Díamair: Composing for Choir and Integral Music Controller

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ABSTRACT
In this paper, we describe the composition of a piece for choir and Integral Music Controller. We focus more on the aesthetic, conceptual, and practical aspects of the interface and less on the technological details. We especially stress the influence that the designed interface poses on the compositional process and how we approach the expressive organisation of musical materials during the composition of the piece, as well as the addition of nuances (personal real-time expression) by the musicians at performance time.

Keywords
Composition, Integral Music Controller, Emotion measurement, Physiological Measurement, Spatialisation.

1. INTRODUCTION
Research on new interfaces for musical expression tends to primarily focus on innovative gesture measurement, often following one of two paths, extending traditional instruments expressivity or creating completely new digital instruments. Reports on this type of research normally discuss gesture-to-sound mapping strategies and pay great attention to the underlying technologies involved. This paper, however, describes the lesser-discussed process of *composing* for a new interface, the use of such a system as dictated by the concept of the piece (rather than an interaction model to explore) and the effect the novel interface has on the decision making for the final compositional result.

Specifically we focus on the challenges of composing a choral piece, Díamair, using various aspects of an Integral Music Controller (IMC) and the influence the interface has on the composition process. The concept of an IMC is to enable traditional musical control (in this case singing and conducting) to occur simultaneously with augmented and remote gestural interaction and even direct emotional interaction. (Please see [4], [5] for a complete description of the IMC). In this paper we will discuss *why* we chose the IMC for Díamair, *which* specific elements of the IMC we chose, and *how* and *why* we chose them.

2. CONCEPT OF THE PIECE
Díamair is a piece for choir and live electronics written as a response to a call for works from the Ulster Youth Choir [13]. It is inspired by the poem of the same name, often translated as "A Mystery" or "The Song of Amergin" (after the author to whom it is attributed). This text, contained in the *Lebor Gabála Érenn* (The Book of Invasions) [1], is the oldest example of Irish poetry kept to date. According to the legend, the words of the poem came from Amergin's *imbas* (poetic inspiration) and they marked the start of the battle against the *Tuatha Dé Danann* (or the Faery Clan) for the land of Ireland. In the poem, Amergin invokes the spirit of the land and claims the elements of the island, becoming their master.

The piece was not written for an electronic music festival or a specialized choir dedicated to contemporary music, but for a very traditional ensemble planning to perform it in traditional venues (schools, churches, etc.). This situation required us to be as non-invasive as possible on our interface implementation. We were more concerned with manipulation of subtleties rather than creating complex compositional structures based on simple input. The result for the conductor and choir can be compared to the experience of an instrumental player suddenly playing a higher quality instrument which is more responsive to his/her nuances at performing. We decided to make the use of technology not visible to the audience in order to avoid the "novelty" value, as we thought that might be distracting for audiences who have not had contact with electronic music before. The use of the IMC is only clear to the performers themselves, especially the conductor. Thus the cleverness of interface implementation and mapping strategies are not directly seen and only the final aural result (and its expressiveness) is appreciated.

3. COMPOSITIONAL APPROACH
A common approach when working with new musical interfaces follows the path described in Figure 1. The interface is designed based on an interaction model that the designer is interested in exploring: imitating or expanding an existing acoustic instrument (e.g. [1], [7], [14]), or creating a novel interaction paradigm (e.g. [8][10], [12], [9], [10]). This model has a disadvantage, as the design of the interface and the composition are two isolated processes. This is understandable as an instrument designer would be interested for his/her interface not to be tied to a particular composer or piece, but to be used as broadly as possible. It is

common for novel interfaces to track more information than required or needed for a particular piece, with the composer often feeling compelled to make extensive use of the possibilities offered by the controller.

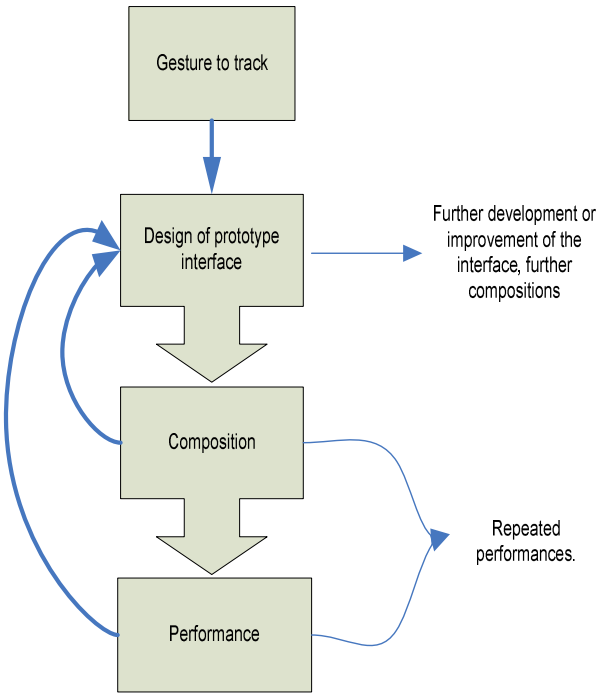

Figure 1: Standard Creative Approach to New Musical Interfaces

The methodology followed for the composition of Díamair differs from the one described above in one important aspect. We didn't start from an interactive model but from the aesthetical concept of the piece. The type of interaction is chosen in consideration of this concept and not in consideration of a particular gesture, set of gestures or technology to explore. This helps to achieve an interactive model which is meaningful to the piece. For this reason, the IMC was chosen as the interface mechanism so as to enable selection of the precise kind of interaction that each component of the piece dictates. As illustrated in Figure 2, once designed, the interface itself (an IMC) acquires the same importance as the traditional instrument used (the voice or the conductor's gestures), interaction between interface and composer can be observed in a similar manner as the relationship between performer and interface. The composer reacts to the controller's possibilities and limitations in the same way as he/she reacts to the traditional instrument (choir). The composer is then free to either choose other levels/types of control to meet practical or logistic constraints or rewrite instrumental passages to address the controller's limitations and/or advantages. Not being tied to a particular interactive model allows choosing the levels of control as needed for the piece. There is no need to retrieve all the information possible for a certain gesture, but only that which is required by the aesthetic concept and chosen type of interaction. When following this work model, musical instruments (both traditional and novel) return to their original role as a toolkit for the composer.

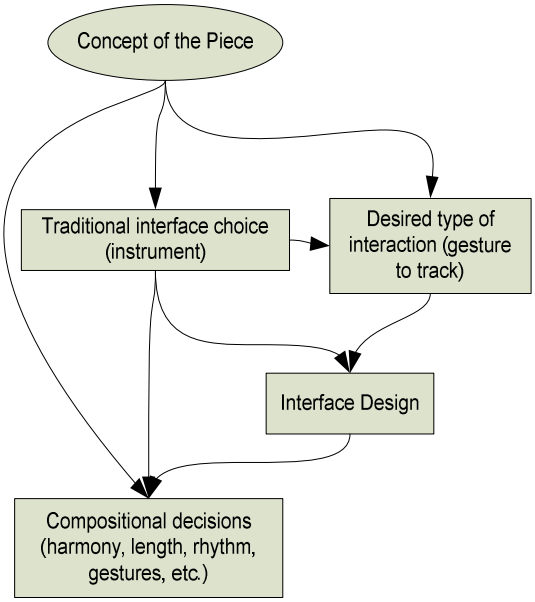

Figure 2: Composition-Driven Approach to Using Novel Interfaces (Including the IMC)

4. CHOOSING THE INTERFACE

Current personal research uses spatialisation and sound diffusion as a means to construct musical meaning. The intention for Díamair was to give the conductor total freedom for diffusing the sound in real-time as well as to use the choirs' emotional states to control timbre and texture without forcing either of them to perform gestures foreign to their traditional performance practice. Furthermore, rather than focusing on extended control, the aim was to allow extended expressiveness of the electronic materials, providing a way to interact and shape sonic results.

We have previously defined an IMC [4] as a controller that:

1. Creates a direct interface between emotion and sound production unencumbered by the physical interface.
2. Enables the musician to move between this direct emotional control of sound synthesis and the physical interaction with a traditional acoustic instrument and through all of the possible levels of interaction in between.

These are precisely the two capabilities that meet the requirements outlined for Díamair. In this piece we have distributed the interface among the choir and conductor as shown in Figure 3. The conductor has the capability of controlling the choir through his physical gestures. His control is augmented by the IMC so that his gestures also remotely control the live electronics. In addition to singing, a group of 8 soloists within the choir shape the materials through involuntary autonomic physiological reactions, creating a direct interface between emotion and sound manipulation. This scheme preserves the hierarchical relationships of the ensemble. The remaining choir members who are below the soloists in the hierarchical tree, have no direct interaction with the live electronics, but close a feedback loop by their singing which affects the conductor's gestures and soloists emotional states.

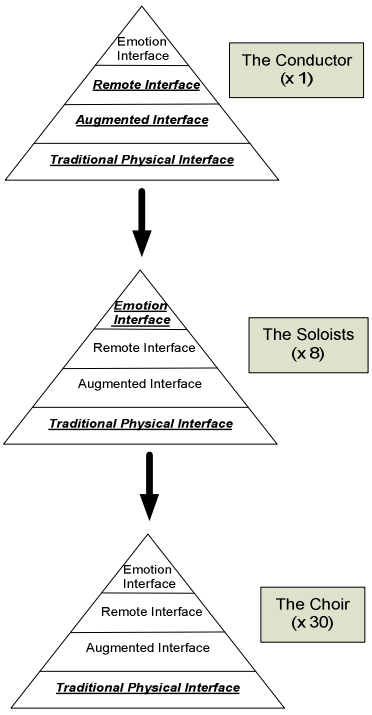

Figure 3: The Levels of Integral Control for the Musicians in Díamair.

4.1. Choir Interface

The choir is laid out in two concentric circles with the conductor at the centre as showed in Figure 4. The inner circle is formed by 8 soloists equipped with the GSR sensors, the rest of the choir is placed surrounding the audience. Four speakers at the corners are used for the electronic components of the piece.

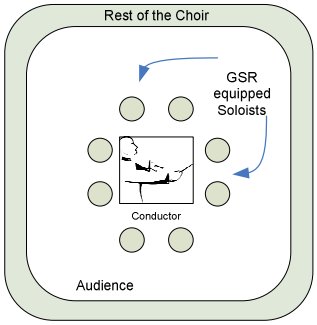

Figure 4: Choir Configuration

The choir members in the outer circle are not grouped by vocal ranges (SATB), but rather, they are alternated. This allows for every vocal part to be located, or moved from/to any position on the circle. The choral parts are written in a way that makes it possible for the conductor to decide in real-time the number of choir members singing a specific voice as well as their location on the concert hall using simple hand gestures.

Having an interactive system that incorporates direct emotional feedback creates a closer relationship between the performers and the end result. The computer-generated sounds change and improve through rehearsal proportionally to the choir members' involvement in the aesthetic contents of the piece, their concentration, and the emotions created by their singing gestures.

To measure the emotional state of the soloists, the Galvanic Skin Response (GSR) component of an IMC was chosen. GSR data provides a continuous signal which shows both instantaneous emotional changes (tonic) and the slow evolution and gradual change of emotional states over large time periods (phasic). In order to create musically interesting patterns the written score had to provide contrasting stimuli for the singers, elements such as dissonant harmonies and *Solo-tutti* relationships had to be manipulated not only regarding their aural effect in the musical discourse, but also as a mean to alter the emotional state of the singers. The interface itself influences the lower level organisation of musical elements at composition time - not simply the musicians' interactions at performance time. In Díamair, the traditional harmonic parameter is "calibrated" to address the individual differences associated with the GSR. The folders containing the written parts are equipped with two contact terminals where the fingers hold the folders. This implementation succeeds in being easy to set up and non-intrusive.

A pattern recognition algorithm determines tonic and phasic emotional states as well as detects artefacts caused by physical displacement of the fingers. These motion artefacts are filtered out of the control signal. However when motion artefact is detected, it is interpreted aesthetically as a lack of concentration and the effect of the emotional state is diminished.

In general the emotional state is mapped to granular synthesis parameters, affecting sound texture, polyphony and transposition /harmony. The signal from each soloist is scaled and mapped directly to one of the controlled parameters, retaining the different responses of individual members to the same overall aural stimuli. This setup allows the soloists to continue interacting even when they are not singing, thus stressing their higher status on the hierarchical tree compared to the rest of the choir.

4.2. Conductor interface

There is plenty of research in tracking conductor's gestures [6] [8], [8], such works usually aim at capturing every aspect of conducting technique in order to create a responsive system which can be "conducted" as a virtual orchestra. The Conductor's Jacket project [6] adds physiological measurement to the gestural tracking by generating expressive music in real-time based on gestures and breathing signals. The conductor interface used in Díamair does not attempt to replace an orchestra or generate music itself. It is used to add spatial flexibility to otherwise fixed sound materials. Specifically, the main parameters controlled by the conductor are source location and "spread" of the electronic sound events.

As described before, the choir's layout allows easy conducting of spatial gestures such as: narrowing the choir to just one singer, "Mexican wave" type gestures, rotation, etc. However, more complex or quick synchronized gestures are difficult to accomplish. An IMC was chosen to augment the standard physical gestures of the conductor in order to directly measure the naturally occurring head and arm gestures without in any way interfering with them. These signals are then used to manipulate the sounds in an analogous way to the choir. In practice, the

conductor can choose, at rehearsal time, between the diffusion of the electronic sounds being orthogonal or parallel in relationship to the choir. Additionally more complex composite gestures can be defined beforehand within the Max/MSP patch. This strategy reinforces the integration of electronic and acoustic sound worlds, the difference in timbre between the choir and the computer is compensated by their spatial behaviour.

There are many techniques for the IMC to track head gestures. In *Self* [11] we used a gyro placed on the conductor's head. Although this proved to be robust enough it was considered intrusive by some conductors who were not pleased with the ergonomics of the interface. Consequently, as was demonstrated in [5], a Logitech® QuickCam® Sphere™ can be used to track the conductor's facial features. The built-in facial recognition and tracking software of the webcam is used, as it proved to be more robust and reliable than any other of the tested systems. Changes in the lighting have little effect on the tracking algorithm and lost tracking points are recovered automatically and accurately.

To detect arm gestures, two EMG sensors of an IMC are attached to the conductor's arms. Unlike inertial, visual, or gyroscopic tracking, these sensors track tension level to identify staccato and legato conducting articulations. [One could argue that in addition to being an augmentative and remote interface, an IMC's detection of muscle tension also detects a level of emotional stress.] The system doesn't implement discrete recognition of the EMG signals, but rather uses maximum and minimum values of distributed tension and interpolates between them for continuous gestural control. These different articulations are used to control the overall spread of the electronic sources: a tense constrained signal sets a small source *point* distribution of the electronic sounds; a more relaxed (i.e. *legato*) signal is interpreted as a broader, more "spread" sound.

5. CONCLUSIONS

We have presented the compositional process of the piece Díamair as a case example of a methodology that doesn't part from a designed interface but in parallel with such design. We have focused on the compositional reasons to use an IMC as well as the implications and consequences these decisions caused from an aesthetical and practical point of view rather than focusing on describing the underlying technologies involved.

We have started to work and explore how novel interfaces can enhance compositional expression, i.e., the expressive formal characteristics of musical materials, their organisation, and their manipulation by a composer to convey emotion through a musical discourse. This then complements the body of work on expressive performance – understood as the nuance a performer adds in real-time to evidence and stress such organisation.

Further work is being made towards a full toolbox for composers. We aim at creating a set of hardware components to track emotion, a software framework which allows for fast deployment, analysis and processing of Biosignals and a set of compositional strategies which take advantage of this tools.

6. ACKNOWLEDGMENTS

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