Testable Design Representations for Mobile Augmented Reality Authoring

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Abstract

This paper applies the idea of a continuously testable design representation to authoring of augmented realities for mobile devices.

Keywords: Authoring Augmented Realities, Prototyping

1 Motivation

Current developments in augmented reality, mobile computing and wireless communication technology will soon enable the implementation of AR applications on commodity hardware, thus enabling the creation of consumer AR applications. Assuming that future PDAs will significantly increase their processing power and the bandwidth of wireless networks will allow streaming video and audio in real-time, new AR services for end users will be possible [5].

Given the current lack of experience in design, implementation and use of mobile AR applications it is difficult to decide in advance which scenarios could be turned into successful applications. This can only happen through testing of many application concepts. However, a simple implement and test approach is not viable for a number of reasons: First, the implementation of completely working prototypes is expensive and time consuming, limiting the number of concepts and designs that can be possibly explored. Second, the currently available technology still imposes serious limitations on AR applications, making it difficult to attribute identified problems to either the concept or the implementation technology.

To address these problems we currently work on an authoring environment enabling content experts to quickly design and test AR mock-ups on different levels of detail. Our approach is based on the following concepts: 1) a conceptual design model based on actors supporting a high-level view of the application, 2) a structured design approach that supports an user centered approach for iterative prototyping [1], and 3) a high-level graphics library (i4D) that provides a direct mapping from the conceptual model to an efficient implementation featuring a Tcl/Tk scripting interface. To support AR authors in all design phase we provide *"testable design representations"* that enable early and repeated tests of concepts before and during the implementation of a working prototype. The design representation should always provide a complete representation of the system, potentially at different levels of refinement (fig1). Design representations are developed for each application element, should be accessible to both designers and users, applicable in user tests and reusable in later design iterations to minimize cost and effort. Corresponding tool support to represent and modify the design representations is essential to make the idea of many quick iterations of the design process viable.

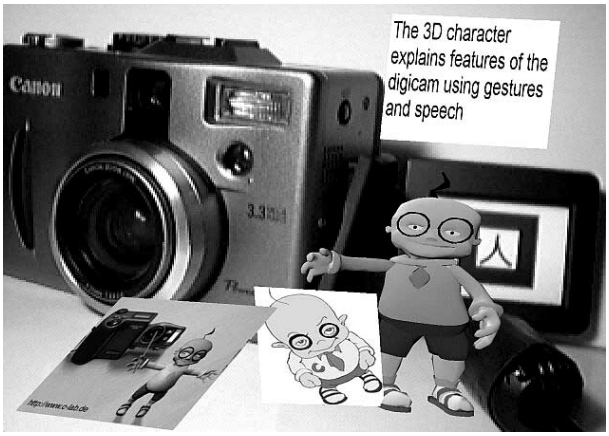

Fig. 1 Design representations of a virtual presenter

2 Conceptual Actor Model

A conceptual design model for AR must fit the dynamic and proactive content and many conceptual models in multimedia design (cards, pages, books) do not meet these requirements. We have chosen an actor based model, loosely based on the "computers as theatre" model. Actors have attributes and can perform actions that are assigned dynamically [1].Virtual, real and meta objects in the AR application are represented by different types

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of actors in our i4D system which have an appearance that can be altered during run time. Special actors with live video appearance provide support for AR functionality.

3 Testable Design Representations

The design representation of actors is developed in two steps: i) based on a global view of the application actors are identified and ii) the representation of actors is refined.

A **global view** is derived by developing a non-linear storyboard describing the application logic. Important key points of the application are illustrated using suitable visual media forms like text, scribbles, images. With our i4D system, this view is implemented using an automata like structure realized as a special actor in the system. This "story-board"-actor implements an extended finite state machine with variables / conditions, executes actions if conditions hold and listens to user interactions that are mapped to conditions. The automata structure can be saved and loaded using an XML compliant file format. During iterative prototyping based on our user-centered design approach, this global actor is divided into a number of communicating local actors simply by transforming groups of states into i4D actors. Visual representations used in a state group may be used a design representations for this actor. External transitions (i.e. transitions between actors) are transformed into structured messages. This transformation is supported by the i4D system.

Each actor developed in this phase may have **different visual representations** depending of the refinement level in the design process and the type of actor. During design iterations new representations are added while the old representations are maintained for future reference and for use in tests. A typical "evolution" of an actor looks like follows: 1) A textual description based on early descriptions of the application (story, screenplay). Interaction is provided using a hyperlink structure. 2) Scribbles and (real) images are used to illustrate the storyboard. Interaction is provided by image map functionality. 3) 3D animation, recorded video and combinations are added. In our examples we use the Maya Live package to augment live videos with 3D CG. 4) Simple 3D models without animation and AR based images are added. 3D models may be animated very roughly by setting transformation values and the object recognition is provided with still images. In our case we use the AR toolkit as base technology [2]. 5) Animated models are provided and live video streams that are processed by the integrated AR toolkit are added. During the iterative design not every actor evolves through all phases but from the beginning all representations are rendered in a 3D environment (with fixed orthogonal camera position in the beginning). The i4D system provides the necessary mechanisms for rendering and compositing of all actors and assumes the newest representation as the default. At each cycle the current design representation can be tested interactively by the developer or end user.

4 Application

We validated the idea of a continuously available design representation for actors in two scenarios: in the "shopping scenario" the PDA explains features of technical device like a digital camera and a "museum scenario" that features a PDA based interactive illustration of the ENIGMA encrypting machine [3]. During the complete design process different representations of individual actors have been designed and used to develop mock-ups and prototypes very quickly. The examples are tailored for small hand-held devices based on standard hardware like iPAQ PDA, IEEE802.11b wireless LAN and mini video cameras. AR applications can not be executed completely at a mobile client, but the implementation of the storyboard actor on a PDA even allows for testing an interactive mock-up. The final applications used the client/server approach described in [4].

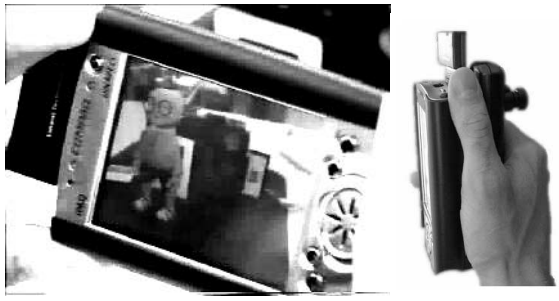

Fig. 2 Mobile AR application

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