Lifeclipper3: Massively Augmented Reality and its Realization Using Community Processes

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Abstract

High-level application description for augmented reality (AR) has received some attention, but is not yet established. If AR is to truly have an impact on the way we use computers, application description must become more general and portable. We propose the development of an event system that provides the means to describe AR applications as (potentially distributed) events. We focus on a scenario in which two-dimensional barcodes placed in the real environment provide the augmentations. Especially for massively augmented areas, this allows interesting forms of wiki-style augmenting of the world. We hope to contribute to the development of AR application description standards and the propagation of AR technology for everyday use.

Keywords: augmented reality, AR application description, event system, 2D barcodes

Problem Statement

We have been developing an augmented reality (AR) system in the Lifeclipper2 project (see [1]) at the University of Basel. The goal was to create an mobile outdoor AR system for new experiences of city space, including architecture visualization, real-life experience of ancient settlements on city ground, and historic walking tours. The hardware components of the system are a head-mounted video see-through display, a laptop computer, and an inertial sensor (InertiaCube 3) in combination with a high-precision differential GPS system (Leica RX1250) for user tracking. The integration of these components in a wearable system and the setup of a unified sensor interface took about two months. In a second step, we have used the commercial software Virtools to generate the user view overlaying the live (real) image stream with (virtual) augmentations (e.g. city model). This task was more work-intensive, but took no more than three months. The development and enhancement of the actual application was much more time-consuming. Overall, it was the most extensive, yet not technically challenging part.

Existing AR systems we have examined during the project all share one property: they are relatively to highly specific, both at the hardware and software level. Writing an AR application means writing an application for just one AR system. If the application is to be used on another system, it must be re-written from scratch. Both on the hardware and software side, AR systems tend to be monolithic.

It would be rewarding for the development and further significance of AR to have a systematic view that allows unified application development and deployment. Creating and distributing AR applications would ideally be as simple as on a personal computer. In my PhD project, I would like to take part in the ongoing development of more general views of AR systems and especially their applications. In a review of the papers accepted by ISMAR and its predecessors between 1998 and 2007, Zhou et. al. (see [2]) concluded that only around 20% of all papers have been about AR applications and AR authoring. There still is no generally accepted way to describe AR applications at a high level, although there have been proposals for authoring AR applications as well as for the development of descriptive languages (see [3]).

Creating a portable high-level description for AR applications is important for the potential of AR to have wide impact on the way we use computers. If we imagine a broad range of devices and architectures, a common standard for describing services is required. An example (limited to sensors) for providing such a standard is VRPN (see [4]), which allows sensors of various designs to be used in a common context and across systems and platforms.

Methodological Approach

The Lifeclipper2 (LC2) base system is the starting point for the creation of a new, improved system. In the new system, an application description level is introduced. It is independent of the proprietary software used to describe applications so far. It allows dynamic loading and unloading of applications and application components. The dynamic behavior of the system is achieved through an event system, which is implemented in the runtime environment of the AR system (see Figure 1). Applications are described as a series of events that occur over time. When present in serialized form, we call the event descriptions messages. The categories of events and their semantics provide the means for describing AR applications.

If application description is to be powerful, the event system must support an extensible message format for describing event semantics. Coming up with adequate semantics requires a systematic description of the AR system in respect to what its essential parts are, how they interact, and how they can be dynamically modified. In a first step, a message model for the data of the three-dimensional model of the environment has been created. In the LC2 system, this 3D model is a model of the city. The model is layered and includes terrain, building facade, building roof and building extensions information. Every component of the model has dimensions (length, width, depth) and is localized in space (latitude, longitude, height). It may have additional attributes. Model data can be loaded or unloaded to and from the AR application, it can be added or deleted to or form the current scene, and its attributes can be queried and altered. For dynamically changing the 3D model data, we have defined several messages using the keywords *load, unload, add, delete, getAttribtue, setAttribtue* and the necessary payload data (component identity, model data, attribute names and values).

Through the development of new messages, the range of dynamically changeable components will increase. Ultimately, we will not only control the static parts of the system (such as model data), but also behaviors and actions. As a result, we have a message-based description level for AR applications. All progress will be tested immediately, and extensions of the event system taken step by step. However, we expect that with the advancement in the development of the messages, we will also be able to come up with a systematic view of our AR application, and from there be able to make statements about the general properties of describing AR applications without dependence on a specific system.

Massively Augmented Environments

The system under development is used in real-world scenarios. The urban outdoor setting of LC2 is maintained, and we focus on the use of two-dimensional barcodes as a technique to provide augmentations. Consider a massively augmented place in a city. *Massively augmented* refers to the possibility that in a range of only several meters, there may be tens or even hundreds of augmentations (relating to the tens or hundreds of distinct objects in the vicinity).

For AR applications using augmentations that are identified only via their location in space, three problems may present themselves in massively augmented areas: (i) tracking inaccuracy makes it impossible to determine which of the augmentations the user is actually facing, (ii) spatially concentrated (and overlapping) augmentations must be filtered according to some criteria, and (iii) the pre-defined coordinates of the augmentations do not by default reflect the dynamic behavior of the objects they relate to (e.g. an object is moved). As a possible solution, barcodes are attached to real-world objects. The augmentations for the objects are encoded in the barcode as messages for the event system. The dynamic change of the system depends entirely on the user progressing through real space and accessing the distributed barcodes. Exact tracking (spatial relation object-user) and filtering are provided intrinsically. Additionally, because augmentations are physically attached to objects, they reflect any of their dynamic behavior.

Augmentations are not only accessed, but also created and placed. Using barcodes embedded in the real world allows interesting forms of wiki-style augmenting. Assuming a common standard for describing AR applications (which is a crucial component of my PhD project), those interested in providing augmentations for the environment they live in could produce such augmentations and attach them to the relevant places. Similar projects exist, like Semapedia (see [5]), where hyperlinks to Wikipedia articles are encoded in barcodes and attached to the described objects. Providing augmentations instead of hyperlinks to articles takes the idea further. Instead of static content, computing services are embedded in and accessible through the real environment. Facilitating the integration of community-generated contents is promising if these services are to span the entire globe and reach a density that reflects the concentration of information in our (urban) environments.

Innovation and Expected Contribution

If AR technologies are to become a fixed part of our everyday lives, several obstacles must still be overcome. One important area where progress is required is the description of AR applications. It can be expected that the range of both hardware and software components with AR capabilities will be broad. The various display techniques such as head mounted displays, projection displays and handheld displays provide a good example. Also, the computing devices used to run the AR applications could be as powerful as high-end laptop computers, or rather limited in performance, as in the case of consumer mobile phones. The diversity of the systems that can be used to provide augmentations of the real world would be very limiting if no common level of description is provided.

In his well-known paper on ubiquitous computing, Weiser (see [6]) suggests that at one point in the future, computing services could be seamlessly embedded in the world that surrounds us, and not be constrained to the limits of a desktop computer interface. AR is a promising if not crucial candidate for providing access to information where attention is fully paid: in the focus of sensory awareness. Comparing possible applications of AR technologies on a large scale to the possibilities of their application today, we believe that the potential for innovation is still considerable.

Our contribution will take the form of the specification of an event system, including definition of messages. The event system enables the description and development of AR applications and can be implemented by other AR systems. AR applications composed using the semantics provided by the event system should then be executable on any such AR system.

We expect that the development of the event system will help in establishing a systematic view of AR application components and their interrelationships. Through our bottom-up approach, we expect that the event system will be actually useful in AR application development, and not be the mere product of theoretical reasoning. Both power and reliability are ensured by concurrently writing AR applications for the prototype implementation.

References

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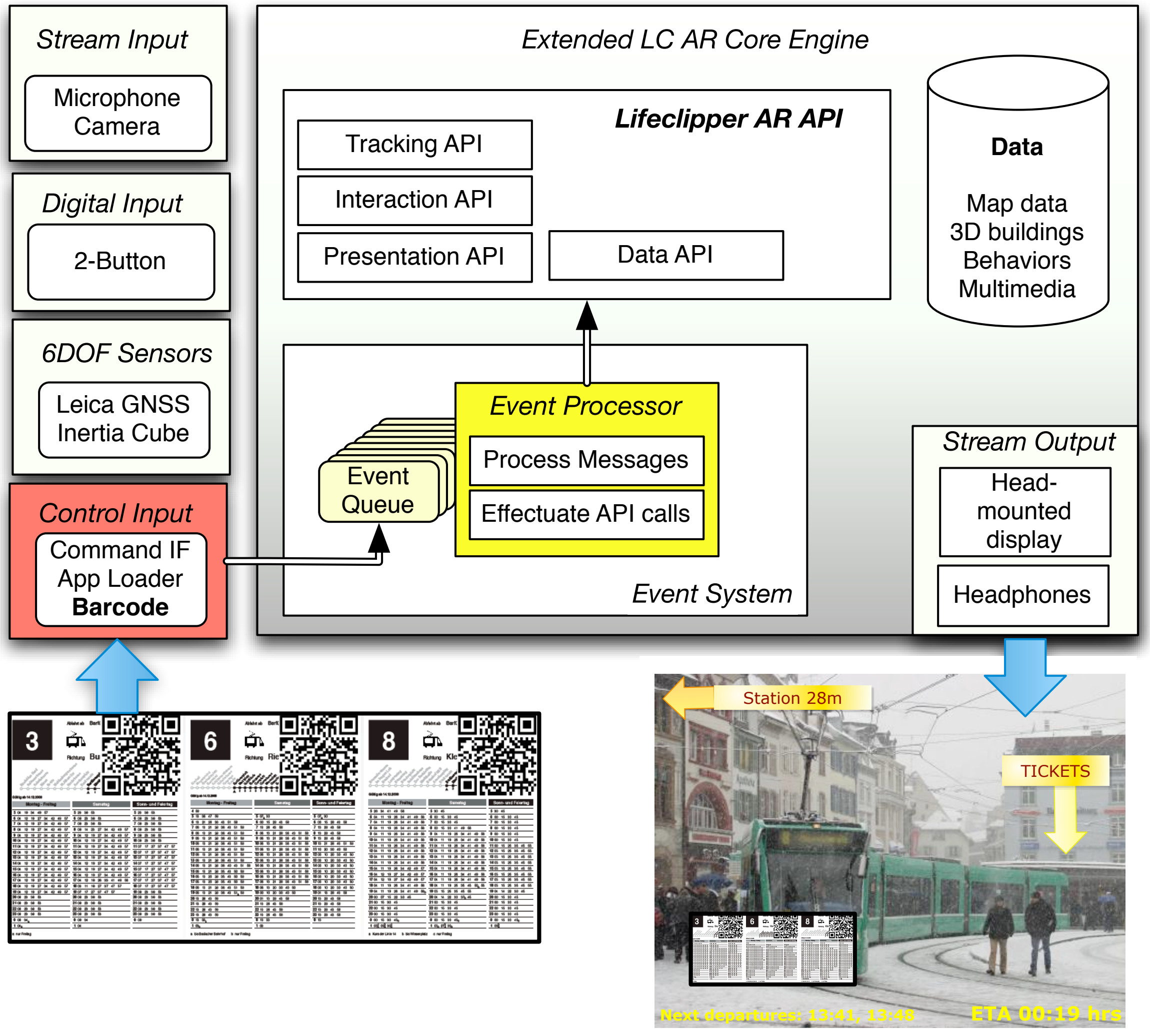

Figure 1: Lifeclipper3 architecture and scenario illustration. 2D barcodes distributed in space (bottom left) are decoded by the system at runtime and provide the augmentations of the environment as a specification of messages for the event system. The event system operates on the API provided by the AR system. The illustration shows the display of tramway schedule information as integrated into a navigation application (bottom right), as well as labeling of nearby points of interest as described in the barcode.