

# Recognition of Hand Clapping Sounds - The Significance of Timbre in Steve Reich's *Clapping Music*

Godfried T. Toussaint

**Abstract**—Although hand clapping is a ubiquitous activity all over the world, and employed in a wide variety of activities, it remains an understudied topic in the field of pattern recognition. In both traditional and modern music, hand clapping is used predominantly as a percussion instrument. This paper describes preliminary results of an ongoing research project to determine how to measure the similarity of hand clapping sounds, from the perspective of timbre recognition, in the context of music composition in general. More specifically the implications of timbre similarity are explored by means of a new software tool - *Clapping Jukebox* - in a minimalist composition by Steve Reich titled *Clapping Music*.

**Keywords**—Hand clapping, similarity, Steve Reich, timbre.

## I. INTRODUCTION

THIS paper is concerned with one of the most common activities of human beings of all ages evident all over the world: the striking of the hands together to produce a sound — *hand clapping*. In both traditional and modern music, hand clapping is used predominantly as a percussion instrument, with primary focus on the rhythmic patterns played, rather than the properties of the sound of the clap. For example, Jones [4] provides a detailed analysis of a cornucopia of hand clapping rhythms used in the traditional music of Sub-Saharan Africa, and Colannino *et al.* [2] explore the emergent rhythms in Steve Reich's minimalist modern composition *Clapping Music*, from the point of view of syncopation variation.

In the earliest studies of hand clapping, Bruno Repp [10], and soon thereafter Tousman *et al.* [12], explored the perception of hand clapping sounds produced by different hand configurations that generated a variety of timbres. In perception experiments they found that listeners were able to accurately identify these hand configurations from the sounds. Jylhä & Erkut [5] and Jylhä *et al.* [6] proposed the use of Bayesian and Hidden Markov Models for person identification based on the timbre properties of their hand clapping sounds. Some work has also been done on electronically synthesizing realistic hand clapping sounds [1], [8].

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This paper describes an ongoing research project to determine how to measure the similarity of hand clapping sounds, from the perspective of timbre recognition in the context of music composition in general. More specifically the implications of timbre similarity are explored by means of a new software tool that has been developed: *Clapping Jukebox*. This tool has been used to interactively analyze, by means of listening experiments, a minimalist composition by Steve Reich titled *Clapping Music*.

## II. STEVE REICH'S CLAPPING MUSIC

*Clapping Music* consists of a rhythmic pattern played by two performers, each clapping the rhythm with their hands. One performer repeats the pattern unchangingly throughout, while the other shifts the pattern by one unit of time after a fixed number of repetitions. This shifting continues until the performers are once again playing in unison, signaling the end of the piece. The pattern and the process are illustrated using box notation in Fig. 1. Each box represents one unit of time. An empty box is a silent pulse, whereas a filled box denotes a clap. The top of the figure shows Reich's pattern, which is played continuously throughout the piece by one of the performers. At the start both players clap this pattern a predetermined fixed number of times. After the first rotation the second player starts the pattern one pulse ahead. Fig. 1 shows only the first three rotations of the pattern.

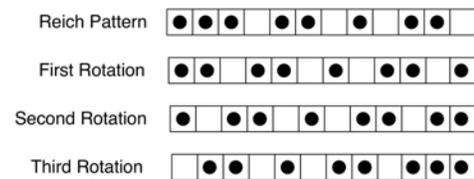


Fig. 1 Reich's pattern and its first three rotations.

On the published sheet music Reich [9] writes: "The choice of a particular clapping sound, *i.e.*, with cupped or flat hands, is left up to the performers. Whichever timbre is chosen, both performers should try and get the same one so that their two parts will blend to produce one overall resulting pattern." These instructions raise two questions: (1) is it possible for two performers to produce claps that have the exactly the same timbre? and (2) if they could, how would the resulting

piece sound? That it is difficult to produce hand claps with exactly the same timbre is suggested by Reich's phrase "should try." On the scientific side, McAdams & Bregman [7] have documented, by means of streaming examples, that the human auditory system is extremely sensitive to even minute variations in timbre. Streaming is the phenomenon of perceiving two separate rhythms as opposed to one. Thus, it may well be practically impossible for humans to perform a sequence of hand claps that have perceptibly the same timbre. However, for computers this is not a problem. Thus computers permit us to perform Steve Reich's piece by following his instructions precisely.

### III. RESULTS

A software tool called *Clapping Jukebox* was designed that plays Steve Reich's *Clapping Music*, and which allows the user to select not only the timbre of the claps utilized by each pair of hands, but also the rhythmic pattern and tempo at which it is played. Listening to *Clapping Music* with different settings of the parameters has led to several insights into the practical considerations of timbre for music making. For example, when the same timbre is used for all claps of both performers, perfect blending occurs and the "one overall resulting pattern" (the stated goal of Steve Reich) turns out to be musically totally uninteresting. For example, Fig. 2 shows the resultant pattern along with Reich's pattern and its first rotation. The resultant pattern consists of an isochronous sequence of identical claps, which is rather boring. The resultants obtained from the other rotations are not much better.

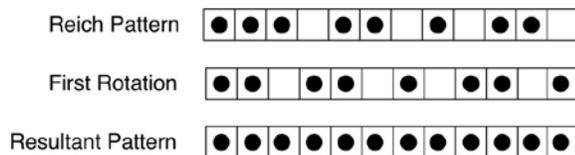


Fig. 2 The resultant pattern from the first rotation.

Furthermore if two claps that sound somewhat different are employed, the streaming becomes so pronounced that two different clapping patterns are heard simultaneously, also making the piece musically uninteresting. Therefore it appears that the best results are obtained when two performers try as best they can (but necessarily fail) to produce the same sound. One of the goals of this study is to determine an appropriate measure of timbre similarity, and to apply it to the determination of the optimal distance between the claps of the two performers that will yield a superlative experience for the listener. Another goal is to determine for the claps of one performer, how much variability in clap timbre is desirable.

With regards to the actual rhythmic patterns employed, several authors have discussed how Steve Reich came to select his particular pattern. Haack [3] proposes a series of combinatorial constraints that reduces all the 495 possible

patterns possible with eight claps and four silent pulses to just two. Several structural properties possessed by Reich's pattern are analyzed by Saltini [11]. What makes Reich's pattern so effective in the *phasing* process, and how the piece would sound with other patterns is another area for future investigation. The *Clapping Jukebox* also permits the exploration of discrete phasing along these lines.

### IV. CONCLUSION

The insights obtained from this project suggest new avenues for research in ethnomusicology. For example, many of the clapping patterns in the African music described by Jones [4] contain two or three patterns played by different performers creating an overall resultant pattern. It would be interesting to study not just the rhythm of the clapping patterns themselves (as has been done in the past, Toussaint [13]), but also the effects of timbre variations among the performers, as well as the degree of concomitant streaming evident in the resultant performances of such traditional music.

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