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Egocentric Interaction — A Design and Modelling Framework for Situative Physical-Virtual Applications

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1 Future Experiences will be Increasingly Physical-Virtual

There is a growing consensus within the field of Human-Computer Interaction (HCI) that the keyboard, mouse and visual display of the PC era have to be replaced with something more mobile and more adaptable to situations where interaction with computers until now has simply not been possible. Moreover, presence of interactive computing power literally everywhere implies that the computing systems have to take into account the physical context of their users. Open issues such as these are core problem areas in fields such as Augmented Reality, Tangible User Interfaces, Context Awareness, Ubiquitous and Wearable Computing.

Most existing efforts investigating and designing for the new kind of everyday computing tend to be severely hampered by the absence of a framework that could define the roles of objects in dynamically reconfigured mixed-reality environments. This position paper describes our ongoing work in developing such a framework, incorporating, among other things, the idea of emerging physical-virtual "applications" based on how collections of everyday objects are exposed to a specific human agent in the course of everyday activities.

2 A Physical-Virtual Design Perspective

Being driven by technology rather than interaction theory, research in the future-oriented HCI areas tends to be based on the prototyping of interactive systems that address one or several aspects of the open issues mentioned in the previous section. Although such prototypes per definition incorporate parts of the physical world into their designs, real-world objects are typically there only for the purpose of facilitating activities in the virtual world. The implicit starting point is the one fostered by classical HCI models: it is in the *virtual world* important things take place. Physical objects in these prototypes act as mediators between human and virtual environment not very different from how the keyboard, mouse, and visual display does in classical PC applications. Although this approach certainly has proven to be useful in the design of specific applications, we believe that this historically motivated bias towards virtual activity support restricts the design space. In particular when existing physical everyday objects are to take part in the interaction. I have proposed a more "world-neutral" design perspective where physical objects and activities are seen as just as important components of interactive systems as are virtual objects and activities [2].

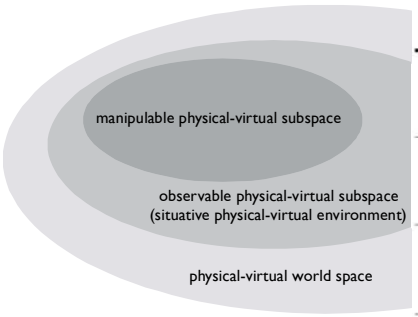
3 Egocentric Interaction

The egocentric view on interaction differs from more classical HCI models by being based on the following corner stones:

- **A physical-virtual stance.** Objects of interest are modelled uniformly no matter if manifested in physical space, virtual space, or physical-virtual space.
- **One human, no user interface.** Focus is on interaction between a single human agent and objects of interest to that human agent, specifically ignoring infrastructure that mediates virtual objects, such as personal computers.
- **Strengthening links between physical and virtual objects.** Focus is on the potential role of automatic interplay between a) physical and virtual objects [residing in] b) physical and virtual environments [making up] c) the physical and the virtual world.
- **"Applications" emerging by doing.** Modelled and infrastructurally supported physical-virtual environments ("applications") are just as likely to emerge through everyday egocentric interaction by specific human agents, as being predefined by external physical-virtual environment designers.
- **Support for living rather than just work activities.** The aim is to support personal everyday activity without drawing the classical border between work and leisure.

The egocentric perspective is based on a situative model of what a specific human agent can see and not see, reach and not reach at any given moment in time (Fig. 1). The particularity of this model is that physical and virtual objects are treated as being located in the same space. As a specific human agent changes physical and/or virtual location, objects come into and leave the observable physical-virtual subspace in a dynamic fashion. Somewhat simplified, one can say that it is the borders of the observable subspace which defines the set of objects that can possibly be part of a physical-virtual "application" at any given time-instant for the specific human agent.

The idea of using computers for assisting individual human agents in everyday life is not new but has gotten increased relevance in the last 5-10 years because of increased capacity of mobile and wearable devices. One example is the research performed at Georgia Tech investigating the possibilities in creating an always present, context- aware "digital assistant" [5]. The egocentric view differs from their and most



	contains	defined in the physical world as	defined in the virtual (WIMP) world as
manipulable PV subspace S^{PV}_{manip}	immediately manipulable objects	the geometrical space *immediately accessible* by the body of the agent	the geometrical two-dimensional display area of a virtual environment provider
observable PV subspace S^{PV}_{obs}	immediately observable objects	the geometrical space *immediately perceivable* through the senses of the agent	The 2.5-dimensional geometrical space possessed by the "desktop"
PV world space S^{PV}_{world}	potentially observable objects	the geometrical space *technically possible to perceive* through the senses of the agent	hyperspace: the multi-dimensional topological space based on "links" between virtual objects

Fig. 1. A joint physical-virtual space model from the perspective of an individual human agent [2].

other similar “intelligent assistant” approaches, by focusing on detecting presence of physical (and virtual) objects rather than places or persons, for detecting and contextualizing human activity. The approaches are, of course, complementary in this respect. However, as mentioned earlier, by taking a world-neutral physical-virtual design stance, the egocentric perspective differs from most approaches by not seeing the state of the real world as merely *context* to virtual activity but an *inseparable part* of it.

4 Computing Infrastructure for Egocentric Interaction

The egocentric approach follows the current HCI trend, breaking with classical Task Analysis that assume human agents to perform all actions based on rational decisions for reaching well-defined goals most efficiently. Egocentric computing systems do not necessarily have to actually *know* what the activity is about but rather what the human agent seems to need in order to perform it, mainly based on historical data of object use. Thus, *emerging* individualised physical-virtual “applications” rather than traditional *pre-defined* general-purpose ditto designed by application designers.

4.1 Experiencing a “Dumb” World as “Intelligent” through Wearable Tech.

Being an abstract perspective on future HCI, the egocentric view does not assume the use of any particular kind of technology for supporting interaction between the human agent and the physical-virtual world. For instance, computing and sensing technology for tracking physical activity of a specific human agent could be imagined to be either worn by the human agent herself, or be situated in the surrounding physical environment. The same goes for virtual environment providers (computing devices providing access to the virtual world) which could be both worn by their user or ubiquitously distributed throughout the physical environment like in Mark Weisers vision [6].

For reasons of privacy, efficiency, design complexity, feasibility, and cost, we have found an implementation approach based on wearable sensing and computing power most attractive. The basic idea is to make the wearable egocentric computing system as self-sufficient as possible, reducing the problem of “uneven conditioning” [4].

As an example of a useful application, wearable egocentric interaction technology has the potential of ensuring that human agents always have the necessary physical and virtual objects at hand for successfully performing the activities they like to. Such systems can act in the conscious “foreground”, reminding the wearer to bring this or that physical object along when changing physical location, or in the “background” by setting up physical-virtual environments prior to the human agent's arrival, making the emerging physical-virtual world a slightly smoother place to be in.

5 Past, Present, and Planned Activities

Based on a combination of a stationary location tracking systems and wearable RFID readers, the Magic Touch system [3, 1] allowed users to keep track of physical objects in an office environment as well as link them to virtual objects and events. The system

greatly inspired the physical-virtual design perspective briefly described in section 2 of this position paper and discussed in detail in my PhD thesis [2].

The long-term goal is to demonstrate the utility of the egocentric interaction framework as a tool for designing (the infrastructural conditions for) future physical-virtual applications, applications that in part will be determined by users themselves.

Current activities include the development of a completely mobile version of the Magic Touch system (Fig. 2) tied to the situative physical-virtual interaction model (Fig. 1) directed towards the support of egocentric interaction.

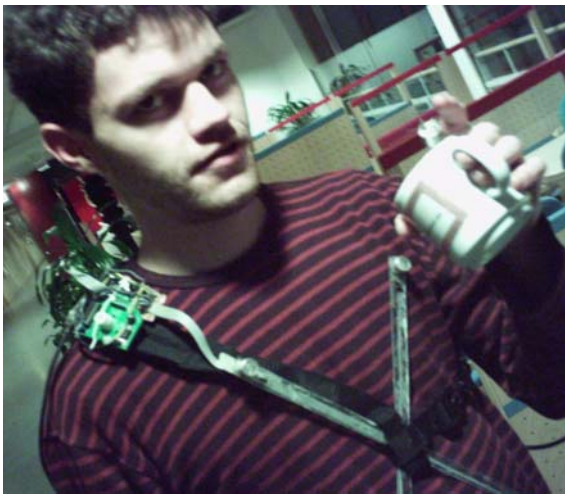


Fig. 2. A first version of a fully mobile Magic Touch system based on ultrasonic hand tracking and RFID-based identification of physical objects.

The physical-virtual design perspective is currently undergoing empirical validation as a tool for design (for designing a distributed physical-virtual bulletin board) and modelling (applied on an existing physical-virtual environment: a large book store).

As future activities we plan to perform ethnographical studies for determining what objects human agents typically encounter throughout the day. We also plan to perform lab-experiments for determining qualities of physical and virtual objects useful for designing Physical-Virtual Artefacts, objects with both physical and virtual manifestations [2].

6 References

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