@scapa: A New Media Art Installation in the Context of Physical Computing and AHRI Design

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Abstract. In this paper **@scapa**, an installation developed in the context of Artistic Human-Robot Interaction design (AHRI design) is introduced. AHRI design is a methodological approach to realize cognitive science's research paradigm of situated or embodied cognition within cognitive musicology to investigate social interaction in artistic contexts [11], [12], [13] using structured observation [2], [6]. Here we focus on design aspects the course of development of **@scapa** using procedures of Physical Computing and the aspects to develop such a New Media Installation in the framework of AHRI design [5].

Keywords: situated cognition, cognitive science, research methodology, New Media Art, Physical Computing, artistic human-robot interaction design, structured observation.

1 Description

@scapa, an installation for robot, light and sound, is developed by Andreas Gernemann-Paulsen, Claudia Robles Angel and Lüder Schmidt.

The artistic idea is apparent behind the sonic conception as well as in the iterative, continuously approximating realization process of **@scapa**, which conforms to the notion of tinkering as known in the context of Physical Computing. In particular the artistic impulses for lighting and the robot's behavior resulted from this approach. The system behavior is controlled by the values of the IR distance sensors of Nibo 2 robot, which can move on a small 'stage' which consists of a circular table made by Tekno. The robot can exhibit four movement patterns labeled *rest*, *tremor*, *escape* and *panic*, depending on certain threshold values. The visitors can activate these different states by approaching the robot with the hands. This also changes in a continuous manner the sound as well as the color of the lights surrounding the table.

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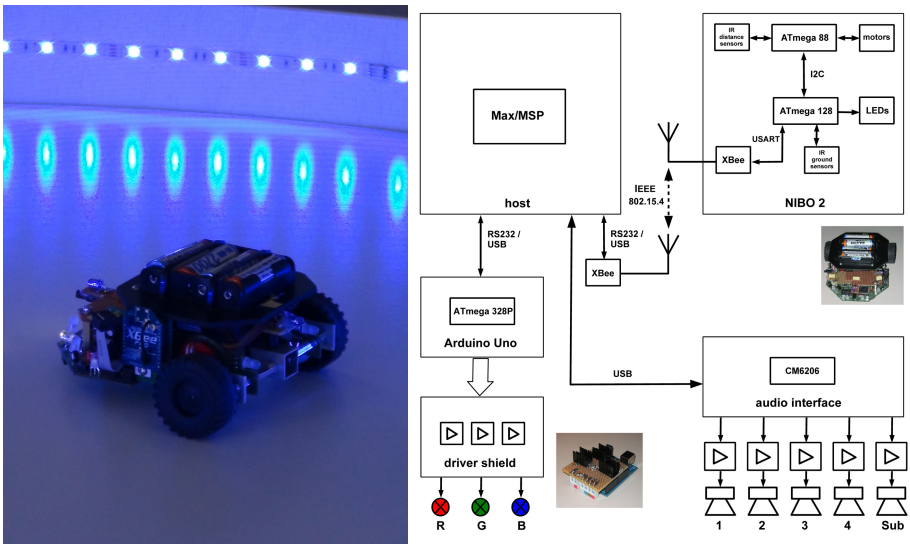

Fig. 1. The modified Nibo2 robot and the block diagram of **@scapa**

1.1 Sonic Aspects

With particular regard to the sonic aspect of this installation, the sound increases the body-awareness of listeners/visitors by using two adjustable sound files containing, on the one hand a heartbeat and, on the other hand, human breathing. The selection of these sounds is due to the fact that in everyday life, people tend not to listen to internal body sounds. Thus, the sound conception of the work allows for listeners/visitors to perceive these generally ignored internal sounds in an extremely audible and perceptible manner in situations such as changes in psychological and emotional affections due to external stimuli. In this way, the robot and its internal sounds, becomes a mirror of the human being.

The aforementioned sounds are assigned to the robot, which reacts according to an external human presence. Those sounds, which seem to be originated by the robot, are exteriorised in a quadrophonic and immersive sound environment inviting the visitors/participants to reflect about unconscious and rather imperceptible internal human reactions.

The artistic intention of **@scapa** is based on the idea of making visible and/or audible the invisible and/or inaudible, the aesthetical position of artist Claudia Robles Angel, one of the authors herewith, who, in her work, seeks to transform what is imperceptible into a perceptible sensation.

1.2 Technical Aspects: Nibo-2 Robot, MAX and Arduino Board

The artist's intention is supported by a built-in table lighting, which is realized by a custom-made border with about 150 RGB-LEDs integrated. Corresponding to the four

states of the robot, the lighting changes constantly and with a slight delay between blue (*rest*), purple (*tremors*) and red (*escape* and *panic*). The light is controlled from a Max patch via the serial interface and an Arduino Uno board with a suitable sketch (Arduino program) and a custom-made driver shield. The sound is realized in the Max patch too. The sensor data of the Nibo 2 are sent via a modified Xbee connection (Nicai NXB2) to a laptop and are further processed in Max. For a better performance the hardware regarding to the IR sensors have been modified: the sensors are placed on a separate board, one of them is now located on the rear side.

All mechanical and electronic components of the installation can be disassembled so that they can be transported in an estate car.

2 Physical Computing

2.1 Physical Computing in New Media Art

A core aspect of Physical Computing is the use of specific hardware and software [1], [4] [5]. In the context of New Media Art the practical aspects emphasize the easy handling and a tinkering approach. Particularly the Arduino project - originating from the artistic context and often used in interactive New Media Art - exemplifies this. Especially the artistic creative use of current low-cost chip technology, the relationship between software and hardware and the human interaction could be mentioned [7]. Precisely the projects from Physical Computing can be an approach to enable humans to express themselves physically and to provide artists with tools to capture and convey their ideas [8]. The realization of hardware and software in a simple, tinkering way and the low-cost design as a continuously approximating approach where sometimes a goal is not clearly defined emphasizes this point of view [1], [4]. Thus, by the use of microcontroller technology not only new artistic ideas can be realized (which could not without this technology) but this practical and iterative approach also results in new creative impulses.

2.2 Implication of Physical Computing in @scapa

The importance of Physical Computing's tinkering approach during the design of @scapa can be observed in the realization and development of the aesthetic and artistic ideas concerning lighting, sound, and robot behavior. The continuously approximating realization of the lighting, the robot's behavior and the modification of the hardware results in an iterative way of using typical parts like the Arduino board and procedures from Physical Computing. Concerning the light effects this process started from the initial idea to use a simple lamp and resulted in the extensive design and preparation of the border lighting of the installation, whose states correspond to the behavior of the robot. Moreover, concerning the robot's final behavior and environment one could observe a mutual dependency mediated by tinkering during the development of the installation of technical realization and artistic ideas. The robot's environment – a round table with light effects – and it's simple and

transparent behavior can be viewed as the artistic attempts to bypass the limited possibilities of movement by two wheels and also the robot's small size in order to facilitate the visitors' interactions with the robot by an attractive appearance creating a specific atmosphere to enhance aesthetic expectations. Additionally, the white cotton gloves invite the visitors to wear and to approach the robot with their prepared hands. The final realization of the aesthetic core idea to let the visitors experience and reflect on vital sounds - inspired by the two sound files - resulted from constant tinkering in connection with aesthetic explorations.

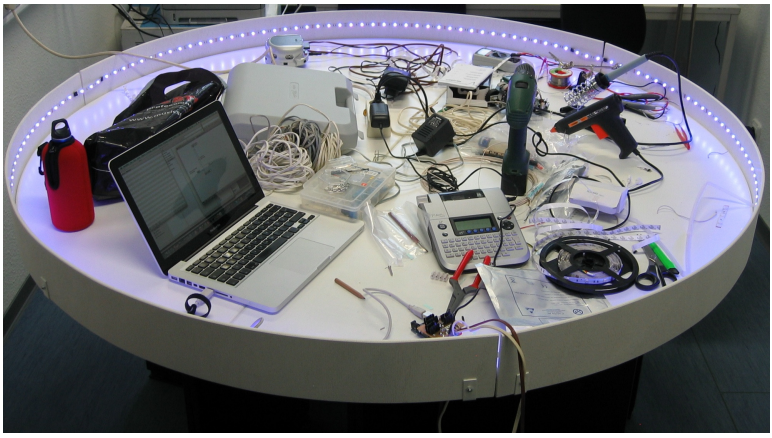

Fig. 2. Many electronic parts and tools referring to the tinkering process during the design of @scapa

3 AHRI Design

3.1 AHRI Design: Situated Cognition

Artistic Human-Robot Interaction design (AHRI design) is an attempt to develop an empirical research methodology which strives for combining computational cognitive modeling and traditional empirical research strategies to study the human mind from the perspective of situated or embodied cognition [11], [12], [13], [6], [3], [5]. One basic assumption of situated cognition is that in studying mental phenomena interactions of a cognitive system with its environment need to be taken into account [9], [10]. In particular, for human cognitive capacities such as language, music, and art social interaction and communication with conspecifics come into play. Therefore, AHRI design uses New Media Art installations "to test theories and collect empirical data in semi-artificial social environments" ([11], p. 67) to study social interaction. Such an approach has to deal with conceptual as well as empirical and practical problems from science, art, and technology at different levels. For example, computational models of interaction and cognition need to be developed and implemented in robotic systems and, then, integrated in an art installation. During

such installations empirical data relevant to the cognitive capacity under study and its related social interactions are gathered from interactions of humans with robotic systems by means of structured observation. Structured observation as a well-established method for data acquisition in psychology, sociology and ethology was chosen as a research method because methodologically it allows to investigate and to develop functional units of analysis for interaction by developing observational categories for further research. As an observational method it offers a more open and flexible way to investigate complex situations such as social interaction than measurements based on interval and ratio scales and yet allows using statistical methods for data analysis. These analyses are used to test or develop ideas concerning the investigated cognitive capacity's underlying processes and mechanisms.

3.2 AHRI Design and @scapa

This installation was developed in the context of the ideas for the research method artistic human-robot interaction design (AHRI design) at the Institute of Systematic Musicology at the University of Cologne. In more detail it is suitable to study social interaction in artistic contexts within the framework of cognitive musicology [11]. Particularly **@scapa** has a distinct artistic approach. This is apparent in the sonic conception mentioned above as well in an iterative „tinkering" way as a continuously approximating realization described in chapter 1.2 and 2.2.

This project provides new aspects in conjunction with the methods of cognitive science. Investigations and reflections on interactive processes should be mentioned in the near future, so the installation would be appropriated in terms of observational studies on interactive processes between humans and machines. In particular, the nature and the process of social interaction should be investigated in the framework of interactive installations of New Media Art.

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