Sonification of drawings by virtually reenacting biological movements

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This study aimed at creating evocative sounds associated with 2D geometrical shapes drawn by human movements. For that, we focused on the synthesis and control of friction sounds that are naturally related with gestures on rough 2D surfaces. We implemented physically-based models of friction sounds that are controlled by normal force and velocity profiles regarding the kinematic parameters. While real time control of these models is quite intuitive by using for instance graphic tablets, the sonification of drawings *a posteriori*, i.e. as it could be performed by human gestures, still remains an issue. Several studies have focused on visual perception of movements and showed that kinetics is perceived as uniform if a biological constraint, underlying a coupling between motor and visual processes, is satisfied [Viviani et al. 1992]. By contrast, auditory perception of friction-related human movements is much less known.

As a first approach to this topic, we studied the perception of sounds produced when a person is drawing to determine whether sounds alone could reveal the drawn shapes. For the experiment, several writers were told to draw 4 basic geometrical shapes (circle, ellipse, straight line and arches) on a sheet of paper placed on a graphic tablet that enabled recordings of the velocity as well as the pressure force profiles. Sounds recorded during the drawing process were used in an association test where 15 subjects were asked to univocally associate a sound to a shape. In addition to the recorded sounds, friction sounds generated by the synthesis models with the recorded velocity profiles were evaluated in the same way by the same subjects. Results revealed that subjects were able to associate sounds with the correct shapes with a high success rate from both recorded and synthesized sounds, highlighting the important role of the velocity profile in the auditory characterization of these shapes.

We then aimed at proposing a sonification strategy for human drawings using the friction models. Inspired by Viviani et al. work who exhibited a 2/3 power law relation between the angular velocity and the shape's curvature for visual perception, we investigated the influence of kinetics on the evocation of shapes by sounds using an interactive synthesis based protocol. In practice, we designed an experiment that aimed at determining whether a similar power law relation could be found for friction sounds. For that, a static curved shape was presented on a computer screen to the listeners who were asked to interactively adjust a synthetic friction sound with a slider (controlling the exponent of the power law) so that the sound evoked a gesture drawing the shape in a most realistic and uniform way. Preliminary results revealed that a power law might also be highlighted in the auditory modality, with the exponent value close to the 2/3 value determined in the visual case. Additional studies are currently conducted to confirm the obtained value and to investigate the influence of the visual presentation of the shape on this exponent.

To summarize, this series of experiments showed that 2D basic shapes can be correctly retrieved through sounds and that the velocity profile corresponding to the generating gesture is substantially responsible for the perception of such shapes. These results are important in the case of intuitive control of synthesis processes for friction sounds and sonification of drawings performed by biological movements. Actually, the estimated power law gives a natural way to associate kinetic profiles to curved, static shapes and consequently to generate sounds coherent with a human gesture. Examples of sonification based on these results will be given during the presentation. To proceed towards the creation of sound metaphors, a generalization of the concept of movement will be discussed and some illustrations based on sonification strategies applied on abstract sound textures will be presented. A direct application of this aspect will be done in the context of the "MetaSon" project in which one of the tasks is dedicated to sonification of handwriting to develop learning assistance software to provide an informative sound feedback to dysgraphic children.
Finally, note that friction models were implemented in a previously designed environmental sound synthesizer (including liquid, interacting solid and aerodynamic sounds) offering interactive and intuitive control. A demonstration of this synthesizer will also be available for presentation.

P. Viviani and N. Stucchi. Biological movements look uniform : Evidence of motor- perceptual interactions. Journal of Experimental Psychology : Human Perception and Performance, 18(3) :603–623, 1992.

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