MUSIC VIA MOTION: INTERACTIONS BETWEEN CHOREOGRAPHY AND MUSIC

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Introduction

In this paper, we present an ongoing research project, focusing on creating an augmented, interactive audio-visual environment, for stage performance, installation arts and other related applications. We describe a motion and colour sensitive system called MvM (Music via Motion), and report an interdisciplinary collaborative project to integrate dance, music, and costume design, using the system, called CoIN (Coat of Invisible Notes). The paper reviews public performances of CoIN, and discusses the interactions between choreography and music. The further enhancement of the MvM framework using sensors, and the future direction of the project, are also discussed.

MvM

The MvM system uses input from a video camera to process video frames acquired in real-time, detects and tracks visual changes of the scene under inspection, and make use of the recognised movements to generate interesting and 'relevant' musical events, using an extensible set of mapping functions (Ng 2000).

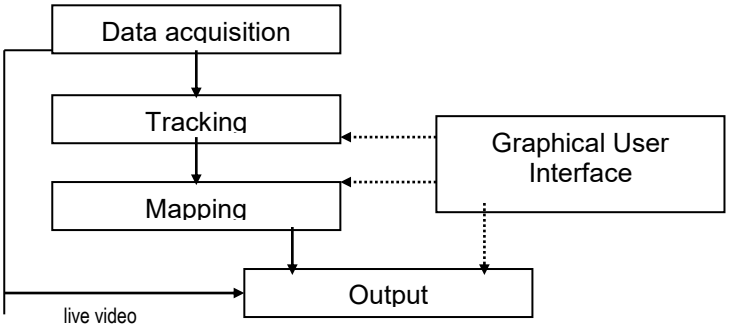

Figure 1: MvM framework

Figure 1 illustrates an overall framework of MvM. The data acquisition module is responsible for communication with the imaging hardware. The tracking module currently includes a motion-tracker and a colour detector. The mapping module consists of an extensible set of sub-modules, which *translate* detected visual changes into musical events, and the output module is responsible for the audio and graphical output. The graphical user interface module enables online configuration and control of the musical mapping sub-modules and provides overall control of the scale type (tonality), note filters, pitch and volume ranges, and other options. It also includes a simple colour calibration interface for the colour detector.

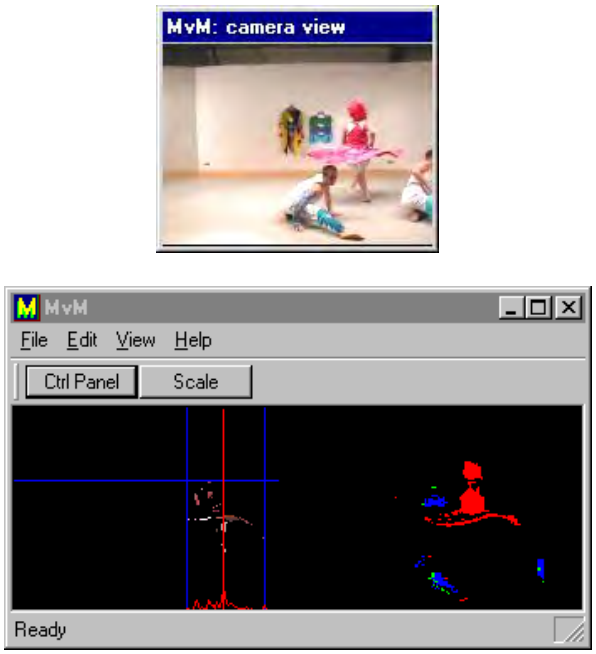

Figure 2: A screen snapshot of MvM in action

Figure 2 presents a snapshot of the system with a live video window, displaying the camera view and a frame differing tracker window, highlighting the areas with detected visual changes (left), and a colour detection window (right) showing the detected colours.

The MvM prototype detects visual activities using video data with no physical sensors or markers. This enables freedom of movement for the users, which is particularly important in a dance performance context. With MvM, dance activities are digitised, tracked and mapped to generate direct musical correlates within the domain of sound. Hence, there is a coherent integration of motion and sound within the performance, as the same body instigates both.

The Coat of Invisible Notes (CoIN)

The CoIN project brings together multiple creative domains to build specially designed costumes, music and dance within an interactive audio-visual augmented environment simulated by the MvM system.

The costumes in this project are not merely visual decoration but an integral part of the project. The designs apply large vibrant areas of colour, combining luscious fabrics such as satin, chiffon and crushed velvets in rich vibrant shades, featuring blocks of colour and texture both inside and out (see Figures 3 and 4). A particular feature of the costumes is that they are reversible and can be split apart into sections allowing the users to re-assemble and re-configure them to achieve different visual effects. These various changes in turn are detected by MvM and can be used to alter the character of the musical responses.

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Figure 3: Snapshots from recent rehearsals

In tune with the costume design, which makes use of everyday objects (e.g. headdresses are made from cut up plastic milk and soft drinks bottles, bubble plastic and loofahs), the

music features sound derived from similar sources. The intention of the music is to bring familiar sounds into the performance to encourage the audience to perceive them differently in this artistic context. A background layer of music was specially composed for the performances, with synthesised and sampled sounds, and effects triggered by MvM, to produce a musical and coherent performance.

For CoIN performances, MvM is configured to track the colour where visual changes were detected. Detected colours are used to control the choice of musical sound and effects. This feature is fully explored and is particularly apparent in a section of the choreography where the dancers are divided into two groups, wearing costumes in different colours. The contrasting movements and interactions between the two groups create interesting musical dialogues with two different musical sounds.

Dance with MvM

MvM and other similar systems alter the traditional relationships between choreography and music. Where the choreographer works with pre-composed sound, whether it be chosen from available material or created specifically for the performance, the dance has traditionally followed the music in direct relationships of tempo and rhythm. Increasingly through the twentieth century, choreographers have worked with more a flexible relationship between dance and music, where the dance exists independently of the music, with the two elements being linked by their style and rhythm. In the latter case, the dance and music coexist, complementing one another within the performance, but not restricting each other. However, in allowing the dancer freedom to perform, the potential for choreographed relationships between sound and movement is sacrificed.

MvM alters these traditional relationships between dance and music. The motion of the dancer *creates* the music, so that the dancer may perform with complete concentration upon the physicality of the movement, knowing that the music will be synchronised to it. While this may or may not be apparent to the audience, the effect upon the dancer is considerable, allowing a freedom to develop the movement to its full potential without restriction, but with direct connections between sound and gesture. Indeed, where technology and choreography complement each other fully, the technology will be transparent to both dancer and audience, so that it acts as a framework for the dance and the music without distracting from either.

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Figure 4: Snapshots from a public performance

MvM and Choreography

Blom and Chaplin (1989) note that ‘The relationship of dance to music is an intimate one ... The ideal relationship is when dance and music appear as one, mutually supportive, enhancing one another.’ Thus, a synthesis of the two elements in the final performance is the ideal. Yet traditionally, where music is used to accompany dance, the music provides the form and structure, and will largely influence, if not dictate, the mood, style and length of the dance (Foster 1986; Smith-Autard 2000). If the music is not to dictate so many elements then the dance should have some control of the music. Theoretically, using MvM, the choreographer and the composer can work so closely, that the dancer may perform the movement without being reliant upon the music. Thus the dancer might seem to perform with an authenticity born of the sense of the movement, rather than being coerced by the effort to stay ‘in time’.

Siegel (1999) refers to 'interactive dance', but it seems more appropriate to call this type of approach 'interactive performance', since all the elements are equal. The visual component of the performance becomes less 'dance' than 'movement', because not all of the usual practices of choreography necessarily apply. Many do remain, but some of those concerned with form and spatial orientation are replaced by conventions governing the use of the technology and the composer's requirements. Siegel also notes that 'simple mappings tend to be immediately understood by the observer but [were regarded as being] trivial, whereas the apparent relationship between movement and sound is lost when complex mappings are used' (Siegel 1999, p.56; Siegel and Jacobsen 1998). Similar features have been experienced with MvM. With simple motion (e.g. where only one or two dancers are moving at a time, or a group is moving in unison), it is apparent how the musical output from the system relates to the dance. However, when more than two dancers are moving independently, the relationship is less clear, and the resultant musical events may seem less correlated to the motion. As a result, there was substantially more unison movement in the MvM/CoIN performance than might normally be used by the choreographer.

Direct mapping of movement can also be tiresome and uninspiring. Hence, MvM has been equipped with modules which aim to introduce basic expressive features. Among these are an *accent detector* module that keeps a history of the size of the region of the visual changes, the directions and velocities of the motion, and their averages. Sudden changes in these parameters can be mapped to control the volume of the sound, in order to produce more *expressive* performances. This is particularly effective when percussive instruments with limited pitch range are used.

Further work in this area includes the sensing of gesture, shape and velocity, tracking only certain specific changes in the direction or momentum of the movement. In this way, the sound may be able to complement the form of the dance to a greater extent. It is difficult for the dancer to recreate the identical spatial localisation and orientation on the stage, on each performance, hence complex music cannot be repeated accurately. However, gestures and shapes can be reproduced with much greater consistency, and thus using these aspects of the performance to trigger musical output is likely to produce a more consistent result.

Conclusions and Future Directions

With computer vision technology, MvM attempts to create a highly dynamic and versatile interactive performance space, to bring together multiple creative domains, for the collaboration of choreographer and musician, providing the users with real-time control of musical sound by their physical movement.

Beside multiple cameras and distributed architecture for future MvM enhancement, small, simple and non-intrusive sensors and switches could be installed onto the floor and other surfaces to provide further input to the MvM framework, and thus provide additional dimensions of interactivity. Figure 5 illustrates a development plan, with a two-cameras setup, an array of pressure sensors on the floor, and a touch sensors installation on the walls. Many simple and low cost switches and sensors (for example vibration and proximity switches) can be used in such installation.

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Figure 5: Distributed MvM and sensors

Other ongoing experiments for the extension of MvM include using the velocity of sound to localise footstep noise. With two (or more) contact microphones on a wooden platform, noise signals from footsteps (or step-dancing) is detected and the difference of the onset position of the signals is used to estimate the location of the signal source. The output can be mapped onto various interesting musical scenarios. For example, if the locations were mapped onto pitch, it could simulate walking on a giant musical keyboard.

Many other researches in visual tracking and sensing can be integrated in the MvM framework. Future plans include face tracking, behaviour modelling (Johnson *et al.* 1998), and other motion, gestural and expression trackers (Camurri *et al.* 2000). With the advancement in science and technology, it is hope that systems like the MvM will continue to explore the integration of art and science to offer artistic and creative sensory experience (Ng *et al.* 2000).

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