Towards rehabilitation of motion deficiencies using rhythmic processes

Objective: Improvement of a prototype that measures rhythmic stability of human movement (e.g. walking) and presents a synchronized acoustic feedback to the moving subject.

Background:

- A large number of patients have difficulties in executing body movements in a regular and controlled fashion (e.g. stroke and Parkinson's patients).
- Problem: establish a stable gait in order to be able to move autonomously and safely.
- Research results show that their abilities can be improved using musical, or more specifically, rhythmical stimuli.

Challenges:

- Form a closed feedback loop between measured gait properties and a generated sound signal.
- Applied technology should be applicable in real world settings.
- Reliable measurement of gait stability.
- Aesthetic considerations when choosing appropriate sounds.

Technologies:
Microcomputers, biosensors, basic audio signal processing.

Outcome:

- Proof of concept that indicates the proper technological choices for a highly relevant medical application.
- Learning outcome: Understanding of appropriate interaction design in a challenging setting, handling sensor signals, introduction to rehabilitation applications.

Study limited to laboratory experiment with non-impaired subjects!

Virtual DJ

Objective: Let a group of dancers drive the decisions of a virtual DJ based on the measured synchronization of their body movements.

Background:

- In Electronic Dance Music (EDM), a DJ combines in-advance planning and real-time decisions -> get crowd to an intense and (hopefully) ecstatic dance experience.
- Provide an application that is able to respond and interact with a group of dancers, by combining body movements and biosignals into a decisionmaking for automatically selecting pieces in a set.
- System of interest in smaller locations or private parties.
- System provides an inspiring tool for the study of human behavior in a group interaction in a musical context.

Challenges:

- Process Motion Capture and sensor data in real-time.
- Define musical parameters that are to be manipulated.
- Experiment with possible mappings of sensory data to manipulation of musical parameters.
- Evaluate the subjective experience of the involved subjects.

Technologies:
Motion capture, biosensors, basic audio signal processing.

Outcome:

- Prototype of a virtual DJ environment.
- Quantitative data of the user experiences.
- Learning outcome: handle MoCap systems, experience with biosignals, experience with music processing.

Tempo and rhythmic aesthetics of popular music production

Objective: Document the development of aspects like tempo stability and microtiming in popular music productions by means of interviews, production tool analysis, and literature search.

Background:

- With the introduction of digital production technologies, possibilities to quantize and reshape temporal aspects of recorded music performances have multiplied (e.g. exact timing).
- Conduction of expert interviews with producers, the analysis of applied software systems in studio environments, and an in-depth historical overview of research on timing throughout various historical periods of popular music.
- The underlying question is in how far the aesthetics of time in has changed throughout periods in popular music production, and what were the factors that caused such changes

Challenges:

- Conduction of interviews and observation of studio practices.
- Detailed ethnography of popular music production.

Technologies:
Studio production technology.

Outcome:

- Detailed overview of the aesthetics of time, a subject that has been widely discussed but that is still not well understood.
- Understanding of common studio practices regarding microtiming and tempo corrections.
- Learning outcome: interview conduction, knowledge about studio production technology, understanding of rhythmic concepts.

Crowd games for sports events

Objective: Form an interactive game environment, in which two groups of fans compete in out-singing each other in a group entrainment competition.

Background:

- Watching a sports competition on television includes only limited interaction with the medium.
- When people watch a match in a sports bar, they tend to socialize in groups and cheer for their team, but without any response from the side of the medium.
- Measure the degree of interpersonal entrainment within each group of fans, in order to obtain a competition game that responds to the actions of fans watching a game.

Challenges:

- Give feedback on the level of interpersonal entrainment within each group.
- How does the feedback change people's behavior? (+how to shape the feedback!)
- Obtain and process multiple-sensor signals (e.g. biosignals, audio) from a complex environment.

Technologies:

- biosensors, microcomputers, basic audio signal processing, game design.

Outcome:

- Game environment that makes sports competitions more interactive.
- Insights into aspects of human entrainment and leadership in groups.
- Learning outcome: processing of various signals, learn visualization/sonification, game design

Micro-timing in recordings of Jazz ensembles: How precise can we detect notes?

Objective: Evaluate algorithms for music note onset detection on jazz performance recordings, and by manipulating parameters to increase precision of the detection of bass and drum onsets.

Background:

- Timing of a rhythm section (drum, bass) in Jazz has been widely discussed.
- No larger studies have been conducted that analyze this timing relations in larger sets of music recordings.
- This is mainly due to the fact that manual annotation of note onsets is too time consuming, and an automatic annotation usually would not be sufficiently accurate.

Challenges:

- Make use of a larger set of recordings of Jazz trios, in which the time instances where bass and drum start playing notes (note onsets) are known with high precision in time.
- Run and improve available algorithms for music note onset detection on this data.

Technologies:
Be able to run algorithms in matlab and python. No musical background is needed, BASIC knowledge of signal processing is helpful but not required.

Outcome:

- Improved algorithms for onset detection with high timing accuracy.
- Insights into timing in Jazz rhythm sections.

Tracking the beat in music: compilation of data and comparison of the state-of-the-art

Objective: Construction of a large beat tracking evaluation corpus from existing material, and systematic comparison of existing approaches.

Background:

- Most music is characterized by a beat, which helps listeners to tap their foot or dancers to move their body to the music.
- No larger studies have been conducted that analyze this timing relations in larger sets of music recordings.
- Algorithms based on deep learning and probabilistic models have been developed, and it is not clear, which of all these approaches is to be preferred.

Challenges:

- Combine music data that leading researchers share with us into an evaluation data repository.
- Evaluate and compare algorithms on the compiled repository.
- Propose further improvements.

Technology:
Python and (some) matlab programming.
Data repository management.
Intro to Deep Learning and Bayesian Models.

Outcome:
Clear documentation of the state of the art, and a data repository, resulting in a major journal publication in the field of MIR.