology [20], and educational research [21].

In design science research, purposeful artefacts are built and evaluated to understand the problem domain and its solution [22]. The artefacts can be constructs such as vocabulary and symbols. They can also be in the form of models such as abstractions and representations, methods such as algorithms and practices, or instantiations such as implemented and prototyped systems [22]. However, outcomes such as working prototypes, algorithms, user interfaces, processes, techniques, methodologies, and frameworks can also be considered valid artifacts under the design science research method [23].

In music recommendation research, several inventive artefacts such as prototypes and graphical representations for music retrieval and visualisation have been developed and evaluated [1, 6, 11, 24]. In particular, the outcomes of this research overlap with the list of artefacts mentioned in the previous paragraph. Therefore, the design science research method applies to this research.

In proposing and validating the framework, five phases are executed (see Fig. 2). A description of each phase is included in the following sub-sections below.

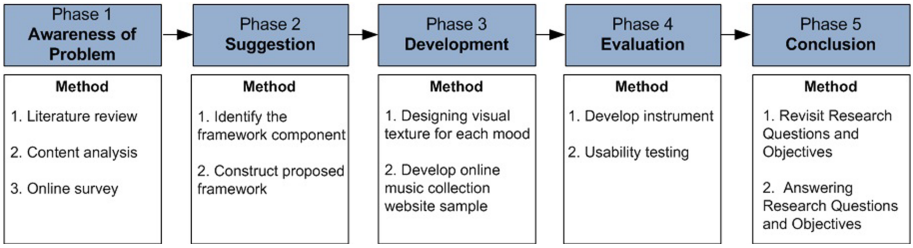

Fig. 2. Research phases

2.1 Phase 1: Awareness of the Problem

In Phase 1, an online survey was set up to determine which type of design element best represents the specific mood. The survey was divided into four mood sections which are angry, sad, happy, and calm. There are four different subsections in each section, namely colour, colour values, lines, and shapes (see Fig. 3). All possible types for the elements are listed in the answer options.

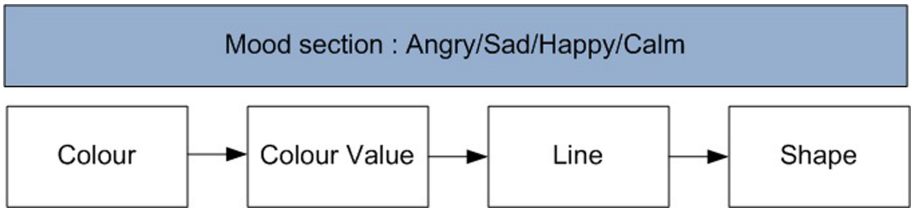

Fig. 3. Online survey flowchart

The respondents will then select an option from the list which they think best represents the mood before moving on to the next subsection and submitting the survey as soon as they have finished. Next, the respondents will select the type of element they think matches the mood from the list of design elements. Once the specific types of design element for each mood have been confirmed, they will be incorporated to construct the proposed framework in Phase 2.

2.2 Phase 2: Suggestion

After confirming the specific types of design element for each mood in Phase 1, a framework for visualising music mood using visual texture was proposed. Derived from the Visualisation Reference Model [25], the proposed framework was developed (see Fig. 4). The highlight of this framework is the visual mapping process. In the process, a specific visual texture was mapped to four different types of music mood category.

One of the components in the proposed framework is the music moods which include Angry, Calm, Happy and Sad. Previous research has shown that 30% of music listeners browse music based on the event's theme, such as birthday parties or weddings,

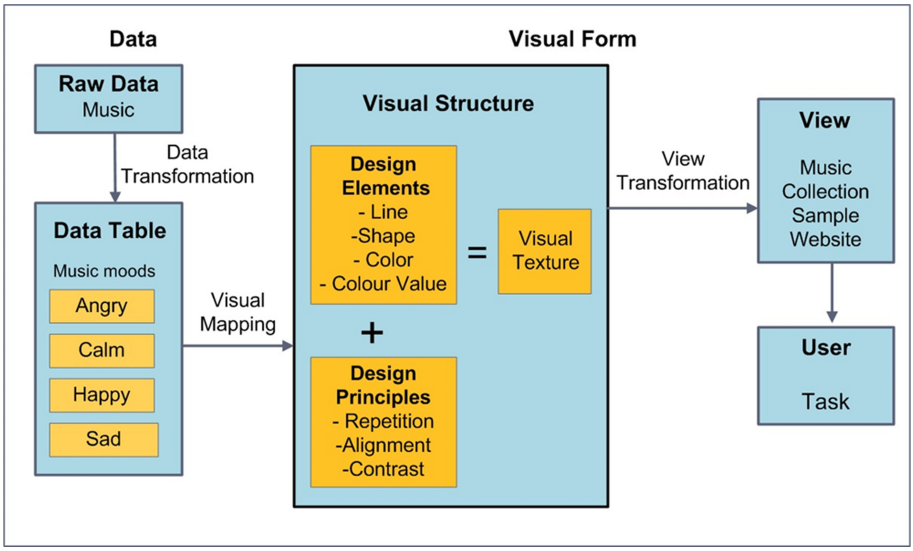

Fig. 4. The components of the proposed framework

while 15% is based on mood, such as sad or happy [26]. Furthermore, other research findings discovered that music listeners prefer to organise their song list in their music library based on mood rather than the song's title, artist's name, and music genre [27]. Besides that, in digital music library research, mood labels have also been considered as promising metadata [28].

Next, another key component in the framework is the design elements. Visual textures also consist of design elements such as colour, colour value, line, and shape, just like any other images. These design elements can represent mood. Different type of moods can be represented by a different type of design element [29]. For example, horizontal lines indicate a calm mood, while zigzag lines can express a feeling of excitement. A round and curved shape appears more friendly, while a sharp-angled shape conveys a negative mood. Certain colours also can convey a wide range of moods.

In this research, selected visual elements are combined using suitable design principles to develop a clear and understandable visual texture that can represent a specific music mood.

2.3 Phase 3: Development

This section discusses the processes in the development phase (see Fig. 5), and there are two activities in this phase. Firstly, the visual texture for each mood is designed. Next, the selected visual elements that were acquired from Phase 1 are combined using appropriate design principles. Then, the visual textures are applied in a music collection demo website to represent the respective music mood category.

Designing Visual Texture. Visual texture for each mood was designed based on the stage of Visual Mapping in the General Visualisation Reference Model [25]. This model

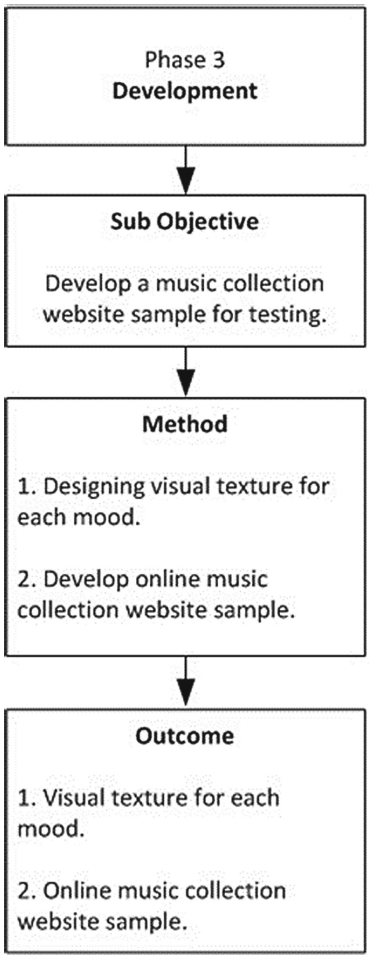

Fig. 5. The processes in the development phase

starts by converting raw data into a visual structure that the user can perceive. By going through the visual mapping process, the data table was then mapped onto visual structures. Visual structures are made of visual variables. Finally, a specific set of symbols can be applied to data to interpret information [30].

Table 2 shows seven essential visual variables that can create visual differences for a user to perceive and interpret the meaning of certain data. These visual variables can create an image or a symbol that has meaning to the audience [30]. The choice of a variable that would be the most suitable to represent each aspect of information depends on its characteristics. The characteristics comprise of selective, associative, quantitative, and order. Selective refers to visual variables that can be perceived as different; associative is defined by visual variables that can be perceived as similar; quantitative is perceived as variables that can be interpreted numerically, and order is identified as variables that support ordered reading. For example, colour is considered an

Table 2. Bertin's visual variable.

Visual variable	Characteristic
Colour	Associative, Selective
Orientation	Associative
Position	Quantitative, Order
Sizes	Selective, Quantitative, Order
Shapes	Associative
Texture	Selective, Order
Value	Selective, Order

associative and selective visual variable because it can be useful when choosing certain items from a group. However, colour should not be used to visualise quantity.

In the field of music visualisation, visual variables such as colour, position, size, and shape have been investigated in representing music data [6, 9, 11]. Texture is also one of the visual variables. It has been established that visual texture can represent a certain mood [29].

To design an understandable visual texture, the design elements are separated to explore their specific meaning in portraying the mood. To verify this, an online survey was set up towards finding the type of visual element that can be associated with a certain mood [31]. From the results, we discovered the visual element for each mood. Next, the selected design elements are composed by applying a suitable Gestalt principle. The Gestalt principle is a set of laws that describe how humans typically see objects by similar grouping elements such as colour or shape [32, 33]. Finally, the design of visual texture for each mood was finalised (see Fig. 6).

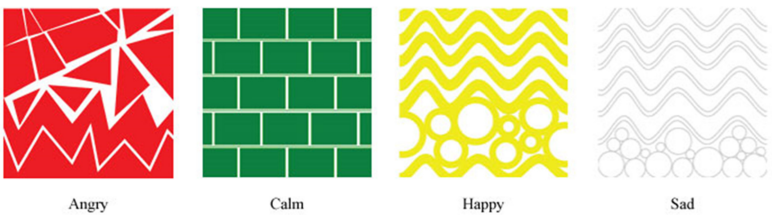

Fig. 6. Visual texture for Angry, Calm, Happy and Sad mood

Music Collection Demo Website. Visual textures that have been designed were applied to the music collection demo website. In this website, we represent four types of mood using four different images of visual texture. First, the website was designed using a free, website creation platform called WordPress. Then, it is published on the Internet using a web host service.

On the main page, mood categories such as Angry, Sad, Happy, and Calm were represented using four different visual images (see Fig. 7). Once the participants click on any of the visual texture, they will get a list of song suggestions according to the type of mood (see Fig. 8). Participants can browse through the suggested song list and press the play button to listen to the song and the pause button to stop.

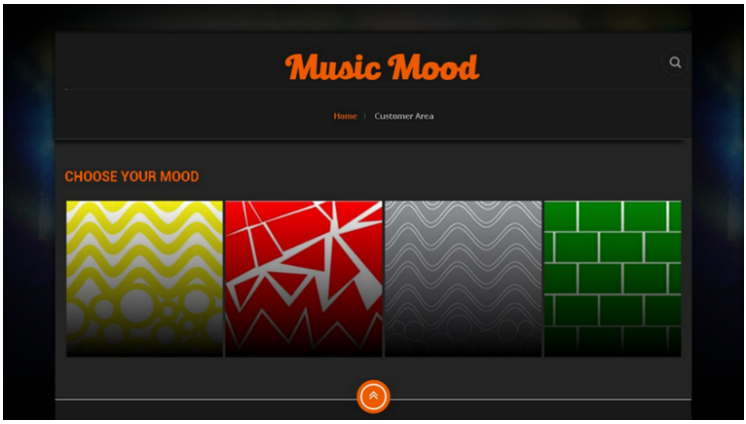

Fig. 7. The main page of the music collection website sample

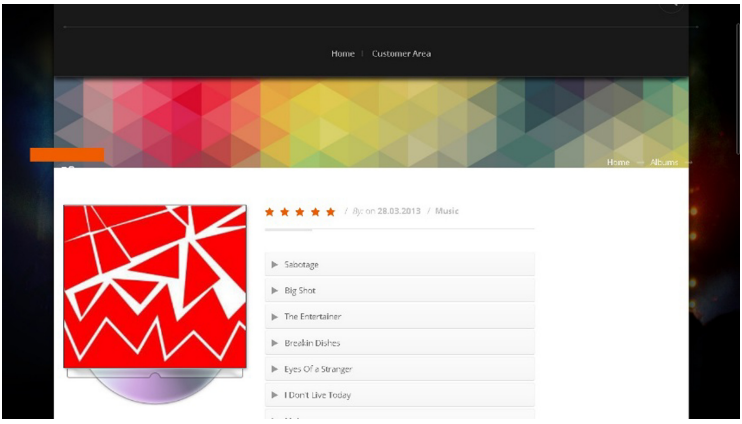

Fig. 8. List of suggested songs for Angry mood

2.4 Phase 4: Evaluation

This section discusses the processes in the evaluation phase (see Fig. 9). This phase aims to validate the proposed framework by conducting usability testing on the music collection demo website. Two outcomes were gathered from this usability testing. The first is the feedback on the suitability of the selected visual textures that represent each

of the music moods. Secondly, it is the usability of browsing music by mood category using visual texture by measuring the Effectiveness, Efficiency, and Satisfaction.

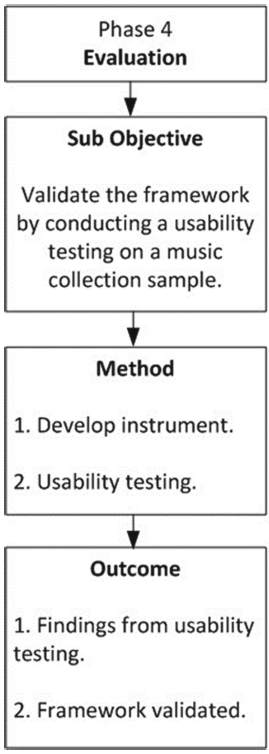

Fig. 9. The processes in the evaluation phase

Research Instrument: Task. In this research, one of the instruments developed to conduct usability testing is the task. The task contains a list of steps required to be completed by the participants during the usability testing procedure. The given task is used to ensure that participants can use and browse through the music collection website sample to look for songs in a particular mood category.

Table 3 shows an example of a task sheet for the Angry mood category. These task sheets are handed out randomly to each participant. Then, participants are given sets of questionnaires after each task to further clarify how much they agree with the suitability of the visual texture used to recommend a music mood.

Research Instrument: Questionnaire. The usability testing measures the suitability of the visual textures, the Ease of Use and the User Satisfaction while interacting with the visual textures to browse for music in the mood category. Hence, a scale type measurement was used to quantify these values. Accordingly, each item in the instrument is measured on a 7-point Likert scale ranging from strongly disagree (denoted by 1) to

Table 3. The task for the Angry mood category

No	Task
1.	Read the scenario below: "You just had a heated argument with your friend and need to listen to an angry song"
2.	You want to look for a song with the title "Mandatory Suicide" from the Angry mood category
3.	Click on any visual texture that you think represents an angry mood
4.	Look for the song from the list provided. If you cannot find it, click on the 'Home' button, and try clicking on another visual texture
5.	Once you have found the song, click on the Play button to listen to it
6.	Listen to the song for at least 30 s. You may also listen to the whole song if you like
7.	When you are ready, rate the suitability of the design elements in the visual texture in Section B of the questionnaire

strongly agree (denoted by 7). In addition, the instrument is partially used as a measure of outcome; hence, scale sensitivity becomes an important concern [34].

Usability Testing. In HCI research, the standard advice is to have 30 or more participants for the questionnaire testing method [35, 36]. However, it is advised to follow a similar number of employed participants from another related research. Assumed on that justification, 40 participants are recruited [11, 37, 38]. The participant recruitment was advertised through email, social media and posted on campus noticeboards. In the advertisement, we invited participants who enjoy listening to music and above 18 years old.

The usability testing is organised into two separate sessions. In Session 1, participants browse the music application demo website and answered a few sets of questionnaires. Next, two days after they have completed Session 1, participants receive a reminder note through email that contained a few simple tasks for them to accomplish. This session is conducted online. At the end of Session 2, they answer questionnaires on the Ease of Use and Satisfaction. As soon as Sessions 1 and 2 of the usability testing are completed, all data is prepared and organised for the data analysis process.

Demographic Data. In this usability study, there are 40 participants from different educational backgrounds involved. 43% of participants are male, and 57% are female. Most of the participants are university postgraduates and undergraduate students from universities around Perth, namely Curtin University, Murdoch University, and the University of Western Australia (UWA). All participants enjoy listening to music and able to use the computer. 75% of them listen to at least 1 to 3 h of music daily. 70% of the participants search for music by artist and band name, 55% by song title, 28% by genre, 45% by mood, and 28% by occasion. When asked if they searched for music according to their mood at a specific moment, 75% of participant selected 'Yes'. 80% of them also agreed that music undoubtedly has an impact on their mood.

Suitability of the Visual Texture for Each Mood. In measuring the suitability of the visual texture, participants were asked to answer a questionnaire right after they have completed each task. It is measured on a 7-point Likert scale ranging from 'strongly disagree' (denoted by 1) to 'strongly agree' (denoted by 7). The questionnaire's objective is to let the participants further clarify the suitability of the visual texture that represents each of the music moods. As Likert scales produces ordinal data, the median and Inter-Quartile Range (IQR) of each item is calculated. The median shows the participants' average response, while the IQR shows whether the responses are clustered together or scattered across the range of possible responses. The median and IQR for each type of mood are presented in the next section.

Angry Mood. Right after looking for a song with the title "Mandatory Suicide" from the Angry mood category, participants rated the suitability of the visual elements in the visual texture by answering the questionnaire. The following results are the median and IQR for each item.

Table 4. Median and IQR for each item in Task 1

No	Item	Median	IQR
1.	It is easy to look for the song in Task 1	7	1
2.	The visual texture matched the song that I found in Task 1	7	1
3.	The type of line used in the visual texture matched the song that I found in Task 1	7	1
4.	The type of shape used in the visual texture matched the songthat I found in Task 1	7	1
5.	The type of colour used in the visual texture matched the songthat I found in Task 1	7	1
6.	The colour value (tone) in the visual texture matched the songI found in Task 1	7	1

Table 4 shows that most participants agreed that looking for a song in the given task is easy (median = 7, IQR = 1). In addition, most participants considered that the visual texture used to represent the angry mood matched the song given (median = 7, IQR = 1). Also, most participants agreed that the type of line, shape, colour, and colour value integrated into the visual texture matched the given song in Task 1 (median = 7, IQR = 1).

Calm Mood. Next, in Task 2, after looking for a song with the title "Kiss of Life" from the Calm mood category, participants rated the suitability of the visual elements in the visual texture by answering the questionnaire. The following are the median and IQR for each item.

Table 5 shows that most participants seem to agree with the idea that looking for a song in the given task is easy (median = 6, IQR = 1.75). Furthermore, most participants

Table 5. Median and IQR for each item in Task 2

No	Item	Median	IQR
1.	It is easy to look for the song in Task 2	6	1.75
2.	The visual texture matched the song that I found in Task 2	5	3.75
3.	The type of line used in the visual texture matched the song that I found in Task 2	5	3.00
4.	The type of shape used in the visual texture matched the songthat I found in Task 2	5	2.00
5.	The type of colour used in the visual texture matched the songthat I found in Task 2	6	2.00
6.	The colour value (tone) in the visual texture matched the songI found in Task 2	6	3.75

somewhat agree that the visual texture suggested in the music collection demo website matched the song given in Task 2 (median = 5, IQR = 3.75). For the design elements, most participants show an agreement that the type of line (median = 5, IQR = 3.00), shape (median = 5, IQR = 2.00), colour (median = 6, IQR = 2.00), and colour value (median = 6, IQR = 3.75) in the visual texture matched the song given in Task 2. However, as shown in the above table, the IQR for items 3 and 6 are quite big. This means that opinion seems to be divided regarding the agreement on the type of line and colour value used in the visual texture that matched the calm mood.

Many respondents (N = 9, 23%) expressed either a strong disagreement or disagreement, but a roughly equal number (N = 14, 35%) indicate that they agreed or strongly agreed that the type of line used in the image matched the calm mood.

Happy Mood. After looking for a song with the title "Two of us" from the Happy mood category, participants rated the suitability of the visual elements in the visual texture by answering a questionnaire. The following are the median and IQR for each item.

Table 6 shows that most participants strongly agreed that looking for a song in the given task is easy (median = 7, IQR = 0.25). They also agreed that the visual texture suggested in the music collection demo website matched the song given in Task 3 (median = 6, IQR = 1). On the visual elements, participants also considered that the type of line (median = 6, IQR = 1), shape (median = 6, IQR = 1), colour (median = 7, IQR = 1.75), and colour value (median = 6, IQR = 2) in the visual texture matched the song given in Task 3.

Sad Mood. Soon after looking for a song with the title "Ain't No Way" from the Sad mood category, participants are asked to rate the suitability of the visual elements in the visual texture by answering the questionnaire. The following are the median and IQR for each item.

Table 6. Median and IQR for each item in Task 3

No	Item	Median	IQR
1.	It is easy to look for the song in Task 3	7	0.25
2.	The visual texture matched the song that I found in Task 3	6	1.00
3.	The type of line used in the visual texture matched the song that I found in Task 3	6	1.00
4.	The type of shape used in the visual texture matched the songthat I found in Task 3	6	1.00
5.	The type of colour used in the visual texture matched the songthat I found in Task 3	7	1.75
6.	The colour value (tone) in the visual texture matched the songI found in Task 3	6	2.00

Table 7. Median and IQR for each item in Task 4

No	Item	Median	IQR
1.	It is easy to look for the song in Task 4	7	1.00
2.	The visual texture matched the song that I found in Task 4	6	2.00
3.	The type of line used in the visual texture matched the song that I found in Task 4	6	1.00
4.	The type of shape used in the visual texture matched the songthat I found in Task 4	5	1.00
5.	The type of colour used in the visual texture matched the songthat I found in Task 4	7	1.00
6.	The colour value (tone) in the visual texture matched the songI found in Task 4	6	1.75

Table 7 shows that most participants agreed that the visual texture suggested in the music collection demo website sample matched the song given in Task 4 (median = 6, IQR = 2). Most participants also agreed with the idea that the type of line (median = 6, IQR = 1), shape (median = 5, IQR = 1), colour (median = 7, IQR = 1), and colour value (median = 6, IQR = 1.75) in the visual texture matched the song given in Task 4.

Usability. The ISO 9241–11 standard was employed to define the concepts of three usability elements. In the ISO 9241-11 model, usability consists of three elements: Effectiveness, Efficiency, and Satisfaction. Definition of each element is defined and measured according to the following:

- Efficiency – resources used in completing a task
- Effectiveness – level of completeness at which users achieve specified goals, and
- Satisfaction – positive attitudes toward using the system (ISO, 1998)

Each usability element was measured by adopting Jeng's usability assessment model [39] as follows:

- Efficiency – time spent to complete the tasks
- Effectiveness – the proportion of completed tasks
- Satisfaction – seven-point Likert scale from "not satisfied at all" to "very satisfied."

Efficiency. Efficiency is a measure of how quickly and easily a task can be accomplished. In this test, task time is used as a primary indicator to evaluate the Efficiency of using visual texture to browse for a song in the music mood category. Task time refers to the length of time it takes the participant to complete a task.

Table 8. Average time to complete all task

	Task 1	Task 2	Task 3	Task 4
Average time to complete (secs)	44.45	81.38	52.73	57.30

Overall, Table 8 presents the average time taken to complete all task. Participants completed Task 1 (Angry mood) significantly faster than others. The average time taken to complete Task 2 (Calm mood) is 81.38 s, Task 3 (Happy mood) is 52.73 s and 57.30 s for Task 4 (Sad mood). From these results, it can be concluded that the participants took a longer time to complete Task 2 than the other tasks. This is probably because some of the participants are confused by the design elements incorporated into the visual texture to represent the Calm mood.

Effectiveness: Completion Rate. Effectiveness can be calculated by measuring the completion rate. It is the percentage of tasks that users complete correctly. Referred to as the fundamental usability metric, the completion rate is calculated by assigning a binary value of '1' if the participant manages to complete a task and '0' if they do not complete it. The average completion rate is 78%.

In total, there are 40 attempts observed for each task. Of those attempts in Task 1, 35 participants are successful, and 5 are unsuccessful, and the completion rate for Task 1 (Angry mood) is 88.5%. In Task 2, an equal number of participants are successful and unsuccessful, making the completion rate for Task 2 (Calm mood) 50%. In Task 3, 39 participants are successful, and only 1 is unsuccessful. Thus the completion rate for Task 3 (Happy mood) is 97.5%. Finally, in Task 4, 37 participants are successful, and only 3 are unsuccessful, and the completion rate for Task 4 (Sad mood) is 92.5% (see Fig. 10). Overall, the completion rates for the tasks: Angry, Happy and Sad are above the average rate.

Effectiveness: Success Rate. The success rate is the percentage of participants who can complete the task given in their first attempt. In this usability testing, the success rate implies whether the participant can choose the right visual texture to find the song

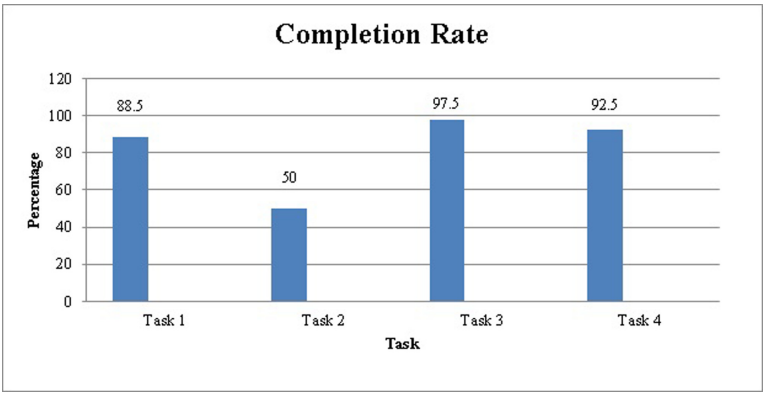

Fig. 10. The task completion rate for each task

in the mood category. A task will be considered a "success" and given one point if it is completed on the first attempt. Then, a task will be considered "partially success" and given half a point if it is completed on the second attempt. Finally, the task is considered a failure if the participant completed the task on the third attempt [27, 40].

Table 9. Success for each task

	Task 1	Task 2	Task 3	Task 4
Success rate (%)	91.25	67.5	96.25	93.75

Table 9 represents the summary of the success rate for all tasks. In Task 1, 35 attempts are considered successful, 3 attempts are partially successful, while 2 attempts are failed. Hence, the success rate for Task 1 (Angry mood) is 91.25%. In Task 2, 20 attempts are considered successful, 14 attempts are partially successful, while 6 attempts are failed. Hence, the success rate for Task 2 (Calm mood) is 67.5%. In Task 3, 37 attempts were successful, and 3 attempts are partially successful. As a result, the success rate for Task 3 (Happy mood) is 96.25%. In Task 4, 36 attempts are considered successful, 3 attempts are partially successful, and 1 attempt is failed. Hence, the success rate for Task 3 (Sad mood) is 93.75%. Overall, the success rate for all tasks is acceptable, and the percentage for Task 3 (Happy mood) is the highest among other tasks.

Ease of Use. After measuring the Efficiency and Effectiveness of browsing music in the mood category using visual texture have been analysed; Ease of Use is measured next. In the usability testing, participants are asked to rate the Ease of Use towards browsing music mood using the visual texture on two separate occasions. The first is after they have completed Session 1, and the next is after they have completed Session 2. The results for both sessions are compared to see if there are any changes in the Ease-of-Use rating between the first-time use and longer-term use.

Generally, most participants believe that browsing music by mood category using visual texture is clear and understandable. Moreover, they also think that it is easy to be skillful at browsing music by mood category using visual texture. From these findings, we can conclude that the participants find it easy to browse for music based on mood category using visual texture.

After using the music collection demo website for 2 weeks, the participants are asked to rate the Ease of Use once again, and both results are subsequently compared. A Wilcoxon signed-rank test shows that browsing music for 2 weeks does not elicit a statistically significant change in Ease of Use for first-time versus long-term use.

Satisfaction. Like Ease of Use, the participants are also asked to rate their Satisfaction (on two separate occasions) towards browsing music based on mood category using visual texture. The results for both sessions are compared to see if there are any changes in Ease-of-Use rating from the first-time use to the longer-term use.

Most participants were satisfied using visual texture in browsing music based on mood. They would recommend it to their friends, and they find that browsing music according to mood category using visual texture is fun. They also believe that the music collection demo website worked the way they wanted it to and browsing music based on mood category using visual texture is wonderful and pleasant.

After using the music collection demo website for another 2 weeks, the participants are asked to rate their Satisfaction once again. The results from both sessions are then compared. A Wilcoxon signed-rank test shows that browsing music for 2 weeks does not elicit a statistically significant change in Satisfaction for first-time use and long-term use.

3 Conclusion and Future Work

This paper presents the processes of validating a proposed framework for visualising music mood by using visual texture. Four visual textures are designed to represent Angry, Calm, Happy and Sad mood. The visual textures are used to represent music mood category in a music collection demo website. Usability testing was carried out to validate the proposed framework. In total, there were 40 participants browses through the website and respond to a few sets of questionnaires. During the usability testing session, activity on the computer screen is recorded.

From the findings, it can be concluded that the design elements that were suggested for each visual texture is acceptable and suits the assigned mood. Therefore, browsing music mood using visual texture is also perceived to be effective and efficient. Furthermore, most participants find that browsing music using visual texture is easy for them. They are also pleased with the new way of browsing music that has been introduced to them. Besides, they would like to suggest it to their friends. Generally, the majority of participants believe that browsing music by mood using visual texture is fun, wonderful, and pleasant to use. Therefore, it is firmly established that visual texture can be used as an alternative way of browsing music by mood.

In conclusion, all phases of validating the proposed framework are completed. Therefore, this framework will be a useful guideline to help the designers and software developers to select suitable visual elements when designing a clear and understandable visual texture to represent specific music moods in the music application.

To the music listener community in general, this research will offer a new way of browsing digital music collection, assisting listeners in discovering songs and artists they might not have been noticed otherwise using the traditional ways.

In the future, it would be more exciting if actual physical objects such as rocks, rugs or glass are used to portray music mood or music genre.

References

1. Allik, A., Fazekas, G., Barthet, M., Swire, M.: myMoodplay: an interactive mood-based music discovery app (2016)
2. Khulusi, R., Kusnick, J., Meinecke, C., Gillmann, C., Focht, J., Jänicke, S.: A survey on visualizations for musical data. Comput. Graph. Forum **39**(6), 82–110 (2020)
3. Marandi, Y.M.H., Sajedi, H., Pirasteh, S.: A novel method to musicalize shape and visualize music and a novel technique in music cryptography. Multimedia Tools Appl. **80**(5), 7451–7477 (2020). https://doi.org/10.1007/s11042-020-09962-8
4. Forsell, C.: Evaluation in information visualization: heuristic evaluation. In: 2012 16th International Conference on Paper Presented at the Information Visualisation (IV) (2012)
5. Baumer, E.P., Snyder, J., Gay, G.K.: Interpretive impacts of text visualization: mitigating political framing effects. ACM Trans. Comput. Hum. Interact. (TOCHI) **25**(4), 20 (2018)
6. Pradeep, A.A., Vispute, K.B., Bhavsar, V.S., Wadile, S.P., Pawar, V.N.: Emotion based music player. Int. J. Comput. Sci. Mobile Comput. **10**(2), 50–53 (2021)
7. Moscato, V., Picariello, A., Sperli, G.: An emotional recommender system for music. IEEE Intelligent Systems (2020)
8. Husain, A., Shiratuddin, M.F., Wong, K.W.: A proposed framework for visualising music mood using texture image. In 2013 International Conference on Research and Innovation in Information Systems (ICRIIS), pp. 263–268. IEEE
9. Pesek, M., Strle, G., Kavčič, A., Marolt, M.: The Moodo dataset: integrating user context with emotional and color perception of music for affective music information retrieval. J. New Music Res. **46**, 1–15 (2017)
10. Hamasaki, M., Goto, M., Nakano, T.: Songrium: a music browsing assistance service with interactive visualization visualisation and exploration of protect a web of music. In: Paper Presented at the Proceedings of the 23rd International Conference on World Wide Web (2014)
11. Lehtiniemi, A., Holm, J.: Using animated mood pictures in music recommendation. In: 2012 16th International Conference on Paper Presented at the Information Visualisation (IV) (2012)
12. Zhao, Z.: Emotional study of ceramic art texture in ceramic. Front. Art Res. **3**(1), 44–47 (2021)
13. Phillips, T.S.: Patterns of identity. Electronic theses and dissertations, 2184 (2020)
14. Mao, J.-Y., Vredenburg, K., Smith, P.W., Carey, T.: The state of user-centered design practice. Commun. ACM **48**(3), 105–109 (2005)
15. March, S.T., Smith, G.F.: Design and natural science research on information technology. Decis. Support Syst. **15**(4), 251–266 (1995)
16. Purao, S.: Design research in the technology of information systems: truth or dare. GSU Department of CIS Working Paper, vol. 34 (2002)

17. Kuechler, W., Vaishnavi, V., Kuechler Sr, W.L.: Design [science] research in IS: a work in progress. In: Proceedings of the Second International Conference on Design Science Research in Information Systems and Technology (DESRIST 2007), pp. 1–17, May 2007
18. Carroll, J.M.: Making Use: Scenario-Based Design of Human-Computer Interactions. MIT Press, Cambridge (2000)
19. Druin, A.: The role of children in the design of new technology. Behav. Inf. Technol. **21**(1), 1–25 (2002)
20. Reigeluth, C.M.: Instructional theory and technology for the new paradigm of education. RED. Revista de Educación a distancia **32**, 1–18 (2012)
21. Barab, S., Squire, K.: Design-based research: Putting a stake in the ground. J. Learn. Sci. **13**(1), 1–14 (2004)
22. Hevner, A., Chatterjee, S.: Design Research in Information Systems, pp. 9–22. Springer, Boston (2010). https://doi.org/10.1007/978-1-4419-5653-8
23. Norshuhada, S., Shahizan, H.: Design Research in Software Development: Constructing and Linking Research Questions, Objectives, Methods and Outcomes (2010)
24. Andjelkovic, I., Parra, D., O'Donovan, J.: Moodplay: interactive music recommendation based on Artists' mood similarity. Int. J. Hum. Comput. Stud. **121**, 142–159 (2019)
25. Card, M.: Readings in Information Visualization: Using Vision to Think. Morgan Kaufmann, San Francisco (1999)
26. Thompson, W.F., Russo, F.A.: The attribution of emotion and meaning to song lyrics (2004)
27. Wetzlinger, W., Auinger, A., Dörflinger, M.: Comparing effectiveness, efficiency, ease of use, usability and user experience when using tablets and laptops. In: Marcus, A. (ed.) DUXU 2014. LNCS, vol. 8517, pp. 402–412. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-07668-3_39
28. Patra, B.G., Das, D., Bandyopadhyay, S.: Mood classification of Hindi songs based on lyrics. Paper Presented at the Proceedings of the 12th International Conference on Natural Language Processing (2015)
29. Husain, A., Shiratuddin, M.F., Wong, K.W.: Combining visual elements as a new method to browse and discover music mood. Paper Presented at the Proceedings of the 2nd International Virtual Conference on Advanced Scientific Results (2014)
30. Carpendale, M.: Considering visual variables as a basis for information visualisation (2003)
31. Husain, A., Shiratuddin, M.F., Wong, K.W.: Establishing a framework for visualising music mood using visual texture (2015)
32. Lester, P.M.: Visual Communication: Images with Messages. Cengage Learning, Wadsworth (2013)
33. Rodgers, P., Stapleton, G., Chapman, P.: Visualizing sets with linear diagrams. ACM Trans. Comput. Hum. Interact. (TOCHI) **22**(6), 27 (2015)
34. Cummins, R.A., Gullone, E.: Why we should not use 5-point Likert scales: the case for subjective quality of life measurement. In: Proceedings, Second International Conference on Quality of Life in Cities, vol. 74, p. 93, March 2000
35. Lazar, J., Feng, J.H., Hochheiser, H.: Research Methods in Human-Computer Interaction. Wiley, New York (2010)
36. MacKenzie, I.S., Castellucci, S.J.: Empirical research methods for human-computer interaction. Paper Presented at the CHI Extended Abstracts (2014)
37. Lehtiniemi, A., Holm, J.: Evaluating a potentiometer-based graphical user interface for interacting with a music recommendation service. Paper Presented at the 2011 15th International Conference on Information Visualisation (2011)
38. Lehtiniemi, A., Holm, J.: Designing for music discovery: evaluation and comparison of five music player prototypes. J. New Music Res. **42**(3), 283–302 (2013)

39. Jeng, J.: Usability of the digital library: an evaluation model. Coll. Res. Libr. News **67**(2), 78 (2006)
40. Nielsen, J.: Success rate: the simplest usability metric. Jakob Nielsen's Alertbox **18**, 3–5 (2001)