Personalized Ambient Media Experience: *move.me* Case Study

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ABSTRACT
The *move.me* prototype illustrates a scenario for social interaction in which users can manipulate audio-visual sources presented on various screens through an interaction with a sensor-enhanced pillow. The technology developed for *move.me* uses the surface of a pillow as a tactile interface. We describe the underlying concepts of *move.me* and its motivations. We present a case study of the environment as the context of evaluating aspects of our approach and conclude with plans for future work.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces.

General terms: Ambient environment, ambient multimedia, interaction, social experience, user context, tactile interface.

Keywords: Guides, instructions, formatting

INTRODUCTION
The *move.me* project, a part of the European ITEA Passepartout project, explores the usage of ambient technologies in interactive digital television for home environments, as well as for public, urban, and social spaces, such as lounges at cafes, bars or cinemas. Key concepts explored by *move.me* include mobility, connectivity, invisibility, and intimacy. By applying context-aware technologies, we have developed a set of small interactive throw pillows containing intelligent touch-sensing surfaces, in order to explore new ways to model the environment, participants, artefacts, and their interactions, in the context of expressive non-verbal interaction within purpose-free social play.

In this paper we briefly describe the underlying technology of the pillows with a focus on the data collection for the context and user models. This paper reports on an evaluation workshop held in May 2006, where users tested the first pillow prototype with respect to its usability, and we investigated the feasibility of our research approach.

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PILLOW – MOTIVATION AND TECHNOLOGY
The overall scenario for *move.me* is situated in a café/lounge environment. Participants are invited to re-mix a set of moving images projected in large scale on the walls within the café through the physical interaction with small interactive throw pillows.

In the *move.me* project we investigate the representation of movement, where the interaction with the pillow creates movement on at least three levels: 1) the movement of the participant as they interact with the pillows (touching, caressing, throwing, hitting, holding); 2) the movement of the pillows themselves as a result of the participants interaction; and 3) the movement of re-mixed images derived and rematerialized as direct response from the public intervention in an environment aware of users and objects.

We root our work in general research on sensing and biofeedback in human-computer interaction [1, 5], which has indicated that a number of well established sensory methods, such as pressure and GSR, obtain a window into the state of an individual.

The affectionate quality of a pillow as a metaphor for intimacy is also used in other works, such as the interactive pillows by Ernevi [3, 2]. Both projects investigate interactive pillows as a means of enhancing long-distance communications. Though we share the notion of a sensual aesthetic of a pillow that encourages connection through feel in an associative and intuitive way, we do support a different vocabulary of expressiveness, based on motion.

Within *move.me*, we interpret users' touch effort, for establishing communication rather than precise communication acts. The work was based upon a somatic/choreographic approach to movement analysis and interpretation, described by Schiphorst et al [6]. It describes the use of qualitative kinesthetic models to represent movements.

Technology - hardware
In our approach we utilize raw data from smart fabric textiles, and apply a set of touch recognition heuristics to allow for a qualitative interpretation of the signal.

We provide several variations of pillows, each distinguished by the set of sensors and actuators they offer. The main sensor we apply is a touch-based interface for measuring pressure. The touch-pad itself is a simple grid (64 sensitive regions) of carbon impregnated open cell polyethylene foam, which we utilize to identify a point of contact or applied pressure. The processing unit is a small, lightweight, gumstix computer and a sensor board card. The sensor board can measure up to 64 pressure sensors and has 4 software calibratable GSR inputs. The gumstix filters the incoming data and communicates it at a rate of ~20 Hz to the server application, where complex interpretation of the data is performed. The communication between a pillow and the server is utilizing the OpenSound Control (OSC) protocol. Fans, vibrators and light sources, either in form of light emissive fibers or as a LED display, provide localized feedback. A typical pillow is shown in Figure 1.

Figure 1: Pillow with actuators touchpad, LED display and vibrator (photos by courtesy of Jan Sprij)

Technology - software

The pillow itself only provides a basic analysis of signals, e.g. calculating pressure, size of touch area, speed of touch and direction as input parameters, which are then transmitted to the *move.me* central system along with information, such as which other pillows or users are near to this pillow. The central system contains a number of modules:

- Communicator module enables the flexible connection of all components. It also contains interfaces to convert data generated by the application to several communication protocols and vice versa. The communicator, for example, handles the control of underlying video mixing software.

- Sensor evaluation module instantiates the device drivers for every detected pillow. The main task is to perform some statistical analysis (some high-pass filtering and mean value calculations) in order to keep the overhead of processing load low.

- Representation Module consists of data structures that describe the current context with respect to users, devices and the interactions between them.

- Adaptation engine uses data from the Representation module to establish a mapping between detected caress and movement effort. It determines appropriate adaptation method and provides instructions for the source to be adapted and means of adaptation to Communicator.

The data structure used by these modules consists of context model, user model, and device model.

Context Model describes the current status of the environment with respect to users, devices and the interactions among them. Users as well as devices become part of the Context Model once their RFID is detected. Interactions between a user and device or between devices are monitored in sessions. The context model also contains a user, device model and history model.

Context User Model (CUM) and *Context Device Model* (CDM) are permanent stores correspondingly for user and device characteristics. Both CUM and CDM are created for each user and device when registered in a particular context and reflects only those characteristics that are relevant for the current context. User characteristics are, e.g. the user identifier, relevant thresholds, current biometric status. Device characteristics are, e.g. device's sensor set, affecter setup, IP, dynamic values like activity state and location).

History Model is an individualized long-term memory of the interaction patterns for every user and device in a context. It stores the contextualized events for each agent. Note, that we also provide devices with a memory so that they themselves become proactive towards users.

The central system is developed in Python (ver. 2.4) and runs on Ubuntu Linux and on Apple OSX 10.4 in combination with Fink. Neural networks handling are developed under Max/Jitter. Communicator is implemented as a Java application. A more detailed description of the technology is provided in [4].

EXPERIMENTAL SETING

To establish a safe ground for the development of the pillow and the interaction with it, we ran a user study on the initial prototype as a first step in our user-centered design.

A qualitative elicitation study took the form of a one-day participatory workshop with 10 users. It aimed at exploring user needs (experiences, aesthetics of objects, etc.) and system requirements (e.g. stability, network connectivity, etc.). We utilized a pillow with a 6x6 touchpad and a LED display. The underlying system could recognize touch based on size and speed; apply a set of 6 adaptation methods.

The test users were representatives of the target user group, namely young urban people in the age group between 20 and 30. Our test group was composed by 3 females and 7 males, all art students from the Piet Zwart Institute in Rotterdam. They participated in two separate sessions conducted in a lounge environment that we created in one of the cubicle houses in which the institute is situated.

To gain an insight on interaction patterns, we covered:

- A *hands-on free exploration session* with a medium-fidelity pillow prototype (the hardware as well as adaptation software for different modalities worked in real time). The free exploration sessions permitted each participant to interact with the pillow for around 15 minutes

in whatever way they wished.

- A *first individual session* of roughly 15 minutes to fill in usability questionnaires. The questions applied comparative scales for evaluating the understandability of the icons used as visual feedback on the pillow and how intuitive and natural the gesture/actions pairs were. Moreover, we also applied semantic differential scales to explore the users' connotative meaning about the pillow/movement space based on [8]. A detailed description of the results is provided in [7].

- A *second individual session* of roughly 15 minutes in form of an interview. The intention of this interview was to gain insight in the users' experience with an attitude towards the pillow as further fundament towards a complete system. Additionally we aimed at investigating requirements and aspects to focus on during further development and the future evaluation steps. The rest of the paper reports on results gathered in this part of the study.

- Finally we ran with all the users at the same time a *"Wizard of Oz" 1.5 hours simulation* of the complete intended functionality of the system (the VJing was performed by a professional as the mixing ability of the system was at the time of the experiment too rudimentary). The participants' experiences with the pillow through the free exploration of the *move.me* system, and the discussion during the 'Wizard of Oz' sessions were both video taped for later analysis.

DISCUSSION – SECOND INDIVIDUAL INTERVIEW

After half an hour of exploration of the pillow and a quarter of an hour session, in which participants individually evaluated particular communication aspects of the pillow, a second individual interview session was launched, where the participants were asked to evaluate the general concept of *move.me*. A verbal question and answer interview style was employed. The topics and related questions were predefined. The participants had roughly four minutes for each topic to describe their ideas about achievements, failures and potential additional wishes regarding the pillow in particular and the overall system in general The topics covered in the interview were: purpose and functionality, interaction, networking/sensors, and actuator settings.

Purpose and functionality

One of the major findings of the workshop is that our initial approach towards invisibility and intimacy by providing the right aesthetics worked: all participants used the pillow as an object to rest, to support body parts, or to express affection through different caresses. All participants agreed that a pillow is a suitable way of collecting body data in a non-intrusive way. Functionality related to the typical use of the pillow was well accepted. However, a variety of additional functionalities resulted in distractions for the majority of participants (7). They would only accept additional functionality, such as the LED screen, which not only provided personalized information but could also be used as a remote control, an option liked by (8), with clear indications in different modalities according to the current usage context.

Expanding on these issues all participants emphasized that an environment as suggested by *move.me* should support practical tasks in the house and combine already automated devices in or around the house (e.g. central heating, sunscreen, light-sources, audio-visual equipment).

Interaction. All 10 participants found the pillow a very pleasant and intuitive object to interact with. However, they would normally not look at a pillow while using it. Thus, the LED screen for additional information caused concerns as it forced the users to change their natural behavior ('I cannot lie on the pillow if I have to look at it to receive messages'). 3 participants perceived the active use of the pillow as unnatural vs only holding it or lying on it. Suggestions were made to integrate the feedback from the pillow into presentations of actuators that serve in the context of activities currently performed. For example, information about the user's current excitement level can be overlaid on the visual material the user is consuming. Another option is to use a vibrator to provide information, which allows the user to lie on the pillow and still receive feedback.

While exploring the pillow two main problems were indicated. First, the pillow appeared rather hard (gumstix box) and containing sharp pins (circuit board connector). Second, the feedback given by the LED's was difficult to understand if at all. The adaptation of iconic messages on the LED display responded too slowly, causing in some users the impression that the icons were randomly generated.

Networking/sensors. All participants experimented with only one pillow. This provoked desire in the majority to have other active pillows so that they can communicate with other people via them. Four users considered implicit and explicit communication (e.g. the exact relation between pillows, pillows in different locations). In that context most (8) participants indicated a desire to experiment more with our various memory models, an aspect not evaluated during this workshop. The necessity for such models was clear if an adjustable level of detail in the result presentation is present. With respect to the sensor capability of the touchpad – three users suggested that the pillow should be able to monitor brainwave activity. In this way the pillow could assist, for example, in improving optimal sleep.

Actuator settings. For six participants the LED's on the pillow were too bright, which they found very distracting and uncomfortable. They suggested the brightness of the LED's to be adjustable (where they were equally happy with automatic, semi-automatic or manual adjustment).

Derived Social Indicators

During the interview the participants also provided feedback on social issues, e.g. trust, comfort, (dis)like, believe, willingness to invest time. The two most important social categories for all the participants were trust and comfort.

Trust was considered as a function of all the technical aspects that are mentioned above. Being confronted with novel technology, it is only natural for people to be suspicious and it takes time to establish a relation of trust. An-

other aspect of trust is the ability to receive feedback. If the system makes certain decisions the user must be able to understand the basis and purpose of this adaptation. Related to the aspect of feedback is the aspect of control. Depending on the level of control (e.g. adjusting actuator settings to users liking) the level of trust can decrease or increase. No control from the user was unanimously rejected as an option. The level of control by the system was not clearly identifiable by the users, as that would require long time testing. Yet, a certain level of control was accepted.

Comfort. All users expected a high level of comfort while working with the pillow. Problems, such as poking out pins or hard objects in a pillow, are serious as they decrease the level of comfort. Wide ranges of sensors are at our disposal, some of which users are already more or less familiar with. Six participants felt highly uncomfortable when biosensor data, like GSR, body temperature or heartbeat, was monitored while others (5) felt less comfortable when monitored by camera's or motion detectors. Ideally, users should be able to choose the sensors of their liking to be used by the system. That is why we provide a set of different pillows (e.g. users that do not like monitoring of biometric data can choose pillows with gesture recognition only).

A lack of trust and comfort leads to *dislike* and *disbelieve* in the system resulting in a non-willingness to invest time with it. In particular *belief* is important for the bound between the user and the pillow and to achieve the balance between effort made and the reward gained.

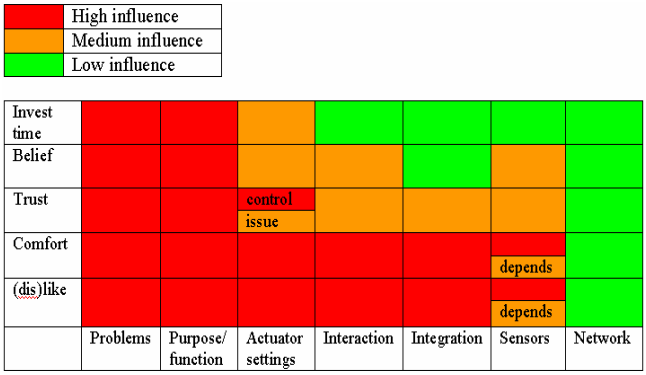

Figure 2: Hardware aspects - social indicators relation

Figure 2 describes the relationship between hardware aspects and social indicators we presented. It indicates the most important hardware aspects and social indicators as success factors. Further development of the pillow is focused on the 'high influence' aspects. We are aware that the pillow is still a limited prototype (even if the current system is stable) and also that the test sample is rather small. Our user-centered approach allows us to perform further studies in order to analyze and evaluate multiple aspects of the ambient environment and the system.

The findings from this experiment draw guidelines for further design and evaluation based on the relations in Figure 2 in to fine-tune the system before the public presentation during DEAF 2007.

CONCLUSIONS

In this paper we have described *move.me*, an experiment on personalized ambient media in the context of purpose-free social play. We described the current implementation and presented a first qualitative elicitation study applied on it.

The novel aspect of *move.me* is the approach to map movements to higher-level adaptation activities, which opens the mapping space between biometric data and its potential meaning. Though the first prototype shows promising results we have to provide significant improvements with respect to adaptation response time as well as the range of adaptations to facilitate an experience-rich environment that reflects the motions of the social interchange. We also have to fine-tune the relations between context, action and presentation modalities.

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