Real-time Sonification in Swimming

-from pressure changes of displaced water to sound-

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Introduction

Swimming is based on
- a cognitively controlled goal-oriented interaction
  - of self-induced body action and displaced water mass
    - under the condition of limited energy-reservoirs

Cognitive control demands
- an appropriate perception of the interaction
  - called “feel for water”

Coachesinfo (C McCabe, R Sander, Propulsion in Swimming), claims
•“… swimmers should be encouraged to feel pressure changes through the cells sensitive to pressure and kinesthetic proprioceptive system.”

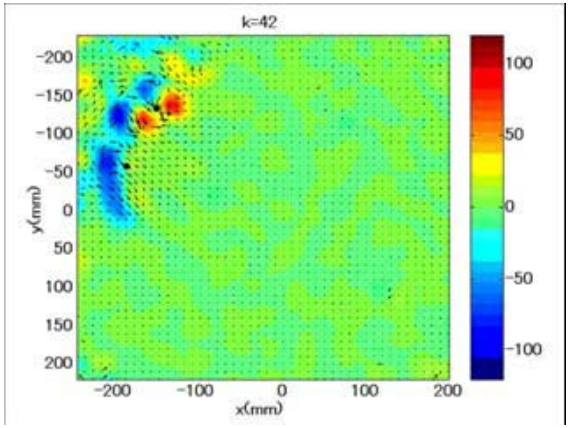
Introduction

In conjunction with
•the perception of the locomotion of the CoM (the end-effect of the interaction)
- swimmer becomes better
  - at controlling
    - their ability to feel the connection between action and reaction

From standpoint of flow physics
•one question is
- “How does hand action best displace water mass
  - to yield highest propulsive effects (at least energy-costs)?"

Introduction

Flow visualisation by PIV shows
how water mass is displaced by hand action



Flow visualization aids the experts to gain insight of the flow changes induced by interaction; so it is in human swimming (Matsuuchi et al, 2009) http://www.sciencedirect.com/science/article/pii/S0021929013002273

Introduction

Efficient interaction
• does NOT simply mean “pull and push on water mass”
  • even if this plausibility is copied in so many textbooks on swimming –

In fact
•efficient interaction is a matter of
  • induced pressure gradient combined with particular flow effects
    • resulting in momentum change of water mass

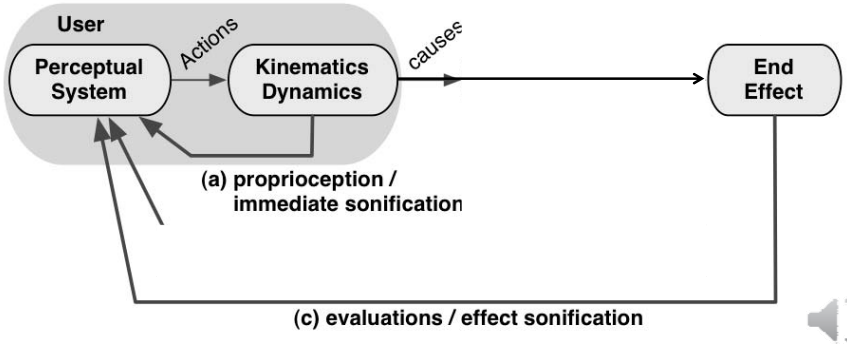
The purpose of this paper is to show

•the pressure gradient can be measured
and
•the signals can be transferred into sound

Sonification of *Intermediate Levels*

Hermann, T., Ungerechts, B., Toussaint, H. & Grote,M. (2012)

Multiple levels of information sources for auditory bio-feedback



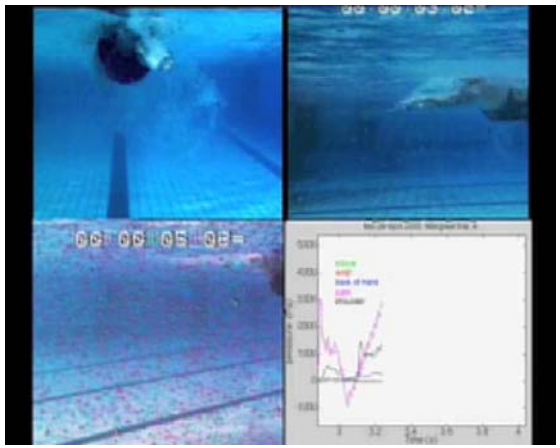
Introduction

Measuring flow pressure in swimming research has some tradition (Toussaint et al, 2000)

In 2012 Hermann, Ungerechts & Toussaint

started
the first attempt of sonification of

pressure data due to hand action in in crawl stroke swimming



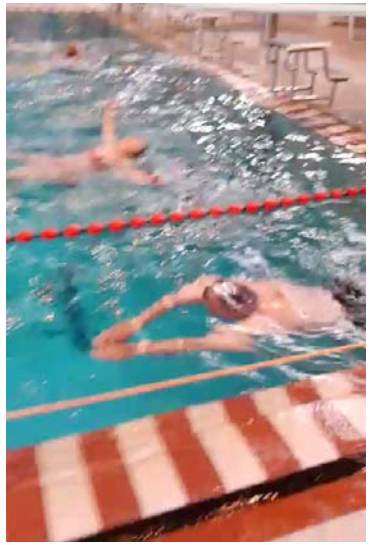
Hermann, T., Ungerechts, B., Toussaint, H. & Grote,M. (2012)

Introduction

The natural sound

of

Breaststroke swimming



Introduction

Sonification is a means
•to perceptualize undetectable data and complement existing sensory data
- by the use of “functional sound”
  - highlighting aspects of a data flow for the purpose of
    - facilitating communication or interpretation

Sonification is more than
•audition which means changes of a data set
- are mapped simply via change of the loudness of one tone

Audition
of hand positions
and foot position
relative to the swimmer‘s
trunk in breaststroke

A Effenberg, 2000

Real-time sonification

Was made possible by the COOPERATION of
Cesarini, Hermann, Ungerechts
•in 2013 at University of Bielefeld

Pressure changes at palmar and dorsal side of
the hand were detected via
•Piezo-probes (Ungerechts, 1980)

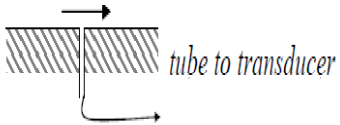
2 Piezo-probes , per hand,
•were connected to sensors, respectively
•located in a waterproof box

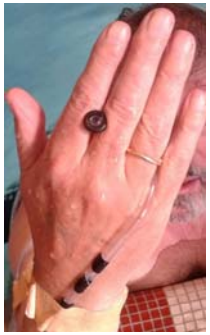
data were transferred to a Laptop
•processed via SuperCollider program :

the outcome was a functional sound of the flow
pressure-difference per hand in REAL - TIME

Real-time sonification

Piezo-probes
as Pressure Tap
to determine static pressure of a flow





-2 Piezo-Probes
per hand
one facing palmar
one facing dorsal

Real-time sonification

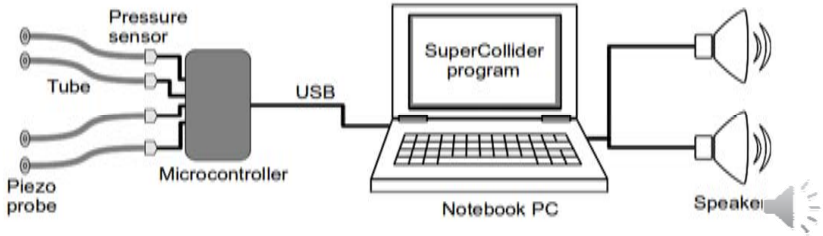
Very helpful tools

-a pole with

- a waterproof box

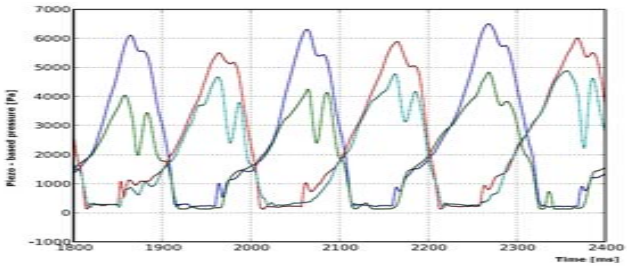
- laptop on hawker’s tray

the whole setting

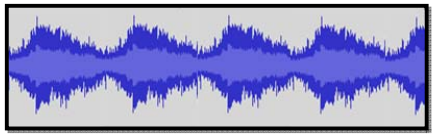


Real-time sonification

first: the pressure-time signals during crawl stroke swimming



next: the functional sound



Real-time sonification

Various mappings of functional sound are possible

Mapping is the term to describe the exact transformation of data into sound

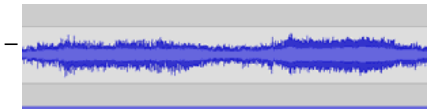
•Without going into details next two different mappings are presented

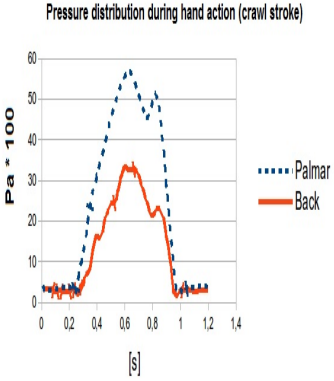
- amplitude – mapping at constant pitch –
  example crawl stroke

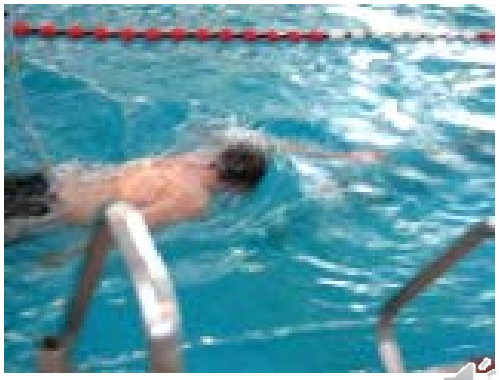
-C6-accord – mapping (more aesthetic) –
example breaststroke

Real-time sonification

amplitude – mapping at constant pitch –
example crawl stroke







Real-time sonification

-C6-accord – mapping (more aesthetic) -

Example

alternative

hand actions

left and right

action

are mapped

separately

Real-time sonification

-C6-accord – mapping (more aesthetic)

Example

symmetric

hand actions

left and right

action

are mapped

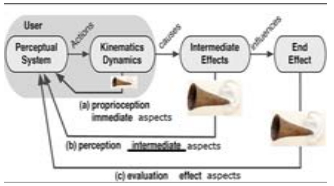
separately

Introduction

Real-time sonification

•is an appropriate means of feedback

- to support research of undetected signals
  - like pressure
  - as a hydrodynamic stimulus
- in a non-steady flow situation



Moreover

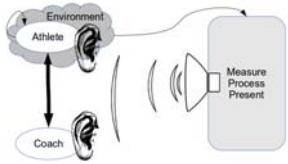
•real-time sonification of induced pressure changes

- becomes a new part of sensory channels supporting cognitive control
  - highlighting the effect of the interaction of two independent bodies

Last, but not …

•communication about the quality of
the swimmer's strokes is enhanced

Further studies will focus on: the use of waterproo
earphones, the structure of cognitive representatio
of stroke actions in long-term memory



swimmer perceives multiple info while the coach shares audible feed k

Thank you

very much

for your attention