Intelligibility in intelligent systems

Visualizing the Internal Processes of a Context-aware Sound System

by joch jansz

*When we're building **intelligent and context-aware** systems that operate autonomously with **less user involvement**, we need to make sure we still **understand** how these devices work.*
Devices do not only need to communicate affordance, but also behaviour.
*However, can we **visualise** how they work without demanding too much **attention**?*

Intelligibility

are my actions are registered? how much is registered? how is it interpreted? which actions follow?

Intelligibility is about creating explanations for system behaviour. What is the system doing? Why is it doing this?

calm technology

"that which informs but doesn't demand our focus or attention." - Mark Weiser & John Seely Brown

Calm technology is a type of information technology where the interaction between the technology and its user is designed to occur in the user's periphery rather than at the center of attention.

study set-up

The goal of the study was to measure whether a visualisation of user input and interpretation caused an increase in the intelligibility of the system.

The users used the sound system for over a week. Halfway, a visualisation was added, or omitted, depending on their starting setup. This was done randomly to avoid bias.

5 participants age 19-26

The participants were asked to deploy the sound sytem in their home environment.

1 week duration

*The study took 1 week, in which the participants either started with or without visualisation, to avoid bias.*

daily diary entries

for extra insights, the participants were asked to keep a diary, describing daily interactions.

questionnaire

A survey on the 4 levels of intellegibility was done to measure an increase in the intelligibility and understanding of the system
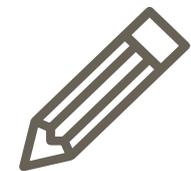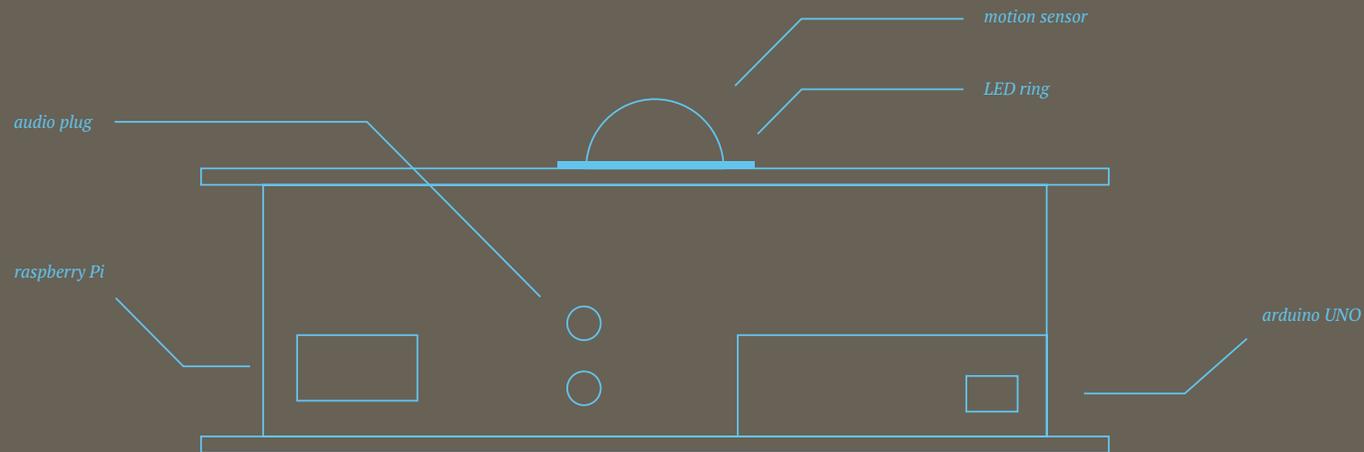
drawing of mental models

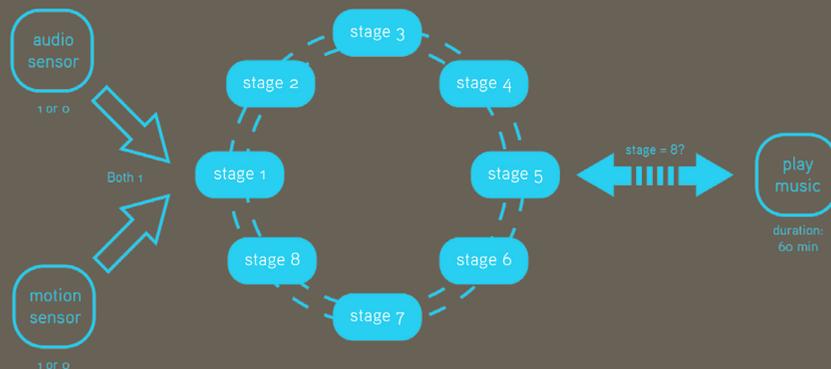*To measure if the participants understood the system, they were asked to draw a mental model using a flow chart.*

Research tool

Intelligent context-aware soundsystem

motion sensor

LED ring

audio plug

raspberry Pi

arduino UNO

Flow chart of the system model:

audio sensor

1 or 0

Both 1

motion sensor

1 or 0

stage 1
stage 2
stage 3
stage 4
stage 5
stage 6
stage 7
stage 8

stage = 8?
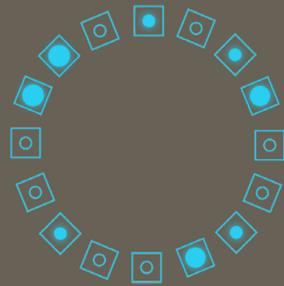
play music

duration: 60 min
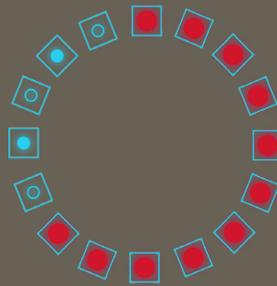
So how exactly did I measure intelligibility?

Since intelligibility is about *explaining behavior*, we can measure this by asking on what levels the visualisation clearly explains what it is doing. Based on the works of Belotti and Edwards (2001), I've devised four levels of explanation:
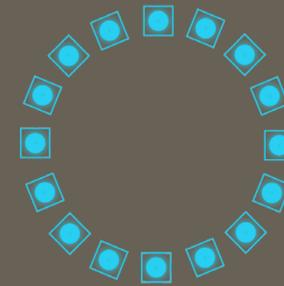
The visualisation

using a simple LED ring

step 1   step 2   step 3

Notice

Does the system perceive the input from the user and its actions? Or in this instance; does the device register the users' sound and movement? (step 1)

Capture

To what extent has the users' input been captured? Or in this instance; how much sound and movement has the device registered? (step 1 + 2)

Interpret

How is the users' input data used? Or in this instance; what happens with the input? And how much is needed for something to happen? (step 2)

Purpose

When will what actions follow? Or in this instance; when has the device registered enough and what will it do (start playing music)? (step 2 + 3)

Research question

"What are the effects of a **visualisation** of user input and interpretation in a intelligent context-aware system on its **intelligibility**?

results

These are the results of a 7 day user study, where the participants were exposed to a sound system with visualisation, and without.

"I did some random clapping and jumping throughout the day because I knew it influenced the light. "

"I gave the device more attention because the light functioned as a motivator for me. "

"Without visualisation it felt longer before the music would start. This made me look to the device much more often"

"With visualisation I could see what is happening but this was not focused."

average rating

5
4
3
2
1
0

Q1 Q2 Q3 Q4

with visualisation
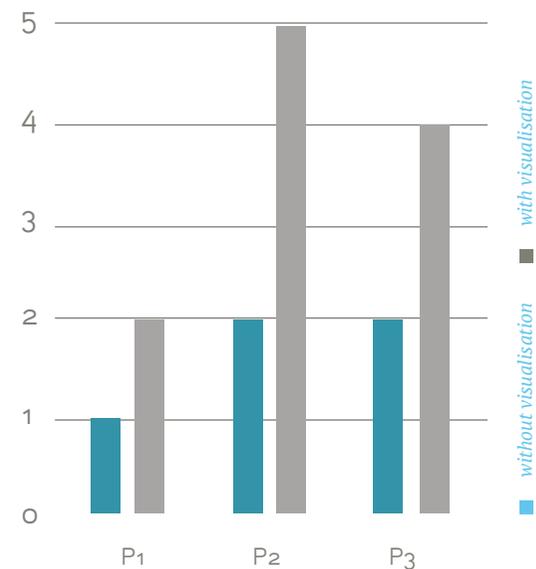without visualisation
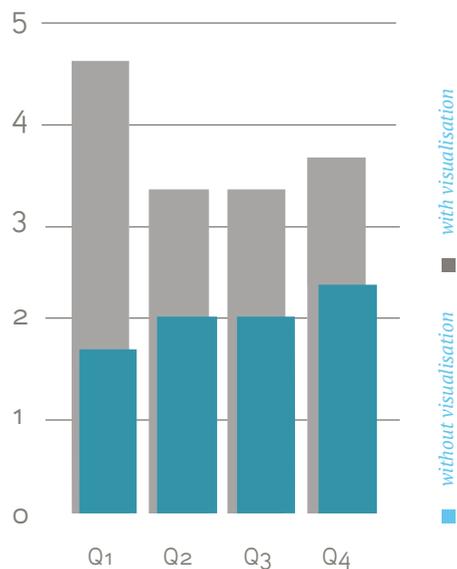
Q1: Did you understand whether the device noticed/registered your behavior?

Q2: Did you understand to what extend the device registered your behavior?

Q3: Did you understand how the device interpreted and used this data?

Q4: Did you understand which actions followed this interpretation?

rating per participant

5
4
3
2
1
0

P1 P2 P3

with visualisation
without visualisation

The participants were asked to draw their mental model of the sound system using a flow chart with and without visualisation.

Q: To what extend did the flow chart match the actual system?

insights – discussion

Since the study is not finished yet, here are some early conclusions and discussions.

1 With visualisation, all of the participants were able to create a more accurate mental model of the system.

2 On all 4 levels, the visualisation increased the devices' intellegibility.

3 While the visualisation asked for more attention, this was not always focused.

3 Without visualisation, there was more need to focus on the device to know when it was doing what, this actually increased the device's attention demand.

From these (early) results, it is clear that visualising explanations in intelligent and context-aware systems improves the intelligibility and understanding of the system.

However, it also adds to the amount of attention the device demands. While this is not often focused, it does contradict the theory of calm technology.

On the other hand, a lack of explanatory visualisation places the device more in the periphery, but also increases the amount of focused attention, since there is more confusion about the operation and behaviour of the device.

This means it is important to have clear explanations of why and what when dealing with such systems, but also to make sure they don't demand too much attention and can function as peripheral information supplier.