Dreamy Eyes: Exploring Dynamic Expression in Human-System Interaction

Abstract
This paper describes the Emotional-Perspective design, a graphical-user-interface platform built to explore expression mappings. The platform utilizes emotional and social skills by shifting from representational and discrete to expression rich, contextualized and continuous-sustained interaction paradigms. A remote robot-view, used to control an assistive robot, allows people to take on the perspective of the robot and thereby explore its action-possibilities in context. This view is extended with a dynamic graphical layer (filters and shape-changing mask). This layer is expressively mapped to the robot’s ‘feelings’ constituted by its internal conditions and direct interaction with its surrounding (environment and person). The Emotional-Perspective design will be evaluated to address the expressive mapping and the emergence of meaning in interaction.

Author Keywords
Interaction design; mapping; expressivity; phenomenology-inspired design

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): User Interfaces – theory and methods, input devices and strategies, interaction styles.
**General Terms**

**Design**

**Introduction**

Attempts to create a robot capable of showing social behavior and interacting with human beings by expressing internal states have been very popular in the recent history of robotics. Research in this sector has rapidly expanded to the design of social robots inspired by the way human relationships and communication are carried out. We explore the hypothesis that when robot’s behavior conforms to human social expectations; interactions are more likely to be found enjoyable, intriguing and meaningful by people.

Different approaches have been tried out to provide robots with emotional, physical-perceptive and behavioral expressions. Artificial emotions in robots are used to increase the ‘credibility’ of interaction [2], to provide the user with feedback on the robot’s internal state and intentions, to act as a control mechanism when activating a specific type of behavior, or to understand how certain environmental factors influence the robot’s behavior.

The work in this paper is carried out in the context of the Accompany project, a European project funded under FP7-ICT-2011-7. The ACCOMPANY system provides support to elderly people in independent living and consists of a robot companion (called Care-O-Bot) in an intelligent environment that informs the robot in its mainly fetch and carry functionalities to come forth to physical and social decay. Our work focuses on the interaction between robot and person to be meaningful, empathic and engaging.

Our approach to designing intelligent products and systems is inspired by phenomenology in order to respect the uniqueness of our life-world’s perceptions, centralizing the experience and its incorporation of context. Phenomenology and in particular Merleau-Ponty’s phenomenology of perception [4] brings forth that meaning emerges in interaction, meaning constituted in a reciprocal interplay between person and environment; interplay of action between one’s body and in our case products and systems. We design for interaction, requiring to paying attention to both the capabilities of the system and the human capabilities. Thereby implying that products and systems should allow for continuous interaction.

From our philosophical stance we target to address human capabilities (perceptual-motor, emotional, cognitive and social skills) in a balanced and respectful manner [5]. Though, the research presented in this paper focuses preliminary on our emotional and social skills; skills dominantly concerned with our feelings and abilities to synergize.

Wensveen [9] explored how skills can influence each other and in particular how emotional skills could be addressed via our perceptual-motor. His Interaction Frogger framework allows analyses of interaction and synthesizes [7] of interactions to be of experienced as ‘natural’, exploiting a direct mapping which closely maps input to output continuously on expressive character.

The ‘Squeeze Me’ and ‘Call Me’ design cases [8] explore the capitalization of skills on a functional level as part of the Accompany project. In these two design cases, the phenomenological notion of intersubjectivity
pushing the phenomenological stance beyond an individual experience of the world was explored between person and robot mainly on expressive perceptual-motor, emotional and social skill levels. By either squeezing or calling, the person gets attention from the Care-O-Bot. The expressivity of this input results in an expressive coherent output: the dynamics of movement of the robot towards the person. The Interaction Frogger Framework was used to design for interaction as off the physical nature of interaction. Here a, earlier mentioned, direct mapping between input and output of continuous and expressive character was explored and applied.

The work presented in this paper approaches an engaging relation between people and robot via a shared perspective or embodiment of context through capitalizing expressive qualities thus preliminary addressing emotional and social skills. We aim for an engagement in interaction through participation and seek for mapping principles extending the direct mapping paradigm by exploring expression mapping paradigms that bypass a strictly palpable interaction and focus more on the dynamic and active reciprocal participation in context.

**Design Case**

The main purpose of the graphical-user-interface, in which we explore expression mapping, is for the person to access functions to be performed by the Care-O-Bot when they do not share the same location. A tablet is used to control the Care-O-Bot and further allows the person to see what the robot is looking at and thereby give insights in what the robot can do. The interface displays action-possibility-labels that in short show what the Care-O-Bot can do in the current given context from the perspective of the robot itself. This means that when the robot looks at for example a dirty coffee cup; that through the view of the robot the coffee cup is augmented with the action-possibilities ‘clean the cup’ or in case it has just been used with ‘refill the cup’. These action-possibilities are highly context-dependant, directed by what the robot can actually do functionally as well by the desires of the person provided by a self-learning grid of behavioral analysis. In this paper we will not go further into depth on this matter, though it does notify a more functional account of seeing through the eyes of the Care-O-Bot with the robot-view.

**Emotional-Perspective**

On top of what the robot can do, we design a graphical-user-interface layer, the Emotional-Perspective, which shows how the Care-O-Bot is feeling. We enrich the robot-view by a layer representing the feelings of the Care-O-Bot. This is not achieved through merely presenting numbers or icons representing the states or conditions the robot is in. We explore the mapping of the ‘feelings’ of the robot to the timbre of the view (i.e., the expressive qualities of the looking-through-eyes) in order to share the states and conditions with the person on an emotional not cognitive level.

Our objective here is not to validate effectiveness or usability of the proposed interaction mappings that address emotional skills per se. Our platform aims to iteratively explore expression-mapping designs and the reciprocal emergence of meaning in interaction concerning feelings in a shared context.

We design two constructs for expressive intentionality representation, the first one concerns internal feelings...
of the Care-O-Bot while the second one concerns the reciprocal interplay with the direct surrounding (i.e., environment as well as person’s input) directing feelings. Even though the two are conceptually interrelated, for clarity sake we split the two types of parameters that constitute the dynamic behavior of the expressive Emotional-Perspective.

Parameters taken as the internal feeling of the Care-O-Bot are for example how full the battery is charged or the heat of the internal processor. These values are commonly communicated via numbers or iconic representations. Parameters taken as feelings of the Care-O-Bot that are constituted through a reciprocal interplay with the environment or person are for example the temperature and light intensity in the space as the robot’s perceptions might be hindered (either by how the Care-O-Bot perceives directly by its own sensors or provided by external environmental sensors). Feelings directly induced by the person in interaction are for example the expressive way the interface is handled (subtle, polite, or aggressive), the ratio in which the person ignores the Care-O-Bot throughout the day or the amount of energy a task approached via the interface demands (once the task is being executed these will most likely be covered by the earlier mentioned internal feelings).

Whereas the surrounding or internal feelings are mainly driven by the robot’s perceptive qualities and action-possibilities, the person driven feelings are designed intended to explore how the person and Care-O-Bot can resonate on a social level. This is inspired by simulation theory [3] that proposes that through simulating the other’s emotion in ourselves we can intuitively understand what that experience might be like.

As mentioned before the person can look through the eyes of the Care-O-Bot as the interface shows the contextual action-possibilities on top of a life view from the camera on the robot. The feelings are not represented by values or icons on top of the view but via two dynamic layers within the robot-view; graphical filters and continuous shape-changing eyesight (mask). The graphical filters are for example continuous-scaled blur, saturation, opacity and gamma. The mask is the view’s shape and size; it is like a goggle view with an adjustable shape. Several dynamic lines, being the border of visible to non-visible, as shown in figure 2, define the shape-changing eyesight. They are separate eyelid-parts that together can constitute several expressive tensions such as angry, explorative, or surprised-ness. Our platform allows exploring dynamic expressions shown in the robot-view in relation to Ekman’s basic expressions [1] and nuances found in the human face.

In our design the feelings of the Care-O-Bot control separate elements in the graphical-user-interface, slightly contradicting our holistic stance rooted in the phenomenology of perception. Though these separate elements are highly intertwined in the holistic representation. In other words, in case one parameter controls the upper eyelid, another the lower, another the gamma and yet another the blur filter; together they provide a holistic expression of feelings.

**Mapping designs**

We here give three mapping designs exemplary for the opportunities the Emotional-Perspective platform opens-up. They should not be read as final, but are initial mapping designs informed by designer-sense and will most likely call for iterations. Nonetheless they here
illustrate the expressive intentionality representations concerning the internal feelings of the Care-O-Bot and feelings deducted from reciprocal interplay with the direct surrounding.

**Sleepiness**
The fullness of the battery of the Care-O-Bot is mapped to the opacity of a black layer within the view of what the person can see through the eyes of the robot (fig. 3). Metaphorically, the lights go out. When the robot is full of power, in other words energetic, the person can see through the eyes of the robot clearly. In case the robot (not the tablet with graphical-user-interface per se) is out of energy, it is not possible for the person to see through the eyes of the robot nor is able to access functionalities. The mapping is of exponential nature to prevent a constant diminishing opacity.

**Annoyed by Sound**
The surrounding noise impacts the robot-view through a mapping with the adjustable shape. Normal surrounding noise does not interfere with the shape of the eyes, but when the sound-scape becomes annoying the shape of eyes will retract as if the eyes get smaller. Metaphorically, the Care-O-Bot closes its senses to the overload of information (fig. 4).

**Give me attention**
The Care-O-Bot is able to see the position and direction of the person in relation to its own. The Emotional-Perspective's has the ignoring scale mapped to the contrast filter; no directed attention has a decreased contrast while more active engagement enables the person to see through the eyes of the Care-O-Bot with more contrast.

**Work in Progress**
A setup comparing the elaborated dynamic interaction design and a static variant of the Emotional-Perspective will be used for evaluation as part of our iterative design process. We will use the Interpretative Phenomenological Analysis [6], a methodology that help to elicit personal meaning in context through in-depth interviews on key concepts like the meaning of experience and first-person perspective, the role of context in shaping the experience and reflective practice on lived accounts.

Evaluation sessions will be conducted using interaction scenarios where the robot is controlled through the robot-view. The scenario will be acted out in two conditions: a plain version with no expressivity of the mask and the dynamic expressive Emotional-Perspective. In this way we aim to assess whether the expressive qualities in the Emotional-Perspective subject to dynamic changes in a reciprocal interaction with person and environment engage the person in interaction with the Care-O-Bot.

The design of the Emotional-Perspective is setup as a platform for exploration. This allows us to modularly tweak and adapt the interaction mapping focused on its expressive qualities between certain ‘feelings’ and the graphical layers in the graphical-user-interface. We will iteratively explore our stacked expression mapping designs in order to gain insight in the expressive structures that can be hidden in the functional values (such as the processor heat of the Care-O-Bot) and further explore how our intended meaning emerges in interaction, if at all.

*Figure 4: Level of annoying sound in environment mapped to ‘closeness’ of robot-view.*
We are aware that holistically provided visual expressions of the Emotional-Perspective are derived from iconic representations and therefore bypass the subjectiveness of the person. Mappings are arbitrary though inspired by cultural and bodily phenomena. The expression mappings here, contrary to applying the direct palpable interaction paradigms such as Interaction Frogger informed by kinesthetic or Gibsonian affordance, are more depending on previous experience. As meaning emerges in interaction capitalizing pre-informed emotional values, interpretation might not be as intended though rich. Evaluation shall focus on the qualitative subjective experience aspects in interaction, not those of efficiency as we aim to engage the person with the robot in interaction.

The earlier mentioned evaluations concern the reciprocal 'feeling' relation between person and robot through the graphical-user-interface, focusing on the emergence of meaning in relation to the designed expression mapping paradigms. We further explore, from a holistic point of view, the meanings that emerge through the convergence of the 'feeling's and the more functional context dependant action-possibilities. In other words, how will for example the running down of the battery embodied through a coherent gradient filter influence the usage of functionalities and provide novel scenarios.

With our work we hope to inspire user-interface designers to utilize emotional and social skills by shifting from purely functional, hierarchical, and representational to expressive rich, contextualized and continuous-sustained paradigms for interaction.

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**References**


