REMUPP – An Interface for Evaluation of Relations between Musical Parameters and Perceived Properties

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\textbf{ABSTRACT}

New media offers new roles, functions and challenges to music, calling for new methods and tools for music research. To meet these increasingly important challenges, REMUPP, a new software tool for the investigation of relations between music and perceived properties or characteristics, was designed. The ideas behind REMUPP and the technology used to realize it are described. In order to test the sensitivity and validity of REMUPP, a simple experiment aimed to examine some properties of music was carried out. 38 subjects were listening to music and instructed to indicate their priority for different aspects of the music (musical parameters) while they actively controlled these aspects. The results show that REMUPP is able to bring out significant differences between the musical parameters, and that these differences correspond well with findings by others.

\textbf{Categories and Subject Descriptors}

J.5 [Arts and Humanities]: Performing Arts – music.

\textbf{General Terms}

Measurement, Experimentation, Human Factors, Theory.

\textbf{Keywords}

Musical experience, non-verbal test techniques, musical parameters, MIDI, HCI.

\section{1. INTRODUCTION}

In contemporary society, music is increasingly becoming an important part of narrative contexts such as film, computer games and other forms of “mixed-mode” entertainment. Typical traits for music in such contexts are: 1) Music communicates in interaction with other narrative elements - such as image, dialogue, sound effects etc.; 2) The music has clear and well-defined functions in the narrative context; 3) It often reaches the listener on a subconscious and unreflected level while the visual elements take priority of attention [7]. The context is what defines the meaning and the function of music. The more unambiguous the context is, the clearer and more explicit the musical “meaning” appears. Marshall and Cohen have shown that when music is performed in combination with other media, as it does in film, the perceived meaning of music seems to take on a concrete and unambiguous quality [6]. In the emerging new prospects for media and entertainment, music is poised to take on new responsibilities. As music gets a larger and more active part in our daily lives, the more important it becomes to study its functions, possibilities and potential. Such studies calls for new methods and interfaces to be developed.

This paper will describe the design, functions and some of the possible uses of the evaluation and analysis tool REMUPP (Relations between Musical Parameters and Perceived Properties). Also, a verification experiment will be briefly described, where the validity of the REMUPP interface as a means to investigate the properties of musical parameters is explored.

\section{2. USING THE REMUPP TOOL}

REMUPP is a software-based tool designed for testing various musical functions, for use within different disciplines of music research. It is developed by the Interactive Institute’s studio Sonic at Piteå, Sweden and it allows for investigating selected musical parameters in interplay with a musical and situational context. By manipulating controls presented graphically on the computer screen, subjects can change the expression of an ongoing musical piece by adjusting structural and performance related musical parameters like tonality, mode, tempo, harmonic and rhythmic complexity, register, instrumentation, articulation, etc. The basic musical material, as well as the types and number of musical parameters included with REMUPP, can be varied and tailored by the researcher according to the needs and purpose of the study at hand. The music can also be combined with other media elements such as text or graphics, providing opportunities for exploring the relational interplay of music with other media.

Having the subjects manipulate the music, makes REMUPP a non-verbal tool where the subjects respond to the musical experience within “the medium of music” itself, without having to translate the response into other modes of expression such as words or drawings. By responding to the musical experience in this way, the user will directly contribute to the musical expression – and thereby to a certain degree control his/her own experience. This way, a dimension of creativity is introduced into the test situation. Managing the parameter controls requires no previous musical training. In a typical REMUPP session, the controls will be presented without any verbal labels or descriptions, making for an intuitive use of the parameters with a focus on the musical sound itself.

An overall aspiration of REMUPP, is trying as much as possible to minimize the negative “laboratory situation” effect. In order to
maximize the user’s sense of immersion, much effort is put into making the music material sound as authentic or professional as possible. The possibility to have several variable music parameters simultaneously available opens up for studying not only the individual parameters themselves, but also for investigating the relationships and interplay between the different parameters. Combining the music with other media such as text or video makes visible the relationships between music and other modes of expression of importance to the computer entertainment context.

In REMUPP, the subject’s manipulations of the parameter controls are recorded into the software and can be output in the form of numerical data, available for statistical analysis. Furthermore, the resulting music (including all the manipulations) can be played back in real time, making it possible to study the creative process as well as the aural end result. The various ways to handle data, and the possibility to combine different data types, makes the REMUPP tool potentially available for use within different types of research disciplines. Further descriptions about initial experiments and possible uses for REMUPP are found in several current and future articles [1][2][8].

3. TECHNICAL IMPLEMENTATION

The REMUPP tool is a MIDI-based software handling dynamic, variable music. The different versions of the REMUPP application are developed using Macromedia Director and Sibelius SequenceXtra. The MIDI music is rendered using various third party synthesizers. The software technically consists of five major blocks: the Session Logic, Subjects’ User Interface, Administrator’s User Interface, Music Player and the Result File.

3.1 Session Logic

The Session Logic holds three data types: Music Examples, Relation Objects and Trial Objects.

The Music Example is the musical raw material that REMUPP uses to assemble a variable musical performance. A Music Example consists of a set of properties used as basic input to the Music Player (see section 3.4) which selects from and modifies the Music Example’s raw material and in real time composes the music played. The most prominent of the music example properties is the reference to a Standard MIDI File (SMF). The other properties give basic constrains for the music manipulation.

Relation Objects are the objects to which the music should be related. A Relation Object consists of a name and a media file, for example a JPEG-file or a QuickTime movie.

When a new Session is initiated, the Session Logic creates a set of discrete trials by combining the Music Examples used, the Musical Parameters and, if used, the Relation Objects, into Trial Objects. The Trial Objects are then stored in a list in random order. When a Trial is taken from the list in order to be presented to the subject, its Music Example is loaded into the Music Player and its Musical Parameter(s) and Relation Object (if used) are loaded into the subject’s graphic user interface (GUI).

3.2 The Subjects’ User Interface

The Subjects’ User Interface consists of a sounding part and a graphic part. The sounding part consists of music played by the Music Player (see section 3.4). The graphic part (see Fig. 2) consists of one or more controllers (e.g. faders and buttons), each of them assigned to a particular musical parameter of the Music Player. Depending on the test design, there might also be a Relation Object (e.g. graphics and/or text) as part of the GUI. When a Trial is completed, the Session Logic stores the settings made and then gets the next Trial from the Trial Object List.

3.3 Administrator User Interface

In the Administrator’s GUI the test designer makes settings for coming sessions. This interface mirrors the Session logic and the test designer can create and edit Music examples, create and edit Relation objects and make global session settings.

Creating, editing and testing Music Examples typically include tasks like:

- Naming the Music Example and linking it to a Standard MIDI-file (SMF).
- Setting basic musical properties such as original key of the SMF, allowed modes (for example major or minor modes), tempo boundaries etc.
- Creating and editing instrument sets.
- Creating and editing harmonic and rhythmic complexity levels and transposition levels.

When testing a Music Example, all the Musical Parameters are available at the same time so the administrator can make sure that the music reacts in a musically relevant way when the controllers are manipulated.

Creating and editing Relation Objects includes adding media files such as graphics or text objects to a list, displaying them and selecting which ones to use.
In the Global Settings dialog, the test designer can build a list of music examples to use in a session from the list of Music Examples known to the application.

3.4 Music Player
The Music Player assembles in real time a piece of music based on two inputs. The first is a Music Example object that supplies the Music Player with musical raw material. The other input is a set of Musical Parameters that are used to influence the way the Music Player uses the raw material to assemble the final music. This raw material consists of MIDI data read from a Standard MIDI File (SMF) pointed to by the Music Example. The SMF is loaded into the Music Player’s MIDI-sequencer and the Musical Parameters are used to influence the behavior of the sequencer, to manipulate the MIDI-data it contains and the way the MIDI-data finally is rendered to sound by the synthesizers. The Musical Parameters are of three different kinds:

1. Parameters controlling the sequencer, for example ‘tempo’.
2. Parameters controlling the synthesizers that finally renders the MIDI stream to music, for example ‘Instrumentation’.
3. Parameters acting as filters and effects on the MIDI stream. These parameters are in turn of two different kinds:
   a. Filtering out MIDI-messages by muting and unmuting tracks of the SMF, for example ‘Rhythmic complexity’.
   b. Manipulating individual MIDI-messages. ‘Articulation’ is one example where the length of notes is altered.

3.5 Result Files
During a Session, the subject’s manipulation of the Musical Parameters is recorded. These recordings are saved in the Result File together with data from the Music Examples and Relation Objects used. Result Files can be imported to Excel or statistical software such as SPSS.

4. MUSICAL IMPLEMENTATION
Since the technical and musical designs will be interwoven with and interdependent on each other, the construction and implementation of the musical material becomes as important as the technical design. Unlike music created for a more conventional use, the music composed for REMUPP must accommodate the parameter changes made by a subject in a satisfactory way. The desired expressional effect must be distinctly achieved at the same time as the overall music performance should remain convincing. Special consideration also has to be taken of the complex interaction of different parameters working together, since the perceived effect of any selected parameter change will be affected by the prevailing settings of the other parameters present. The musical material can thus be thought of as an algorithm, where each parameter is put in relation to all the other parameters in a complex system interacting on many levels. The composer must carefully define and tailor the basic musical material to fulfill the demands of the experiment at hand – as well as take into account the technical framework of REMUPP.

5. VERIFICATION EXPERIMENT
In order to test the REMUPP software, an experiment was designed to explore the suitability of the REMUPP interface as a means to investigate the properties of musical parameters. The objectives of the experiment were 1) to find the interrelations of a selected number of musical parameters in terms of their perceived capability to change the music excerpts controlled by these parameters; 2) to investigate whether these interrelations were differently perceived due to differences in the musical background of subjects and/or differences in musical context.

In this section, a brief summary of the experiment will be given. A more comprehensive paper is to be published in the future.

5.1 Method
A group of subjects indicated which of the musical parameters, when presented in pairs, was perceived as having the greatest influence on the reproduced music.

The following seven parameters were included in the experiment: mode (major – minor), instrumentation, tempo, accent evenness, articulation (legato – staccato), volume and register (pitch).

In total, 38 subjects participated in the experiment. The subjects were recruited from two categories Musician (n=20) and Non-musician (n=18). Men and women were equally represented in each category.

Two different music examples were composed for the experiment. Each example was created with the purpose of communicating a different and distinct emotional expression: “happiness” and “sorrow” respectively. The music was composed with consideration to factors – such as tempo, articulation, harmony, pitch, rhythm, timbre, form etc. – shown by previous research to be important elements in expressing these emotions [4].

Each subject completed a session comprising 47 trials in total. Prior to a session, four trials for training were completed. In each trial, a piece of music was reproduced to the subject via loudspeakers or headphones. On the computer screen, controls for two of the seven parameters were presented together with two associated buttons marked A and B (see Fig. 2). The selection of the two parameter controls out of the seven available was made randomly for each trial until all combinations were utilized. The subject was instructed: “By these controls, the music you are hearing can be altered in different ways. Decide which of the two controls that alters the music mostly. Answer by clicking the button (A or B) that corresponds to the chosen control.” When the subject had made the choice, a new trial followed. The trials were repeated randomly for all combinations of music examples and pairs of parameter controls, thus yielding 42 trials. In addition to that, the first five trials in the test session were repeated after the completion of the 42 trials, leading to a total of 42+5 = 47 trials in a complete session. The reason for the five repetitions was to acquire a coarse indication of the consistency in performance of each subject. Data from the repetition sequence was only used for this purpose and was not included in any of the other analyses.

For each trial, the parameter pair compared and the parameter chosen was recorded together with the duration of the trial. For every test session (=every subject), the number of times Np a specific parameter P was chosen as a function of the Music Example was calculated.

5.2 Results
The median value of Np, Md(Np), was calculated for each of the seven parameters across all subjects. There was a significant difference (a Kruskal-Wallis test yielded p<0.0001) between the musical parameters in the number of times the parameters were chosen. There were no differences assignable to whether the subjects were men or women.

The level of significance in the following statistical tests p=0.01.

The median values of Np within each Subject Category were also calculated (Table 1). Significant differences between the medians
were observed: The Mode parameter was chosen more frequently by the Musician category, whereas the Non-musician category chose Instrumentation and Accent evenness more frequently.

The difference between the subject categories regarding which parameters were judged more influential indicated that two hierarchies of the parameters existed, depending on the subjects’ musical training. To examine this, the seven Md(Np) within each Subject Category were pairwise compared by Mann-Whitney tests. In each of subject categories, the parameters form three groups of parameters. In the Non-musician category, two of these groups overlap. Hence, these groups cannot be fully established statistically. The groups and the suggested order of parameters are shown in Table 1.

Table 1. Hierarchy of parameters within each subject category based on median values Md(Np) of the number of times a parameter was chosen for each Music Example and Subject.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Musicians</th>
<th>Non-Musicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>Md(Np)</td>
<td>Groups</td>
</tr>
<tr>
<td>1 Mode</td>
<td>5</td>
<td>x</td>
</tr>
<tr>
<td>2 Register</td>
<td>5</td>
<td>x</td>
</tr>
<tr>
<td>3 Articulation</td>
<td>4</td>
<td>x</td>
</tr>
<tr>
<td>4 Instrumentation</td>
<td>3</td>
<td>x</td>
</tr>
<tr>
<td>5 Tempo</td>
<td>3</td>
<td>x</td>
</tr>
<tr>
<td>6 Accent evenness</td>
<td>1</td>
<td>x</td>
</tr>
<tr>
<td>7 Volume</td>
<td>1</td>
<td>x</td>
</tr>
</tbody>
</table>

In order to investigate the influence on the parameters by the musical context, differences attributable to the factor Music Example were examined for every parameter across all subjects as well as within each of the subject categories. The analysis showed that the parameters Instrumentation and Tempo were judged more influential on the music example “Happiness” across all subjects.

The duration of each trial is of interest, as it may serve as an indicator of the perceived difficulty of the trial. In the analysis, the parameter Volume occurred in the pairs with the shortest durations, which indicated that Volume was evaluated most easily. The longest durations were found for the parameter pair Mode – Register and the pairs that comprised the Accent evenness parameter, which seemed to pose more difficulties to the subjects.

6. DISCUSSION

The REMUPP tool used, in combination with the experimental design, was able to produce statistically significant differences between different properties of the parameters. It can be concluded that musical parameters are perceived differently depending on the musical background of the subject, as well as the musical context, i.e. the musical ‘style’. Some of the findings in this experiment also correspond to those of other authors [4][5], which supports the validity of the employed test paradigm.

REMUPP offers a potential for investigating a range of music-related issues from fresh angles, offering new alternatives when compared to traditional test methods. In addition, the subject’s interaction and control of the musical expression, allows for investigation of the creative dimension and establishes a deepened sense of agency for the subject. The emphasis on interactivity and the high quality music engine provides an environment resembling a computer game, which enhances immersion and effectively works against the otherwise potentially negative effects of the laboratory situation.

In this paper, emphasis has been put on the use of REMUPP as an interactive non-verbal tool suited for research of various aspects of musical experience. It should be noted however, that the technical and musical concepts behind REMUPP also offer a platform for other potential applications. For example, the REMUPP concept can be thought of as an embryo for a “musical engine” to be used for computer games and other interactive situations. Some of these possibilities will be presented in forthcoming projects and papers.

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8. REFERENCES


