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FOSTERING LEARNING THROUGH MUSIC IN DYNAMIC CONCEPT MAPS

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Abstract. This project aims at developing a rich environment that integrates music in order to reinforce learning. Fostering learning through music is based on the visualization of concept maps. This novelty approach relates the rhythm and melody of a song with the dynamic appearance of the concept map; this is carry out by changing some design properties of the elements that composed the concept map. We try to encourage the connection between songs and ideas, more precisely between the notes and rhythm of a melody and the concepts expressing an idea. For this purpose we build a rich concept map editor and record some songs for testing our environment.

1 Motivation

Music plays an important role in every day life. From the mass media such as publicity, video games and cinema to the music entertainment, music is used for emphasizing images, games and feelings. On the other hand, music has attracted researchers for enhancing learning in different ways. Some of them correlated music literacy with basic process like reading, writing or the process of creativity, while others works like (Weyde, 2004) creates dynamic concept maps based on the score of a musical single piece.

The fact that it is easier to remember the text included in a phrase song than a single readable or audible text is our start point for trying to reinforce the connections between melodies and the visual representation of a sentence in the form of concept map. Our project thus aims at enhancing connections between music and the visual appearance of a concept map. This is carried out by analyzing the spectrum frequency of a song with concrete mixing and mastering features, being this what mainly differs form other similar approaches.

2 Our Approach

Let's assume that we have a concept map with one main element and five surrounding elements (see Figure 1). Our first idea is to compose a song according to the elements that the user sees on the screen, thus for this case we create one melody that has a main chord (main concept) and a secondary melody that has five notes (the five surrounding concepts). Once the melody of the song is composed and the rhythm section is added, our next step is to modify the appearance of the concept map according to how the song is developed in time, namely according to rhythm and melody.

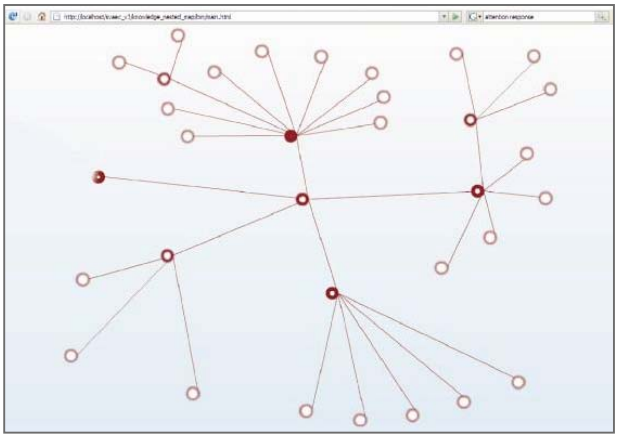

Figure 1. An example of an initial concept map with one main node and five child nodes.

For this dynamic visualization through the time the system analyses the spectrum frequency and then it modifies the appearance of nodes (concepts) according to the frequency response. Furthermore, the system speeches the node's text for improving the user's attention.

Table 1 details a prototype of the visualization in order to dynamic adapt the appearance of the nodes contained in the concept map. As we can see in the table, the dominant chord is placed at the left channel and the melody is situated at the right channel, while in case there are drums playing, they are located on both channels, thus the systems compares both channels, if the output frequency is the same in both channels, it treats the frequency data as rhythm section's signal, therefore as rhythm pattern. These mixing and mastering features allow the system to extract the dominant chord, the main melody and the rhythm pattern.

What we get as a first result is a rich piece of knowledge visualization coupled with a melody that stimulus our senses and thus we believe we stress the interaction with the concept map in order to enhance learning.

Instrument	**Element in harmony**	**Range Frequency (Hz)**	**Visual element that is modified**	**Values/actions over the element**	**Audio channel**
Piano (bass notes)	Dominant chord	[28, 131]	Main node	Appear on the screen	Left channel
Bass and/or Cello	Dominant chord	[33, 262]	Main node	Color, glow effect	Left channel
Piano (middle C)	Melody	[131, 1047]	Surrounding nodes	Appear on the screen	Right Channel
Guitar	Melody	[131, 1319]	Surrounding nodes	Color, glow effect	Right channel
Xylophone and Piano (high notes)	Melody	[1319, 2093]	Secondary nodes	Appearance	Right channel
Drums	Rhythm	[28,3951]	Node structure	Size effect, glow effect, transparent effect	Both channels

Table 1: Prototype of mixing and mastering features applied to our set of songs

Once we have showed the relatedness between a particular song and a concrete concept map a question arise: is it possible to input any particular song in our environment and let the system manage the concept map's layout according to the melody and rhythm as showed above?

For answering this question we should considerer that one of the main open research issues in intelligent retrieval systems based on music content information is rhythm pattern mining and sound recognizing and in spite of many advances the problem remains open (Betser et al., 2007; Bello, 2007).

Our system is being developed with *Flex Technologies* for constructing a rich environment (Sanchez-Zamora et al., 2008); this technology allows to analyze separately the two channels of a stereo recording. What this is meant is that the system analyses the spectral frequency and it returns the values of the sound frequencies that are playing in time *t*. For instance, if we input a standard song that plays drums, bass, guitars and voice, the main problem is to divide the signal into the instruments that are playing and extracting the melody of each of them. Moreover, this process is long time consuming (Bello, 2007; Norman et al., 2004).

Figure 2 shows the harmonic frequency range of most common instruments, as we can observe the range frequencies overlap one with each other in most of the hole range. That is the reason we are composing a set of songs with a particular mixing and mastering processes (see Table 1) in order to extract the melody and the pattern rhythm.

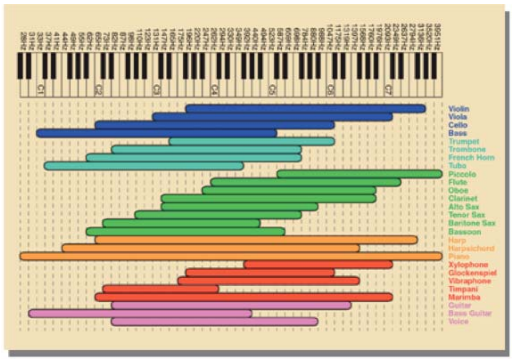

Figure 2: the harmonic frequency range

3 Conclusions and Future Trends

The representation of the first pieces of knowledge based on concept maps that evolve dynamically with regard to music and audio features has as a result a rich experience for the senses, thus the user is immersed in a stimulate way of learning through the visual and audio representation of the concept map.

We plan to evaluate the environment in a real classroom, comparing the results obtaining by students that make use of the system with students that do not use the system in their daily visual representation tasks.

As a future trend we pose a question for further research on this trend: could the system suggest new knowledge based on the evolution of the musical structure of a song? Can we achieve this feature by construct new node-link relations between already existing concepts according to the initial melody-concept relation?

4 Acknowledgments

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