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Control of Affective Content in Music Production

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Music is a ubiquitous media in our lives, used in many contexts. The possibility to select appropriate affective music can be helpful to adapt music to our emotional interest. Our work intends to design a system to control affective content in music production. This is done by taking into account a knowledge base with mappings between affective states (happiness, sadness, etc.) and music features (rhythm, melody, etc.). The knowledge base is grounded on background knowledge from Music Psychology. Our system starts with the reception of an emotional description specified by the user. Next, mappings are selected from the knowledge base, according to the emotional description. Music is retrieved from a music base (recorded sound and MIDI files) according to similarity metrics between music features (of mappings and music base). Afterward, selected music can be subject to transforming, sequencing and remixing algorithms and then played. The inclusion of third party composition software is also envisaged. To assess the system, listener emotional state can be analysed using psychophysiological or self-report measures.

Keywords: Affective music, music production, emotions and music, Music Psychology, music features manipulation

Music has been widely accepted as one of the languages of emotions. The possibility to select appropriate affective music can be helpful to adapt music to our emotional interest. Nevertheless, only recently scientists have tried to quantify and explain how music influences our emotional states. According to Klaus Scherer (Scherer, 1984), emotions may be conceived as consisting of various components: cognitive appraisal, physiological activation, motor expression, behavior intentions, and subjective feeling. Emotional states can be described as particular configurations of these components. For a long time, Cognitive Sciences have been studying the foundations of emotions. More recently computational models have also been proposed and are being applied in several domains (e.g., music, dance and cinema).

There are distinct approaches and techniques used to generate music with appropriate affective content. Starting from results of previous work (Schubert, 1999), Livingstone and Brown (Livingstone and Brown, 2005) established relations between music features and emotions. Both emotions and a set of music-emotion structural rules were represented in a 2 Dimensional Emotion Space with an octal form. A rule-based architecture was designed to affect the perceived emotions of music, by modifying the musical structure. Livingstone et al. made a symbolic music performance engine that could adapt score reproduction with the audience emotions. This engine was grounded on a list of performative and structural features, that could be changed, and their emotional effect (Livingstone et al., 2006). For instance tempo, mode and loudness are structural parameters, and tempo variation, melody accent and note accent are performative parameters.

A MIDI-based software named REMUPP (Relations Between Musical Parameters and Perceived Properties) was designed to study aspects of musical experience (Wingstedt et al., 2005). This system allows the real-time manipulation of musical parameters like tonality, mode, tempo and instrumentation. For instance, articulation is changed by altering the length of notes and register by altering the pitch of notes. This system has a music player that receives music examples and musical parameters. Music examples are composed by MIDI data and a set of properties. Musical parameters can be used to control the sequencer, to control synthesizers or to employ filters and effects on MIDI stream. Winter (Winter, 2005) built a real-time application to control structural factors of a composition. Models of musical communication of emotions were reviewed to get an insight of what musical features are relevant to express emotions. Pre-composed musical scores were manipulated through the application of rules. These rules have some control values for different musical features: mode, instrumentation, rhythm and harmony.

In recent years many research areas have been working to reduce the semantic gap that exists between music features and human cognition. From this research some works established mappings between music features and emotions. Our work intends to design a system to produce affective music by taking into account a knowledge base with mappings between emotions and music features. This work is being developed in two stages. Firstly, studies of the relations between emotions and musical features are examined, to select mappings useful in our computational context. Secondly, a computer system that uses these mappings to produce affective music is designed, implemented and assessed.

MAIN CONTRIBUTION

From a general standpoint, this work intends to contribute to the fields of Music Psychology and Computer Music. Our multidisciplinary review (and selection) of mappings between emotions and music features can contribute to a systematized scientific research in Music Psychology. Both structural (e.g., harmonic mode and overall pitch) and performing features (e.g., melody accent and beat accent) can be controlled (selected and transformed) in the production of music with the intent to generate appropriate affective music. Thus, our system can be used by musicians as an affective music production tool or as an autonomous affective DJ-like application.

Computational Approach

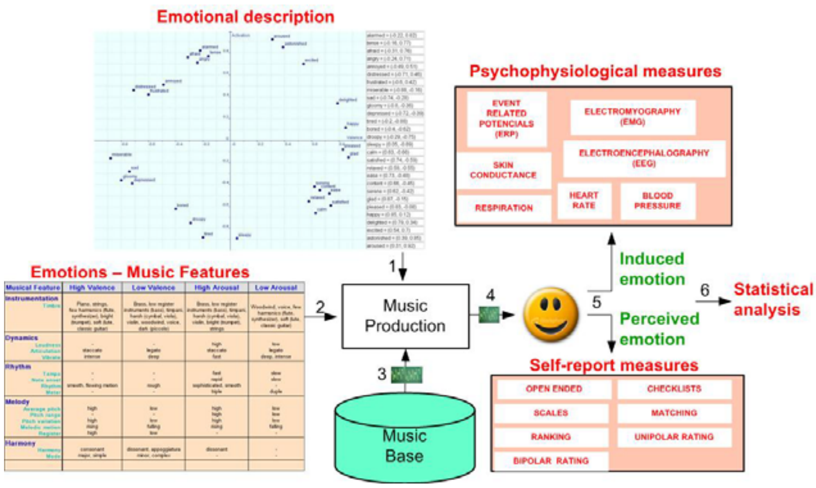

Figure 1. Computational Approach.

Our computational approach deals with the problem of inducing emotions with music. A brief overview of our approach is presented with the aid of figure 1. The input is the description of the emotional experience that the system is intended to induce in the listener. A Knowledge Base with mappings between emotions (calm, anger, sadness, happiness, fear, among others) and musical features (harmony, melody, rhythm, dynamics, tempo, texture, loudness, among others) allows the system to retrieve the more appropriate music from the music base. Then, music is played and the emotional state of the listener can be analysed using psychophysiological and/or self-report measures. Results from these measures are then subject to statistical analysis methods.

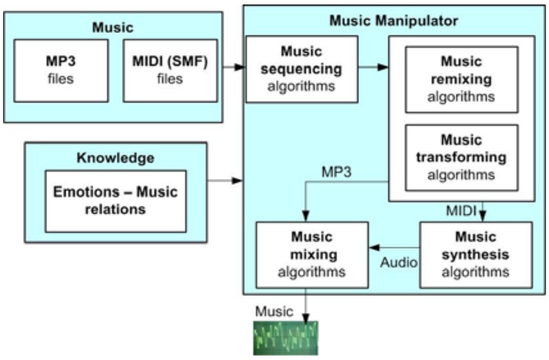

Figure 2. Module of Music Production.

Now, we will concentrate our attentions in the description of the module of music production, which is responsible for the generation, sequencing, remixing and synthesis of music. This module uses algorithms to manipulate audio and MIDI. Sound effects usually used by DJs may be used to try to manipulate music to induce specific emotions. Equalization may be used to change the frequency envelope of a sound by applying filters. For instance, high-pass filters are used by DJs to reduce low frequencies (e.g., drums) to promote moments of relaxing. Other effects like 3D, chorus, diffusion, distortion, echo, flanging, phasing and reverbation are also used to manipulate audio. More information about the role of these effects on the emotional response of audience can be consulted on (Barrington et al., 2006). There are many algorithms to manipulate MIDI in ways that may be used to adapt music features to the intended emotional effects over the audience. Phrase expression, chord asynchrony, melody dynamics, ADSR envelope, humanising functions, tonality, mode, harmonic and rhythmic complexity, register, instrumentation, articulation, tempo and perception parameters (roughness) are some of the features that can be manipulated in the MIDI plane. The following works can be consulted to obtain information about algorithms used to manipulate MIDI files (Livingstone et al., 2006; Wingstedt et al., 2005; Winter, 2005; DInca and Mion, 2005).

The manipulation and sequencing of MP3 files and/or MIDI files is done at this stage. The way this is done is similar to the approach followed in REMUPP (Wingstedt et al., 2005). Our work considers music examples represented in Standard MIDI Format (MID/MIDI) and MP3 format. These examples are selected from the music base in the previous stage. Musical parameters are selected from the knowledge base during the knowledge selection stage. Some algorithms for music manipulation of music properties (e.g., sound effects and synthesis) and the way music examples are sequenced will be implemented/adapted. Figure 2 presents the main processes involved in this module (it is similar to the architecture of REMUPP's music player).

Techniques and Algorithms

The Knowledge Base (KB) is like a white box module with mappings between emotions and musical features. This means that all represented mappings are always visible. This option derives from the fact that this KB can be used in the future by Music Psychologists and Therapists. Both Case-Based and Rule-Based techniques are known to be adequate for this kind of representation. Semantic networks and frame/analogy-based systems can also be helpful.

Some algorithms will be developed: music transformation, music sequencing and music remixing. Others will be adapted from third party software/algorithms: music composition, music selection (energy, timbre, etc.), music mosaicing (automatic remixing) and music synthesis. All these algorithms take into account the control of music affective content.

IMPLICATIONS

This research reviews affective computing and music psychology works relevant to the design of a computational model of automatic music production according to an emotional description. We intend to develop a computational systematization of relations between emotions and music, which can contribute to a high affective control in the selection and transformation of both structural (e.g., harmonic mode) and performing features (e.g., beat accent).

We intend to tune our system with users to promote a reliable induction and expression of emotions by using music. This way, our system can be applied in areas that intend to produce music given an emotional input. It may assume the role of a tunable support tool for scientific research in Music Psychology. It may be applied in the production of soundtracks for arts, movies, dance, theater, virtual environments, computer games and other entertainment activities. It may also be useful in Music Therapy as a way of emotional, cognitive and physical healing. Musicians can also benefit from this system as an affective music production tool or as an autonomous affective DJ-like application.

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