Augmented Learning: Context-Aware Mobile Augmented Reality Architecture for Learning

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Abstract

Mobile Augmented Reality System (MARS) based e-learning environments equip a learner with a mobile wearable see-through display that interacts with training/learning software. MARS has the potential to adapmt to individual learner needs and dynamically distribute tailored instruction to improve learning performance for a life time. While using MARS, learners may interact with their natural environment while MARS digitally annotates real-world objects with digital content. This digital content may combine multi-modal animation, graphics, text, and video as well as voice used to augment instruction based on empirical pedagogical models. The challenge, however, is building a MARS software architecture that fulfills this potential and is also reusable, interoperable, and adaptive to individual Augmented Reality (AR) "heads-up displays" while, at the same time, capable of delivering personalized instruction to the learner.

1. Introduction

A Mobile Augmented Reality System (MARS) that provides on-demand instruction as well as context-aware services requires reusable, interoperable, scalable, and robust system/software architecture. Target applications generated from the architecture requires instructional capabilities for understanding individual learning strengths while tailoring empirically evaluated pedagogical and andragogical techniques to enhance learning for children and adults, respectively [3]. Additionally, the human computer interface delivered through the MARS "heads-up" display needs to be consistent, minimize the cognitive burden on the learner, and facilitate easily accessible information (i.e., from voice commands/dialogue).

The context-aware requirement of MARS learning includes the ability to deliver instructional information based on location, learner's learning strengths (e.g., tactile, auditory, visual, etc.), time of day, emotional state of the learner, previous knowledge of the learner, and cognitive capabilities (e.g., adapted to cognitive disabilities). The architecture should also be designed as an extendable and flexible infrastructure to support other contextual data without impacting the core of the system/software architecture design and to consistently delivery pedagogically correct instructional content independent of an individual MARS heads-up display.

MARS involves a wearable head mounted display worn over a user's eyes (like goggles) that overlay the human visual field with graphics and/or text [5]. MARS combines research in AR and mobile/pervasive computing, in which increasingly small and inexpensive computing devices linked by wireless networks allow users to roam the real world while they receive information based on a particular context (e.g., location). Additionally, MARS may provide flexible mobility and location independent digital annotation services without constraining the individual to physical position. By providing this mobile and location independent interface that is context-aware, MARS holds the potential to revolutionize the way in which information is presented to people and has enormous potential for on-demand, context-aware, and collaborative training [1][2][4][6]. With this mobile instructional tool, individual and collaborate learning may be enhanced in areas ranging from K-12 history, science and technology training to workforce training.

2. Context Aware MARS Architecture

To build a context aware MARS architecture requires an extensible, interoperable, modular, and scalable software/system architecture model. Researchers have conducted extensive research to formulate such an architecture model, the Context Aware-Augmented Reality System (CAARS).

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2.1. CAARS Goggles

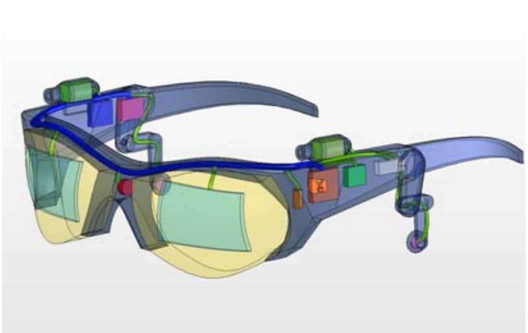

Figure 1: CAARS Consumer Goggles

The CAARS goggles are depicted as a schematic view in *Figure 1*. Considering the fact that current augmented reality based headsets are bulky and many-times require a backpack, researchers have designed a novel MARS headset with all embedded components. Various styles were designed to satisfy various learning functions. All the headsets were designed with a miniature PC compatible camera to capture visual elements in a learner's environment (e.g., historical trails, architectural artifacts, etc.). As images are captured by the camera, they are transmitted wirelessly, in real-time, to the *CAARS Training Service* in which software agents process the data and respond with pedagogically intelligent instruction. With simple voice commands learners may request instruction based on a location or domain contexts and, consequently, visually see and hear assistance through the MARS heads-up display and mini-speakers, respectively.

2.2. CAARS Training Service

The mobile augmented reality training service is facilitated by a *service level* software architecture made up of several subsystems that provide visual display, conversational, and training services. The software architecture is interoperable, reusable, extensible, and adaptable. The visual subsystem handles the image recognition and analysis to facilitate accurate real-world object recognition (e.g., recognize historical landmark). The human computer interface (HCI) subsystem controls the speech recognition and speech synthesis services that enable hands free and more natural interaction with the CAARS mobile learning interface. The Training subsystem is extensible such that new pedagogical models may be "plugged-in" and registered so that software agents may deliver instruction based on the pedagogical model.

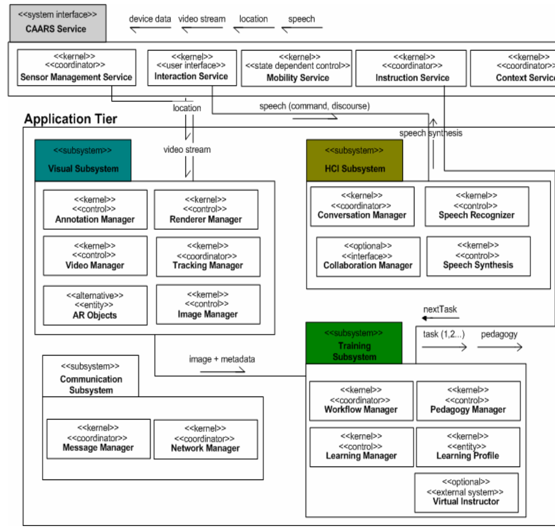

Figure 2: CAARS Lab Goggles

In conclusion, this modular based architecture facilitates a customized and personalized instructional content service through mobile see-through displays without requiring much additional software modifications.

3. References

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