Designerly ways of exploring Human-Agent Interactions at the Expressive Intelligence Lab

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ABSTRACT

As more intelligent products, systems and services are entering our everyday lives, there is an urgent need to understand how intelligence can be expressed and interacted with. We present two design cases to illustrate how we have applied Research-through-Design (RtD) to better understand how to make intelligence expressive through a product's embodiment and how this impacts interaction as being physically and socially embedded. We then articulate these insights more broadly as design-related research questions for Human-Agent Interaction (HAI) and discuss how we intend to explore them at our newly established, Expressive Intelligence Lab.

CCS CONCEPTS

• Human-centered computing → Interaction paradigms; HCI theory, concepts and models; Empirical studies in HCI; Interaction design;

KEYWORDS

Research-through-Design, human-agent interaction, human-robot Interaction, speculative design, data-enabled design, interaction design.

INTRODUCTION

Intelligence is becoming ever more prevalent in the artefacts around us—in anything from domestic robots to refrigerators and clothing, to name but a few. We will refer to such artefacts as Embodied Intelligent Agents (EIAs). Intelligent because they are able to sense, reason, act, and communicate with other agents, both human and nonhuman [5,19]. Embodied because they have a physical manifestation, i.e., their intelligence is integrated in materials and artefacts, and thereby they can function in the same environments in which people live [2,3].

As an emerging product category, EIAs appeal to design-related research questions about making the intelligence of EIAs visible, negotiable, and meaningful. These questions are similar for robots and smart objects alike and are being discussed in the fields of Human-Robot Interaction (HRI) and Human-Agent Interaction (HAI): How do people understand the intelligence of EIAs and their ability to sense their environment and make informed decisions? To what extent can and should EIAs have intentions that they autonomously act upon, and how will people respond to them? What kinds of roles could and should EIAs fulfill in the social environments that they are embedded in, and for what purposes can they be appropriate?

In this paper, we discuss two design cases, which helped us to better understand how to make EIAs expressive through their embodiment and how this can influence interactions with them. These cases, Fizzy the robotic ball and Mr.V the Spaceman, were developed in close collaboration with the Princess Máxima Center, a medical center for pediatric oncology. Both designs aimed to foster the development of children with cancer through EIAs. They serve as grounded examples for understanding how RtD—as a designerly way of doing research in sensitive and complex social settings—can lead to both practical and methodological insights on HAI. Building on these two cases, we then discuss three design-related research questions for HAI and how we intend to explore these in light of our future work in the Expressive Intelligence Lab at Delft University of Technology.

TWO DESIGN CASES

Fizzy the robotic ball

Fizzy is a robotic ball designed to stimulate young children's physical activity in hospital settings, in particular in the form of spontaneous and unstructured play (Figure 1: Left). Fizzy achieves this through its embodiment as a ball in combination with its behavioral repertoire: it rolls away when it is approached, shakes wildly when it is picked up, purrs when it is caressed, and wiggles when it hasn't received any attention for a while.

Figure 1: Fizzy the robotic ball (left) and Mr.V the Spaceman (right).

Central to the fieldwork with Fizzy was building a prototype that appeared like a normal everyday ball, which could be remote-controlled. This enabled us to "puppeteer" Fizzy's behavior. A key insight was that an EIA can play multiple roles during play activities. Fizzy was interacted with as a "thing", "tool" and "creature" in children's play, and these roles and framings continuously shifted [16]. These shifting roles were also key in stimulating children's physical activity and play [1].

Mr.V the Spaceman

Mr.V the Spaceman is an interactive dispenser designed for families dealing with childhood cancer to encourage them to engage in quality time during stressful times at home (Figure 1: Right). Mr.V appears as something between a space-man character and a gumball dispensing machine, dispensing balls that contain suggestions for family activities, written on paper notes produced by the families themselves. Throughout the day, Mr.V drops these balls at random moments, creating an element of surprise. A key aim in the research was how to make Mr.V "tactful" as an EIA and this required careful detailing of its physical embodiment and temporal form [15].

By allowing families to experience Mr.V in their homes for about a week, we learned that the experienced tactfulness of Mr.V depended on how it was appropriate for the home environment, how it could mediate social interaction for the family as a whole, and on the extent it could be appropriated in families' everyday routines. Furthermore, the use-data collected by Mr.V's embedded sensors, in combination with how families experienced Mr.V, served as an intermediate step to envision how Mr.V could use its intelligence to be tactful. Key insights were that Mr.V should be responsive to the needs of individual family members and adapt its behavior to suit the circumstances.

DISCUSSION

The development processes of Fizzy and Mr.V and the insights they yielded were presented in detail elsewhere (see [1] and [15,16], respectively). In this short paper, we will briefly describe three design-related questions they additionally opened up in the context of HAI, and how we will explore these questions further at our newly established Expressive Intelligence Lab.

How to sketch and prototype intelligent behavior?

Our research with Fizzy and Mr.V demonstrate distinct designerly ways of exploring intelligent behavior in EIAs, each bringing along different challenges and opportunities. Puppeteering with Fizzy allowed for playing out its character in order to elicit desirable interactions, and the researcher could improvise with different kinds of behaviors in response to the situation at hand. However, the freedom that this approach offered the researcher in automating the EIAs' behaviors also poses some challenges. Mr.V on the other hand, was a data-enabled prototype, using a variety of sensors. This did not allow for improvisational flexibility but instead enabled a process of scaffolding Mr.V's behavior towards more advanced prototypes, being inspired by, and based on, data.

These examples show how sketching and prototyping intelligent behavior is a process of balancing between eliciting meaningful interactions and considering technical feasibility. Sketching and prototyping EIAs' behavior will generate new and necessary insights into what these can *mean in real life contexts and situations*. However, care should be given that the sketched behavior remains true to the intelligence that may actually be realized, now or in the near future. In our lab, we will explore ways to systematically sketch and prototype EIAs. For example, how to document spontaneous decisions by the

puppeteer in order to inform later design decisions? And what techniques can we use to deliberately limit the sensing and acting capacity of the puppeteer in order to stay true to what's technologically possible (e.g. following [7])?

How to explore expressive potential?

Another aspect that stands out in the two design cases, is the aesthetic sensitivity and skill with which the prototypes had been crafted. Both Fizzy and Mr.V were carefully designed to embody a particular "character" by integrating aspects of their appearance, materiality, behavior, and interactivity, in ways that could harmonize their identity as a product and as an agent. Exploring the expressive potential of EIAs thus requires an understanding of how multiple form elements come together as an integrated whole [8,17]. This might be supported by expanding the register of metaphors available to represent artificial intelligence, instead of relying on anthropomorphism as its stereotypical representation [4,12].

Formgiving will be an integral aspect of the research in our lab. Exploring the expressive Intelligence of EIAs is a future-oriented activity that requires speculation about what EIAs could behave and appear like in a believable and compelling way. We suggest that designers will need animation skills as an important addition to traditional (industrial) design skills because of the importance of behavior being an expression of computation. We intend to develop design tools that allow us to experiment with new morphologies for EIAs inspired by techniques used in film and theatre making.

How to include context?

Both design cases have shown how interaction emerged from the interplay between human and object as being embedded in a particular context (i.e., patient-room and family-home). For instance, the layout of patient rooms and its furniture affected children's interactions with Fizzy in various ways (e.g. making Fizzy "hide-able"). For Mr.V, we also noticed an important temporal dimension: It took time for families to develop a relationship with the object, as Mr.V's supportive role started to crystalize in tandem with its embedding in family daily routines.

In our lab, we will explore the expressive intelligence of EIAs as embedded in the context. This requires exploring HAI within the wider ecologies that the agents are embedded in [6] and new modes of thinking that approach EIAs not as singular agents, but as parts of a larger system of humans and nonhumans, each having their own intentions, agendas, and functionalities [9,10,11]. Second, addressing the context also necessitates a longitudinal perspective on interaction, which takes into account the changing dynamics of the relationship [13] and the perception of the object [20]. Another question we will respond to in this regard is what can, will, and should happen when agents and people interact over longer periods of time?

CONCLUSIONS

EIAs prompt us to consider how their intelligence can be expressed in ways that are purposeful and that people can relate to. We presented two design cases, and showed how these generated rich insights and opened up new areas of interest in the field of HAI. In the scope of our Expressive Intelligence Lab, we have discussed how we intend to develop speculative design approaches to craft EIAs as propositions that allow them to be discussed and critiqued in the early phases of their technical development. Furthermore, we propose to research how methods from theater, design and engineering can be combined to make EIA's expressive, while staying true to the capabilities of their sensors, software, connectivity and means of actuation. We look forward to developing these lines of inquiry in support of the creation of meaningful and socially appropriate EIAs.

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