

# Methods for effective ancillary gesture sonification of clarinetists

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**Abstract.** Through advanced recording and simulation possibilities the amount of 3D movement data is constantly growing. This data type stems from different origins ranging from sports, HCI and music research (body movements and gestures). Although these data sources look at first glance very disparate, they are in fact structurally very similar since they represent dynamic processes in 3D space with many degrees of freedom. The standard technique to investigate alike data is the scientific 3D visualization of moving points or models. However, the rather young research field of sonification offers novel inspection techniques that complement visual analysis by transforming the data into audible sound so that particularly dynamic patterns can be understood by listening. This is beneficial for several reasons: Firstly, if properly used, sonification is ideal for representing multivariate data sets with temporally complex information such as fast transient motions. Secondly, in many applications the eyes are already occupied with a specific task and have therefore limited capacities to focus on additional information thereby limiting the cognitive load of the operator. Thirdly, sound requires neither a particular orientation of the user nor directed attention. In this paper we develop and test two sonification methods for 3D movement data. Specific sonifications for this purpose have already been developed to some extent by the authors [3] [7] and others [2] but there is still a lack of generality as far as methods are concerned. In contrast, we aim towards more generic methods for this data type and therefore we use in our sonification designs as little a priori knowledge as possible. Furthermore we conduct psychophysical experiments with these methods using concrete data samples together with meaningful visual stimuli in order to assess their efficiency. For that purpose we chose to sonify the ancillary gestures of clarinetists. Ancillary gestures are those body movements which are not directly involved in the sound production [1] [9]. For clarinet players, lip and finger motions are effective gestures, whereas motions like weight transfer and body curvature for instance are ancillary gestures. Their importance is due to the fact that they tend to align with musical motives in the score [9] and are therefore an integral part of the player's performance as these movement patterns show consistency even for various levels of expressiveness [8]. For instrumentalists, sonifications have potential benefits during instructions and practicing. Our primary goal in this paper

is the development of effective sonification methods as a complementary tool for the understanding of musicians' expressive movements. Sonifications in general often show a shortcoming in apt data preprocessing. This means in turn that the most salient sound parameters are often not addressed explicitly (e.g. via mapping) by the most relevant data features. We suggest as a data mining approach to generate more meaningful features for mapping of relevant acoustic features in sonification. In this paper we therefore introduce (i) a direct mapping sonification as benchmark, (ii) a PCA<sup>1</sup>-based motion sonification which decomposes the data into eigen movements of dominant variance. We further discuss experiments using (iii) SOM<sup>2</sup>-based motion sonification, which uses neuron coordinates as parameters for mapping sonifications. We then compare the utility of these novel sonification approaches at hand through psychophysical pilot studies with the before mentioned clarinetist data. The movement data of the clarinetist that we used were recorded with a VICON system using a standard plug-in-gait model. We decided to apply sonification to the posture information in terms of marker positions each with  $x$ ,  $y$  and  $z$  Cartesian coordinates and its derivatives. We aimed at the design of qualitatively similar sonification strategies in terms of the overall acoustic experience, which is a necessary prerequisite for the subsequent comparative pilot study. For the experiment we rendered several sequences of movements of three clarinetists playing Brahms' sonata for clarinet, op.120 nr 1. These sequences were selected along articulated musical phrases. For each sequence, the sonification together with the movie of an abstract stroke figure from two perspectives and without the instrument was presented to the participants. The abstract visual representation is necessary in order to avoid specific acoustic expectations, most important it excludes effective gestures of the performer such as finger movements. For all the three clarinetists the subjects are asked to rate, which sonification method matches best with the abstract visual representation of the performer. The paper will give full detail about the sonification techniques, present sound examples together with animated visualizations and report results of the conducted experiments.

**Keywords:** sonification, data mining, 3D movement data, ancillary gestures

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<sup>1</sup> Principal Component Analysis [4]

<sup>2</sup> Self-organizing map [5] [6]

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