

A System for Mapping Physical Movements into Sound Synthesis Parameters



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1. Introduction

Along with the development of multimedia technologies, many practitioners in the international community of contemporary dancers and choreographers have begun to use computer-based systems for enhancing their performances with multimedia elements. Such new tendencies in performing arts opened interesting opportunities which relied on interactivity between humans and computers. Interactive systems enable performers to control algorithms for sound, image, and video processing in a real-time environment. The control over a digital signal processing algorithm is established through capturing the performer's gestures, extracting relevant features from the gestures, and mapping those features into parameters of the algorithm.

2. Problem Description

Sound synthesis controlled by physical movement is often a part of such interactive systems. The aim of this project is to propose two different approaches to controlling a sound by physical movements of a dancer. The movement of a dancer is captured by a video camera and analyzed. In the first approach all extracted features are processed by an expert system based on fuzzy logic which maps features of the physical movements to sound synthesis parameters. Fuzzy logic rules are therefore used for combining different gestural features and calculating the numeric values of synthesis parameters in real time. In the second approach all extracted features are mapped to the parameters of prewritten melodies that play simultaneously and periodically repeat. Mapping was computed using simple linear mathematical operations.

3. Implementation

The system consists of camera located above the dance floor, projector and the central module which collects all data, extracts features and controls the sound synthesizer. The flowchart of algorithm is shown in Figure 1.

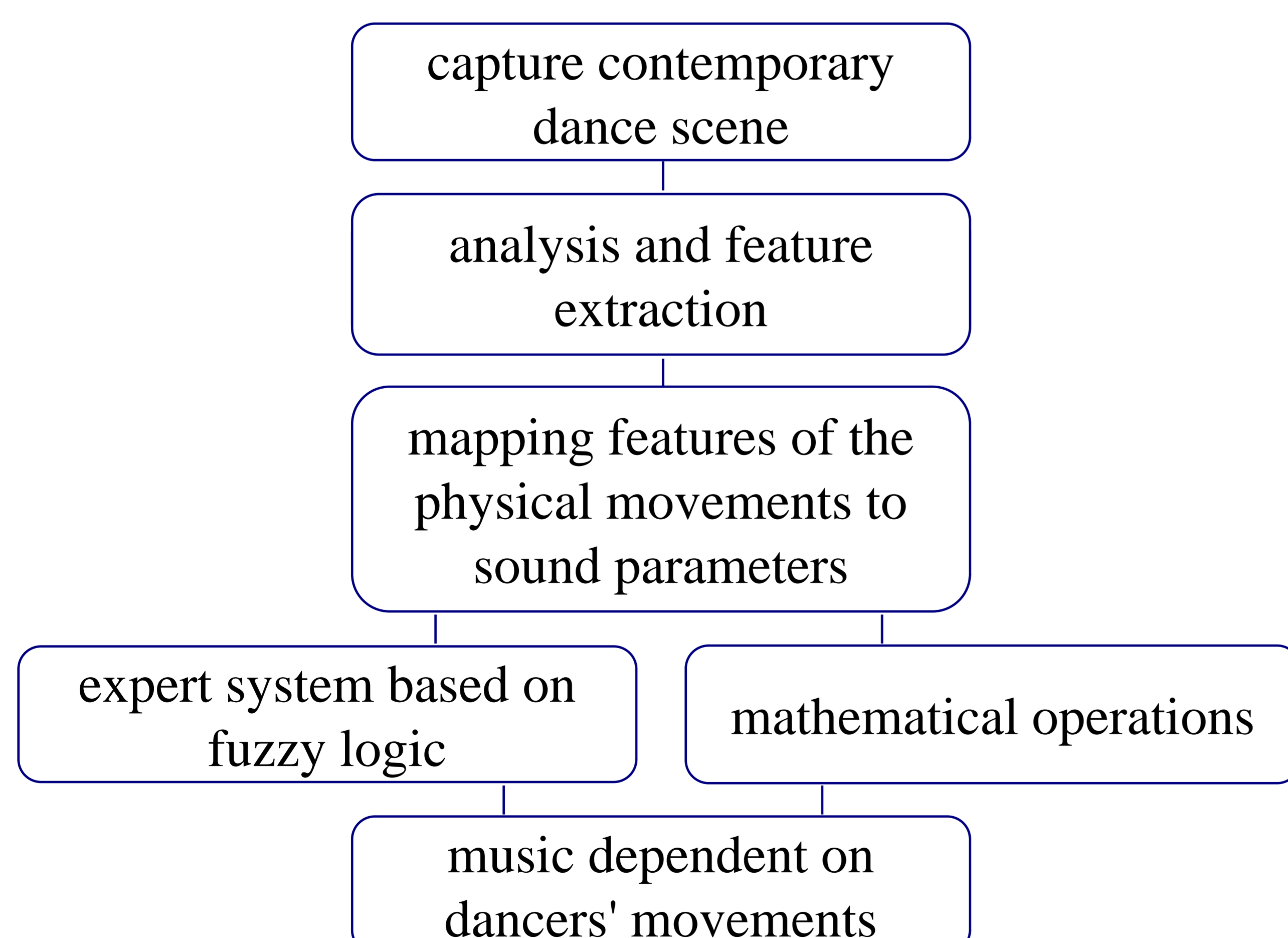


Figure 1. Mapping physical movements into sound parameters algorithm

For the purpose of this project were chosen fairly simple features which are robust and can be efficiently calculated. Those are coordinates of a dancer within the scene (x, y) and the amount of movement (a).

The calculation of the features was based on subtracting the current image of the background, applying the threshold, and analyzing the resulting blob. Threshold could have been changed during the execution of the algorithm and affect the result. Extracted features were mapped to the sound parameters using mathematical operations as follows:

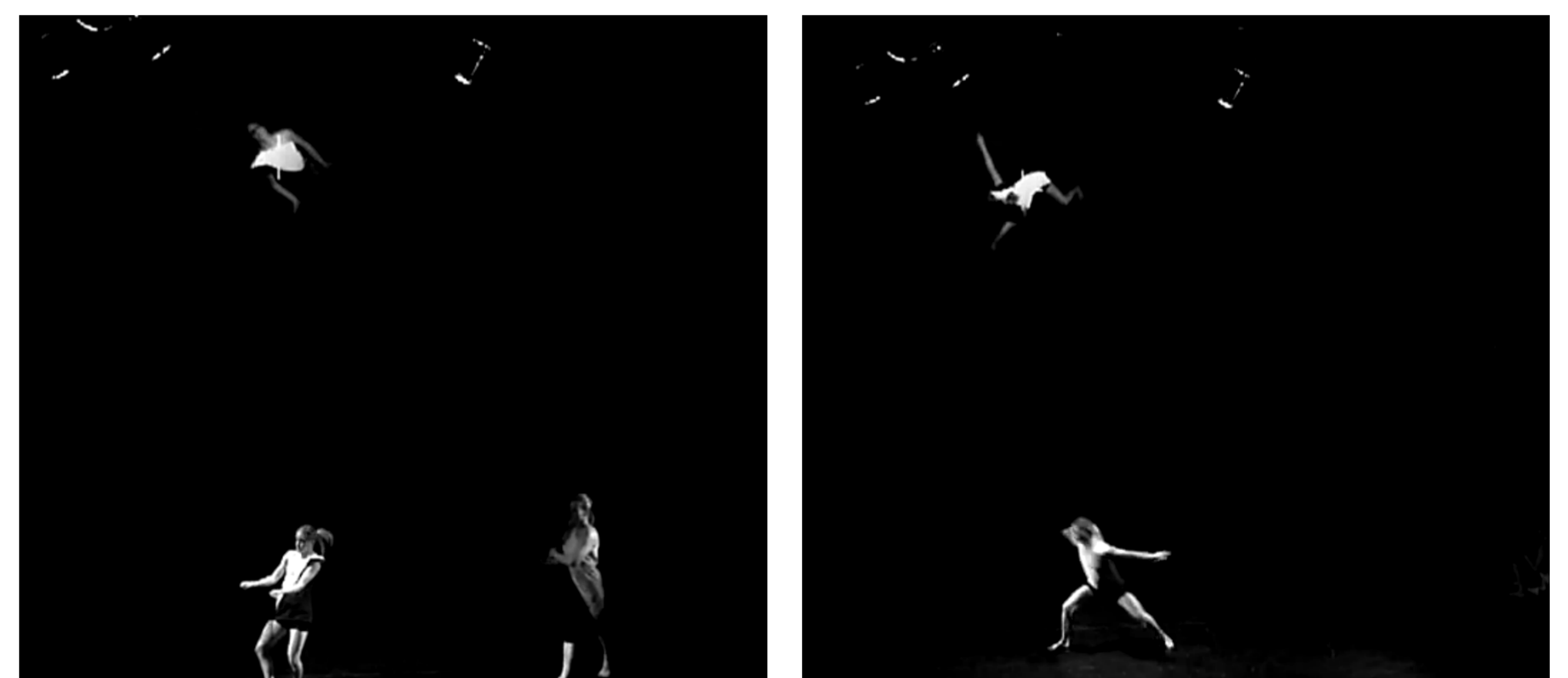
1. coordinates of a dancer (x, y) and the amount of movement (a) have affected the level of each melody,
2. coordinates of a dancer (x, y) have affected the frequency of each melody,
3. x -coordinate of a dancer has affected the panning effect.

The system was implemented using Pure Data, a visual programming environment which is freely available for different operating systems and which is popular among musicians and multimedia artists. For video analysis it was applied Graphics Environment for Multimedia (GEM) library.

4. Results

Implemented system was employed in the contemporary dance performance *Doors of Perception* which was performed at the 30th Contemporary Dance Week.

Dancer's movements captured by a camera located above the stage were used to control a vector synthesizer with dynamic cross-fading between four sound sources. Levels and frequencies of each sound source in the overall mix were calculated from the dancer's position within the scene. The dancer's position also affected the panning effect, whilst the amount of movement was employed to control the master volume.



5. Conclusion

Controlling a sound synthesizer by physical movements enables performers to extend the perceptual impression of their actions in the musical domain. Mappings based on fuzzy logic are convenient for establishing such control, since they can be described by intuitive rules and used for nonlinear mappings.