Reunion2012: A Novel Interface for Sound Producing Actions Through the Game of Chess

Anders Tveit*
SkRR
Gyldenløves gate 28
3117 Tønsberg, Norway
anders.tveit@gmail.com

Hans Wilmers†
Notam
Sandakerveien 24 D Bygg F3
0473 Oslo, Norway
hanswil@notam02.no

Notto J. W. Thelle‡
Notam
Sandakerveien 24 D Bygg F3
0473 Oslo, Norway
n.j.thelle@notam02.no

Magnus Bugge§
Notam
Sandakerveien 24 D Bygg F3
0473 Oslo, Norway
magnusbugge@gmail.com

Thom Johansen
Notam
Sandakerveien 24 D Bygg F3
0473 Oslo, Norway
thomj@notam02.no

Eskil Muan Sæther
SkRR
Galgeberg 3H
0657 Oslo, Norway
eskilms@gmail.com

ABSTRACT

Reunion2012 is a work for electronically modified chessboard, chess players, and electronic instruments. The work is based on—but also departs from—John Cage's *Reunion*, which premiered at the Sightsoundsystems Festival, Toronto, 1968. In the original performance, Cage and Marcel Duchamp played chess on an electronic board constructed by Lowell Cross. The board 'conducted' various electronic sound sources played by Cross, Gordon Mumma, David Tudor, and David Behrman, using photoresistors fitted under the squares [1]. *Reunion2012*, on the other hand, utilises magnet sensors via an Arduino. Like in Cage's *Variations V*, this resulted in a musical situation where the improvising musicians had full control over their own sound, but no control regarding when their sound may be heard. In addition to a concert version, this paper also describes an interactive installation based on the same hardware.

Keywords

Reunion, John Cage, Chess, Hall effect sensors, Arduino, Max, Perl, OSC, UDP

1. INTRODUCTION

Reunion2012 was first presented as a work for electronically modified chessboard, chess players, electronic instruments and visual effects. The work bases itself on John Cage's *Reunion* from 1968. The idea behind *Reunion* was to reflect the chess game's flow and dynamics through sound by using a chessboard equipped with sensors which would register movements on the board, and which in turn would result in various sonic results.

*Software section
†Hardware section
‡Editor
§LaTeX preparation

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Reunion2012 is a technologically and artistically updated version of Cage's work, with a revitalised artistic expression and technology that ensures a higher degree of interaction between the chess movements and the sound. Magnetic sensors are mounted underneath each of the 64 squares on the chessboard—effectively turning the board into a matrix that influences the artistic result of the performance. Laptop musicians connected to the system are able to perform music based on the compositional framework defined by the chess game. Put simply, the chessboard acts as the conductor of the music.

In addition to the concert version described above, we also developed an interactive installation version of *Reunion2012*. Here, the electronic chessboard is a standalone musical instrument, where the game controls a sound engine generating compositions in real-time.

2. HARDWARE

In the original 1968 performance, a chessboard equipped with light dependent resistors (LDRs) was used. This chessboard functioned as a mixing matrix feeding sound from four live musicians into eight loudspeakers. For *Reunion2012*, there was a desire to get more information from the chessboard, and to be able to use advanced sound processing. The most straightforward way to accomplish this was to detach the interface from the sound processing. Thus, the chessboard now contains the interface only, and all sound processing is done on one or several computers. In fact, at the opening concert of *Reunion2012*, data was sent as OSC broadcast to both a central computer acting as a matrix, and to the collective of eight live musicians that were acting as sound sources.

To read the position of the chess pieces, an array of 64 Hall effect sensors was embedded underneath the board, and the chess pieces were equipped with small magnets. To be able to distinguish black and white, the polarity of the magnets was reversed in the black pieces. This made it possible to interpret the position on the board on a fairly low level, without knowledge of the previous course of the game.

The hardware consists of eight identical custom-designed Arduino shields, each incorporating eight Hall effect sensors (Allegro A1301LH) and one eight-channel 16bit A/D converter (Texas Instruments ADS8344). The boards are daisy-chained, with only digital lines and supply in between. As a result, we get an array of 8x8 sensors with 5cm spacing. On one of the shields, an Arduino UNO is mounted.

Figure 1: The chess board, built from a standard wooden board.

This reads out data from the A/D converters and sends the results to a computer via USB.

The hardware is mounted underneath a standard wooden chessboard (Figure 2), using non-magnetic screws. The chessboard has a thickness of 12mm. As a consequence, the magnetic field at some distance below the surface of the board is measured, which allows for some misplacement of the pieces. Still, because of the nature of magnetic bipoles, the pieces must be placed near the centre of the squares to produce a good reading. The receiving software is realised with Max. After an automatic calibration, the data array represents the magnetic field strength and polarity over each of the squares of the chessboard. As the values in principle are analogue, there is also a smooth transition during the move from one pattern to another. This information is now analysed on different levels:

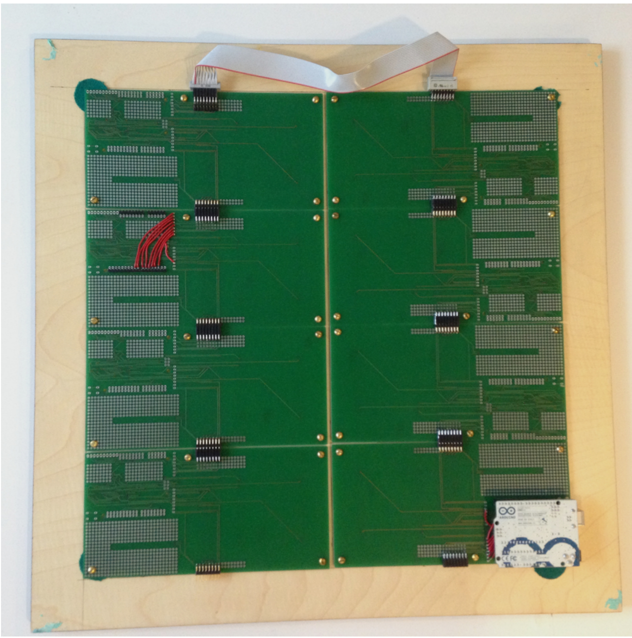

Figure 2: Aurdino shields mounted underneath the chess board.

First, physical aspects of the pattern of black and white pieces are calculated: the centre of masses on the chess board, the total energy captured in the constellation of magnets, and the attractive (or repelling) force that each piece is experiencing from surrounding pieces. These values are agnostic to the actual rules of the game, but can be used as slowly varying parameters in live electronics.

Second, as a higher level of analysis, the actual moves are analysed so that the positions of all individual pieces are known during the course of the game. Events get triggered when a piece is lifted, and when it is set down on another square.

3. SOFTWARE

3.1 Software overview

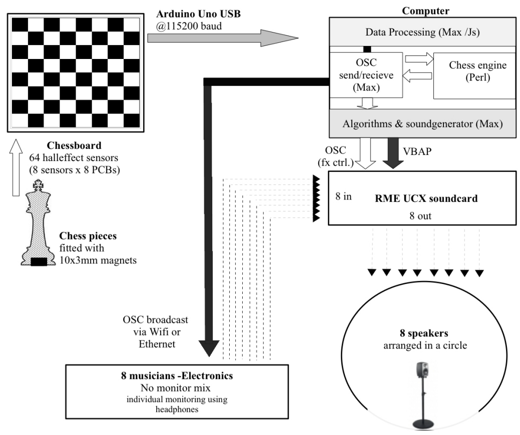

Figure 3: An overview of the hardware and software implementation in Reunion2012.

As *Reunion2012* was going to be in two versions, a concert version and an interactive installation, we programmed a common structure implemented in Cycling74's Max and Perl for both the versions: The pre-processing and 'cooking' of data received from the Arduino-driven chessboard, the communication (OSC) scheme and the chess game logic. However, the two versions differ in the direct sound generation and algorithms.

One of the main challenges was to make a stable chess engine or logic, i.e identifying and tracking the chess pieces moved, removed and so on. As we initially wanted to run everything in a Max environment, we first opted for a custom chess engine written in javascript (JS). However, due to less than optimal implementation of JS for these types of tasks in Max, this was ultimately scrapped. The stable solution was to have the engine running as a Perl script with bi-directional OSC communication internally to and from Max. Using the OSC protocol also gave us a highly flexible solution for both sending and receiving events occurring in the game itself. Additionally, selected parameters based on the magnetic sensors are broadcast to the musicians,[1] which enables them to freely map these as control data and events for musical use in their own preferred setup. To further simplify such use, we made a Max standalone app (Figure 4) that converts OSC to MIDI data and provides real-time visualisation of the events happening on the chessboard.

3.2 Algorithms and sound generation

In the concert version, each of the eight musicians' (four on white, four on black) outputs are connected to a central computer. The computer acts as a matrix mixer outputting the musicians' sound into the eight-speaker circle, spatialising the signals using the Vector Base Amplitude Panning

[1]OSC data has also been used to control an RME audio interface for setting amount of overall reverb on the output based on certain events in the game

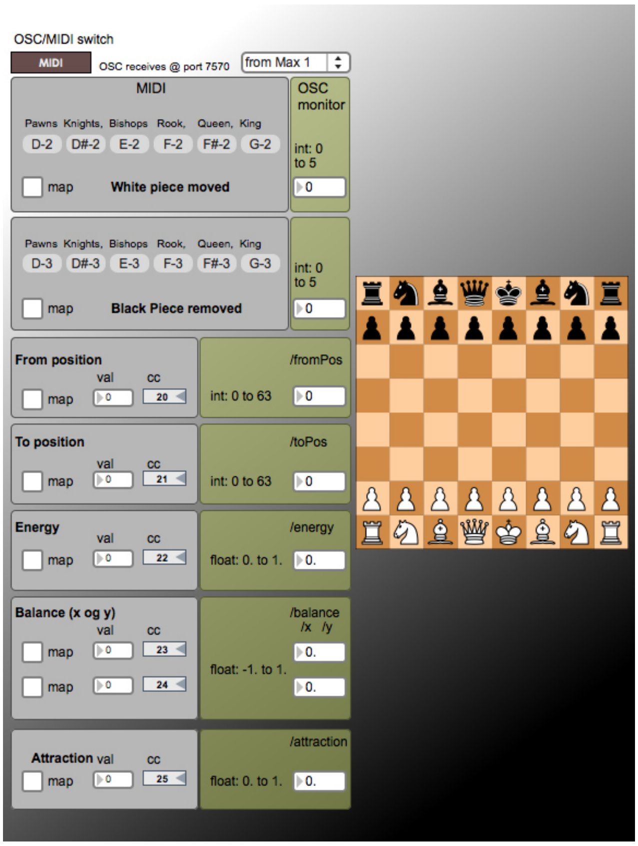

Figure 4: Standalone application for mapping events and sensor data to Midi.

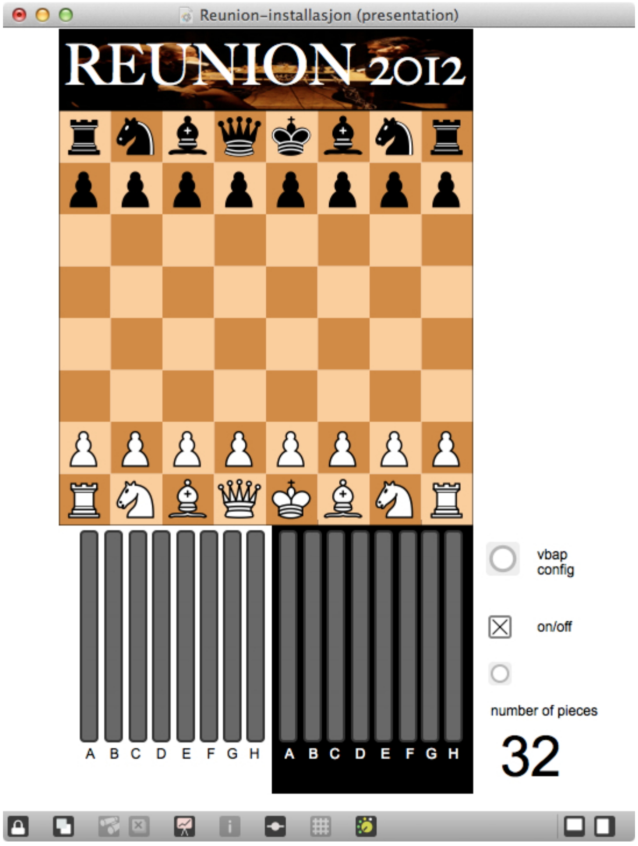

Figure 5: Screenshot of the interactive installation.

(VBAP) algorithm [2]. Depending on which type of piece, *from-to* position, and colour that has been moved, a semi-random process controls how many and which musicians are to be heard at all times. More specifically, the *from-to* position on the eight rows *1-8* determines how many (it can also be one or none) are to be let through dependent on colour moved, and the *from-to* position on the eight columns *A-H* corresponds to the eight VBAP-panned outputs to the eight speakers.

In the interactive installation version, the sound generation is more complex. Here, sound is generated from a sample bank containing sounds designed in such a way that each type of piece has a certain salient timbral quality—its own *leitmotif*. The *from-to* position on the columns *A-H* also corresponds to the VBAP-panned outputs as in the concert version. The OSC parameters that in the concert version are sent out to the musicians for mapping to their own sounds, are instead mapped to transform the audio samples in various ways. This is in some cases fixed, for instance; playback speed/pitch is determined by the position on the board (1-64), where in other cases a semi-random process controls how much of certain effects such as reverb is applied. Certain types of movements or shifts, like castling or win, changes timbral factors and even introduces additional sounds in the case of a piece defeated. Furthermore, sensor data such as magnetic energy, balance and magnetic attraction is used to control and add types of modulation to the sound such as ring modulation and FM. Such sensor data is also interesting, because magnetic attraction may tell us if a piece is surrounded by the opposing players pieces—something which could lead to a heightened sense of drama in the music. If the system registers game over via checkmate, it automatically turns off all audio.

4. PERFORMANCES/APPEARANCES

Reunion2012 was originally planned as a one-time event at Ultima Oslo Contemporary Music Festival in 2012. Opening as a concert for eight laptop musicians and two high-profile chess players, the setup was re-rigged immediately after the concert, and stood as an interactive installation for a week—the remaining period of the festival. The location was in the foyer of the main library at the University of Oslo, and the audience could view the concert/installation from several perspectives: at close range within the speaker circle, or from flights of stairs or even from upper floors looking down into the large open space. Apart from during the concert, any visitors could obtain chess pieces from the library reception and play games of their own—simultaneously composing music generated by the sound engine.

Both the concert version and the interactive installation garnered media attention and received positive reviews. Subsequently, the installation has made several appearances in various formats since the premiere. It has been used as an artistic interlude at a leadership conference, assumedly to demonstrate how a well-composed framework may ensure more autonomous organisation and less need for micromanagement. In 2013, the installation was exhibited at the annual Oslo Maker Faire at Norwegian Museum of Science and Technology, where several hundred people got an opportunity to try a hand at chess-induced musicking. In 2014, both the concert and the installation will be featured at several events, including a visual arts biennale and possibly at the opening ceremony of the upcoming Chess Olympics in Tromsø, Norway.

5. FUTURE WORK

Our goal for making *Reunion2012* was to have a correlation between the chess game itself and the sound producing events. However, we needed a stable system and setup in the first place, so decisions were made to achieve this, and that meant that we had to temporarily leave out a full-scale and a more intelligent chess engine that could analyse the movement and report back in real-time. In a chess game there are several hundred different variants considered standard from just the opening phase of the game (in chess terms called 'The Book'). Chess is a highly complex game and it is formidable task to sonify a game on certain levels. In order to simplify, we must look at the overall feel of the game from what we can divide in three parts; the opening phase, the middle phase and the end game phase. Conversations with the acclaimed chess players that performed at the *Reunion2012* concerts, and advice from our collaborators in the Norwegian Chess Federation (NSF) revealed that in a normal-timed game situation the three different phases mentioned above are often driven by a certain tempo. Whereas the opening is quite fast, the game usually slows down to a more stasis-like phase (middle phase to endgame). The endgame is usually quite fast again. In musical terms, a standard three-part form could mimic these game dynamics.

Our future work is to correlate this tempo change to both the sound-material and overall feel of the music, especially in the installation version. The need to have a proper chess engine is also high in priority, as the real-time analysis of the game can provide insight for us. This could help us improve the correlation on higher and lower levels of control and events, thus creating a truly interactive music environment created and controlled by the game of chess.

We think that *Reunion2012* is interesting not only for exploring the connection between chess and music, but also in terms of using it as a novel controller for music on a more general basis. The 64 Hall effect sensors with continuous read-outs from each square constitutes quite a sensitive controller that for experimental musicians could be an interesting and creative tool for exploring new music, ideas of control and performing music. Therefore, we have opted to make both the hardware with schematics (PCB Eagle Cad files) and software open source under a Creative Commons license (CC- BY-SA). We would like to invite people to make their own interpretations of *Reunion2012* or to come up with ideas for new ways of using the interactive chessboard to control music.

6. CONCLUSIONS

The sustained interest in *Reunion2012* may possibly reflect the truly universal appeal of the game of chess—while often considered as a game of intellect and skill, it also stirs up primitive emotions related to war, death, sacrifice and class struggle. Chess terminology certainly reflects this, and upon comparison, music terminology reveals that mapping chess events to music may potentially be anything but arbitrary. The key to a successful integration of chess game dynamics and musical form is manyfold: well-calibrated hardware, a stable software environment, and—perhaps most importantly—a twin passion for, and understanding of, chess and music in order to create intuitive mapping systems and ingenious sound design.

We cannot honestly state that *Reunion2012* represents the ultimate marriage of game and music—we have merely picked up an old idea which we think is worth pursuing. Although not strictly a novel musical interface, chessboards as musical controllers are surprisingly rare, and one reason for initiating this project was a conviction that all attempts we are aware of (Cage's original included) have not succeeded seen from an artistic point of view. In this paper, we have presented two possible ways of sonifying the game of chess: a concert version and an interactive installation. We have made both hardware and software open-source, and we invite anyone interested to embark upon their own projects with specifications for *Reunion2012* as a vantage point.

7. ACKNOWLEDGMENTS

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8. REFERENCES

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