Real-time Sonification in Swimming
- from pressure changes of displaced water to sound- .

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This very first testing of a set up to produce real-time sound of the displaced water mass due to self-propulsive actions like breaststroke is a promising step towards the aim of using auditory biofeedback in aquatic space activities as an essential complementary information towards Multisensory Motor Behavior.

INTRODUCTION

Effects of aquatic space activities are depending on the interaction of limbs and water mass set in motion. Commonly limbs' actions are considered as a matter of teaching not considering the impact of water motion so much. Plausibility may tell that hard pull/push actions create velocity changes of the swimmer. Since water gives way a push-off from water is not possible and a push off from a force like drag neither. Flow physics, however, emphasize the local Energy-Density-Change of a volume of water displaced by e.g. a hand in crawl-stroke, named intermediate effect.

The Energy-Density-Change per volume, a fluidal issue, is measured in Pascal, but although it is the same unit like pressure known from solid state physics, it is different but can be perceived by living organism. Aquatic vertebrates would not survive without flow sensing effects and skilled swimmers report also to sense the density-changes. But the communication about perception and reaction is not really possible due to e.g. improper terminology. Sonification of the invisible intermediate effects allows for another sensing channel not yet used in swimming evaluation and fits into multiple levels of information sources for auditory bio-feedback.

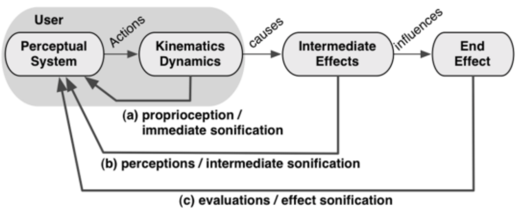

Figure 1 Multiple levels of sources for sonification.

The purpose is to present the state of art to provide functional sound of the displaced water mass on-line while swimming a) a longer distance and b) at different strokes.

METHOD

In fluid dynamics the intermediate effects are measured using three types of probes for three aspects of flow-pressure. With self-induced propulsion the unsteady flow effects are best quantified with a Piezo-probe [1]. It is a plastic tube whose flared end lay snugly between the fingers, there were 2 per hand one facing to the back side and the other to the palmar side. Each tube was connected to a sensor (MPX5010DP Freescale Semiconductor) located in a waterproof box (sampling rate of 1000 Hz). .The data were transferred via USB-cable to a laptop running SuperCollider program and here the pressure-differences (palmar-backside of each hand) were transformed into audible functional sounds, respectively. Three event-based parameter-mapping sonification schemes could be selected a) discrete – pitch – mapping, b) amplitude – mapping at constant pitch and c) C6-accord – mapping (more aesthetic).

The tests were executed by five swimmers different in gender, age and swimming skills, respectively, swimming 200 m using crawl-stroke and short distances using breaststroke (or artificial actions). The equipment was carried by a person walking at pool deck parallel to the self-propelling swimmer. Another person took video sequences for first discussion of the quality of real-time sonification.

RESULTS AND DISCUSSION

All swimmers told a) the tubes did not disturb stroking and b) the real-time quality was "unbeatable" according to the saying "each action in water gives immediate reaction". After the first approach of using functional sound to represent pressure-time recordings in two steps [2] now the real-time sonification of pressure changes is a major step towards the aims a) to enhance interrelated perceptions of effects of actions via sound (instead of prescribing a movement) and b) to discover unknown relevant patterns of the (flow)data. Since the link between kinematics of the hand and the resulting pressure changes or propulsion is not fully understood, a better communication between swimmers/experts about flow and the sensation of flow is needed.

It is too early to judge which mapping would please the swimmer when using the real-time sonification of displaced water in training situation as well as to report which mapping is functionally the most appropriate to the unsteady flow situation.

Our vision is to combine real-time sonification of pressure changes together with the audition of an effect variable like the intracyclic speed-variation or kinematic aspects of body motion while swimming in a pool.

REFERENCES

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