

ISE 599 Paper Review

Title: The kinematics of musical expression

Author: Neil P. McAngus Todd

Reviewer: Jie Liu

The author of this paper is Neil P. McAngus Todd, who is also the author of the paper I presented in the last week, *the dynamics of dynamics: A model of musical expression*. He did a lot of work on exploring the intimate relationship between musical motion and physical movement. In the first part of the paper, he extended the previous research to include accelerandi as well as ritardandi from complete performances. In the second part of the paper, he suggested that the origin of metrical space, on which the motion concept rests, lies in the way the auditory system processes rhythm.

He gave 3 goals for the paper: (1) to formulate the problem in a more precise mathematical form; (2) to extend the studies of Sundberg et al. to include accelerandi as well as ritardandi in performances of complete pieces; (3) to show that the metrical grid discussed above has its origin in the way the auditory system processes rhythm. The first two goals were achieved by showing a detailed mathematical model of tempo change, but I think the third goal was not successfully achieved, because the discussion in the paper lacked of sufficient examples and proof.

The tempo model in the paper is the same as the one in his previous paper, *the dynamics of dynamics*. However, the main goal of that paper was to derive a model for dynamics, so the tempo model is only a transition to the model of physical motion from the model of music dynamics. In this paper, the author elaborated on the regression method, and showed the final results, based on the performance data of Chopin pieces. From the results, we can see that the model is somewhat effective.

Although the idea of relating music motion to physical movement is plausible, I have to say it is still a limited tool for modeling musical expression. First, it is parameter-dependent; different kinds of pieces might need different parameters. For example, the parameters b_1 and b_2 in this model will change if another piece is studied. Moreover, I think if we are trying to model the musical expressions of the performances of other musical styles and other musicians, different physical motion models might be needed. That would require a large amount of work again. Second, as the author also mentioned in the paper, the relationship between musical motion and physical movement is also limited. There is an essential difference between the motion of an inanimate particle and the motion of musical expression. In physical motion, the motion is completely determinate, but in the music motion, the acceleration varies from segment to segment in a structured but non-determinate manner.

I had a hard time understanding his discussion in the second part, maybe because there were not enough data and examples in this part. However, I was still interested in his point that mathematically the sensory-motor process can be described by a dynamical system which has two weakly coupled mass-spring-damper systems. The first system represents the dynamics associated with an action such as foot tapping, which has a

shorter period. The second one represents the action of body sway, which has a longer period. I recall at this point Edward Large's paper which I presented in the class two years ago. In that paper, the coupling between two oscillators with different periods was also mentioned.

There are also some interesting points in this paper. For example, the author suggested that the music motion could be mapped to a 2D space. The horizontal axis represents the metrical distance space, and the vertical axis represents the pitch space. I think it is a good point since most of the current study only focuses on the horizontal space, but this point gives a broader view. Also, the author mentioned that the expression in music to be analogous to the problems of kinematics and trajectory planning in robotics or the theory of motor control. Since the robotic trajectory has to be smooth, we can see the corresponded problem of the tempo smoothness in musical expression.