Amplifying Reality

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Abstract. Many novel applications take on the task of moving the personal computer away from the desktop with the approach to merge digital information with physical space and objects. These new applications have given rise to a plethora of notions and terms used to classify them. We introduce amplified reality as a concept complementary to that of augmented reality. To amplify reality is to enhance the publicly available properties of persons and physical objects, by means of using wearable or embedded computational resources. The differences between the two concepts are discussed and examples of implementations are given. The reason for introducing this term is to contribute to the terminology available to discuss already existing applications, but also to open up for a discussion of interesting design implications.

Keywords: amplified reality, augmented reality, ubiquitous computing, wearable computing, embedded vs. superimposed properties, private vs. public

1 Breaking away from the PC

When moving the computer away from the office desktop in order to make it fit other activities and situations, one can choose between two different approaches. Either we choose to move the computer closer to the user, making it even more personal, or we choose to move it away from the user, into the environment, making it a widely spread resource much like water or electricity.

So-called *wearable computers* take the first approach, making the computer so small and mobile that the user can carry it continuously. The aim is to create the truly personal computer, a prosthetic device closely integrated with its wearer. One important characteristic is that the wearable computer is a computational device in the user's personal and private control; the user carries the device on his or her body and is the only person to interact with it. For some illustrating examples of wearable computer systems, see [8, 11, 2]. In contrast, *ubiquitous computing*, is the approach of embedding computational resources in the environment [14]. The role of the personal computer is made less significant by placing small computers everywhere in an

environment; these sense, control and display interesting information depending on some context [3]. In this approach, the user does not have to bring a computer to the task or the task to a computer, as computational resources are already present in the environment.

Currently there are a number of different approaches to merging physical space and digital information (cf. [12]), which bring together techniques from both wearable and ubiquitous computing. With ubiquitous computing, computational properties might actually be embedded into objects. However, another approach seems to have been more influential so far: wearable computers that deploy techniques to superimpose virtual properties onto physical objects, thereby giving users an *augmented reality*.

In this paper we introduce the concept of *Amplified Reality*. This concept differs from augmented reality, in that it emphasizes the importance of the shared experiences that result from *publicly available properties* of objects. Augmented reality is about how the user perceives reality, while amplified reality is about how the perceived might control how information is made available. Finally, we discuss some implications of amplified reality.

2 Augmented Reality

Augmented reality systems are systems, in which computer-rendered properties are superimposed on the real world, allowing the user to experience virtual aspects as if they were real world properties. One basic definition of the term states that augmented reality *combines virtual and real objects in real time* [1, 5].

Even though this definition does not specify how the augmented reality is presented, many "augmented realities" are only experienced through specialized equipment, such as goggles or head-mounted displays to visually enhance the user's environment [5, 10]. The use of this type of equipment allows for private information visualization, tailor-made for each specific user.

In contrast to the personal systems, some research groups are experimenting with the alternative idea of superimposing visual information that can be publicly experienced with the aid of projecting techniques [13, 15]. Such systems allow for many users to experience the same augmentation in real time, without the requirement of personal viewing equipment.

Regardless of how personal or communal the augmented experience is, the "reality" it creates is not real per se. Computer-rendered virtual properties are superimposed on real objects in such a way that the user's impression of the real world is enhanced or otherwise altered. Hence, the properties of an augmented world are associated with the observer's interpretation of the augmented reality system, rather than with the objects themselves.

3 Amplifying Reality

We will now present the concept of amplified reality as a complement to augmented reality. Part of the reason is to introduce a term that will aid in describing already

existing systems, but also to point to interesting possibilities when designing mixed reality systems.

3.1 Defining amplified reality

> *To amplify reality is to enhance the publicly available properties of a physical object, by means of using embedded computational resources.*

While augmented reality is about enhancing our impressions of everyday objects in our surrounding, *amplified reality* is about enhancing the *expressions* of objects and people in the world. Since the difference may seem subtle at first, we will explain by describing the key phrases in our definition.

With *publicly available properties*, we assume that the added virtual properties are equally available to all users or everyone present. While augmented reality based on wearable technology can create large differences in how objects are presented to different users, amplified reality stresses the similarity. This is however not to say that it should be the single goal to make virtual information public in this way; sometimes a private augmented reality system will be more suitable. This can be illustrated by a simple example: suppose you want a new color on the walls of your apartment. Usually, this is achieved by painting them in the preferred color, but this result might also be achieved by wearing a pair of colored eyeglasses that make the wall appear different. In essence, the colored glass in the spectacles adds an additional layer of information on the real world, and in this way augments it. Now, re-painting the walls would correspond to amplifying reality, wearing the eyeglasses to augmented reality. If the walls are painted, anyone entering the room will be able to perceive the color; if the eyeglasses are used, only the person or persons using them will be able to see the "new" color.

An amplified object is self-contained in regards to its properties. In practice, this means that that the properties are *embedded* parts of the object. In contrast, augmented reality superimposes virtual properties on an object, which in effect does not change the actual object, but rather how we perceive or experience it. Augmented properties are not persistent outside the augmented reality. The important difference between these two approaches lie in the proprietary rights to the information. An amplified object controls the flow of information, while in an augmented reality system the perceiver is in control of the information. For instance, if an augmented reality system is used to supply its user with additional information about a person she is currently speaking to, this person has no influence over the information provided. In other words, an augmented reality systems alters the impressions of its user, without there being any corresponding properties in the *expression* of the object she is perceiving. This is quite different from ordinary life. For example, we choose what clothes to wear and thus (partly) in what way other persons will perceive us. The concept of amplified reality is designed to acknowledge this. By embedding publicly available properties, the information distributed (or the virtual properties added) will be controlled by the perceived object itself. This is perhaps most important when it

comes to communication between humans, as integrity in large part has to do with what others "know" about oneself.

In an attempt to relate key attributes of amplified reality with those of augmented reality, we were able to arrange them as depicted in the figure below (see figure 1). This shows a model that groups the identified attributes of the two approaches as opposites of each other, summarizing the main differences between augmented reality and amplified reality.

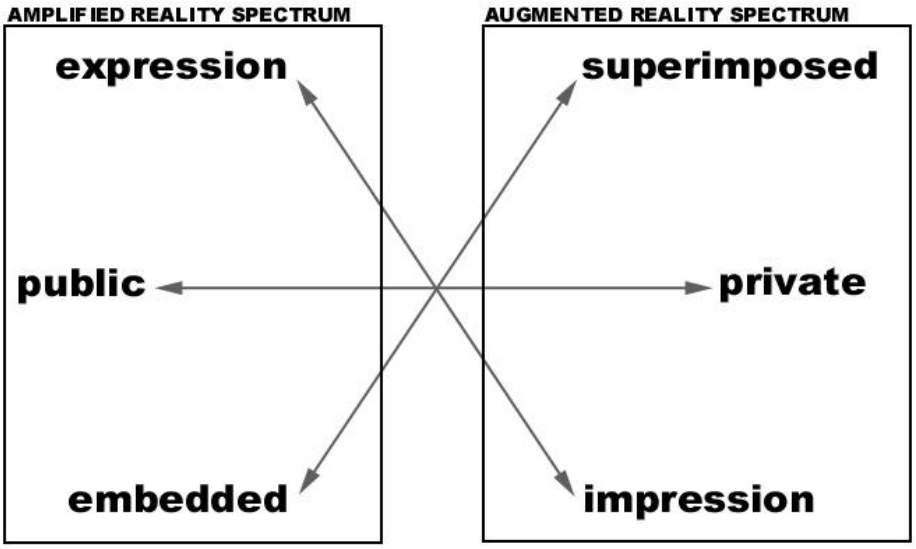

Fig. 1. Key attributes of amplified reality and augmented reality can be arranged as opposites to each other.

3.2 Examples

In order to anchor the concept of amplified reality further, we provide three examples of systems that satisfy the amplified reality definition. The first example, the Lovegety [cf. 7], is a commercial product while the following two, the Hummingbird [6] and the BubbleBadge [4], are part of our own work.

Two examples that are somewhat similar on the conceptual level can be found in the Lovegety and in the Hummingbird. Although their intended use differs, they have significant similarities that comply with the notion of amplified reality. They are palm-sized, portable electronic devices equipped with radio transceivers that continuously broadcast and listen for information. The Lovegety comes in two colors - pink for girls and white for boys. There are three user-selectable settings - "talk", "karaoke", and "get2" and when two differently colored Lovegetys on the same setting are close, an indication is given in form of a beep and a flashing light. With the

Lovegety it is possible for a user to broadcast interest in for instance karaoke, in effect providing a publicly accessible (to all who carries a Lovegety) expression about herself with the aid of technology.

The Hummingbird [6] is designed to support awareness of presence between people who frequent the same physical space. They give users constant aural and visual indications when other users carrying Hummingbirds are in the vicinity. Hence, for the user it is possible to be seen or heard by people even when out of sight, e.g. behind a closed door, or out of hearing range. Thus, the Hummingbird amplifies the user's presence.

A third example is the BubbleBadge [4], which is a wearable computer display that is worn like a brooch, hence directed towards its viewer rather than its wearer. The device is an experiment in turning a wearable computer's display inside out, effectively transforming the wearable computing concept by making digital information *public* rather than *private*. Since the device is pinned to a person, it is effectively taking advantage of its wearers mobility in serving a public audience. The BubbleBadge may be granted to show information that is private to the viewer, provided the viewer can identify herself to the device. In addition, the BubbleBadge can display public information broadcasted from locations in the environment, much like a public announcement system.

In addition, there are implementations that have a mixed approach, incorporating attributes from both amplified reality and augmented reality [13, 9, 15]. When looking at these applications we can see why they comply well with the conventional definition of augmented reality, but we can also find important and interesting attributes that do not belong in this categorization. This observation has led us to believe that it is both valuable and useful to assign a complementary term to aid us when talking about and classifying applications within these fields.

3.3 Amplifiers and Digital Sound Processing

The inspiration to the field of applications we envision in this domain, and the reason for choosing the name amplified reality, was taken from the music domain. When popular music started to develop in the early 50:s it was accompanied by an equally rapid development of musical instruments, or rather, of musical sound. Until then, electronics had not been used to alter the sound of acoustic instruments, but when microphones and amplifiers entered the stage, the sound of music was changed forever. Not only did microphones and amplifiers allow music to be played far more loudly; they also enabled musicians to change the sound qualities of their instruments. Today, digital sound processing have taken this even further, and most digital artificial reverbs, digital sound effect devices, digital instruments etc. conform to the MIDI (Musical Instruments Digital Interface) communication standard. The possibility to use MIDI to connect and control different devices, and the standard for audio contacts (making interchange of audio signals possible) imply that a MIDI set-up should qualify as a collection of appliances connected in a way characteristic to ubiquitous computing. Moreover, as far as such a set-up is used to alter the sound of an acoustic event, e.g. a person singing to an audience, it is an example of amplified reality as defined above.

4 Conclusions

We have shown two distinct strategies of how to use computers to alter or add characteristics to objects that users interact with: augmented reality and amplified reality. We introduced the term amplified reality in order to stress properties like public and embedded (compared to augmented reality's corresponding emphasis on private and superimposed) properties.

We have also shown that amplified reality can be achieved using techniques *both* from wearable computers and from ubiquitous computing. An amplified object can for instance be created by "turning a wearable computer inside out," i.e. by making the wearable computer's display available to people looking at the wearer. Further, the idea of having many amplified objects in a given area is very similar to the idea of ubiquitous computing. Usually, wearable computers and ubiquitous computing are viewed as each other's opposite, but it is not the technology as such, but the purpose of using of them that are opposite. Wearable computers focus on how to interact with information on a *private* level, while ubiquitous computing aims at enabling interaction with information on a *public* level. The concept of amplified reality breaks the linkage between hardware and software and illustrates that there can be a difference between the nature of a device and the information displayed on it. A public announcement may be displayed on a screen carried by an individual, while a private email may be shown on a communal information display (given that the owner has authorized the retrieval). How the privacy issues arising from these possibilities should be solved is a question that needs further research.

References

1. Azuma, R. (1997). A Survey of Augmented Reality. In *Presence: Teleoperators and Virtual Environments*, pp. 355-385, MIT Press.
2. Bass, L., Kasabach, C., Martin, R. et al. (1997). The Design of a Wearable Computer. In *Proceedings of CHI´97*, ACM Press.
3. Demers, A. J. (1994). Research Issues in Ubiquitous Computing. *In Proceedings of PODC´94*, ACM Press.
4. Falk, J., and Björk, S. (1997) The BubbleBadge: A Public Wearable Display. In *Extended Abstracts of CHI´99*, ACM Press.
5. Feiner, S., MacIntyre, B., and Seligman, D. (1993). Knowledge-based Augmented Reality. In *Communications of the ACM*, Vol. 36, No. 7, ACM Press.
6. Holmquist, L.E., Falk, J., and Wigström, J. (1999) Supporting Group Collaboration with Inter-Personal Awareness Devices. To appear in *Personal Technologies*, Springer-Verlag.
7. Iwatani, Y. (1998). Love: Japanese Style. In *Wired News*, 11June, 1998.
8. Mann, S. (1997). Smart Clothing: The Wearable Computer and WearCam. *Personal Technologies*, Vol. 1, No. 1, Springer-Verlag.
9. Mynatt, E., Back, M., Want, R., et al. (1998). Designing Audio Aura. In *Proceedings of CHI´98*, ACM Press.
10. Rekimoto, J., Ayatsuka, Y., and Hayashi, K. (1998). Augment-able Reality: Situated Communication through Physical and Digital Spaces. In *Proceedings of ISWC´98*.
11. Starner, T., Mann, S., Rhodes, B., Levine, J., et al. (1997). Augmented Reality Through Wearable Computing. In *Presence, Special Issue on Augmented Reality*, MIT Press.

12. Streitz, N. A., and Russel, D. M. (1998). Basics of Integrated Information and Physical Spaces: The State of the Art. In *Extended Abstracts of CHI'98*, ACM Press.
13. Ullmer, B., and Ishii, H. (1997). The metaDESK: Models and Prototypes for Tangible User Interfaces. In *Proceedings of UIST´97*, ACM Press.
14. Weiser, M. (1991). The Computer for the Twenty-First Century. *Scientific American*, pp. 94-104.
15. Wisneski, C., Orbanes, J., and Ishii, H. (1998). PingPongPlus: Augmentation and Transformation of Athletic Interpersonal Interaction. In *Extended Abstracts of CHI´98*, ACM Press.