DART: The Designer's Augmented Reality Toolkit

Blair MacIntyre, Maribeth Gandy, Jay Bolter, Steven Dow, Brendan Hannigan
GVU Center, Georgia Institute of Technology, Atlanta, GA
(blair, maribeth,steven,brendan)@cc.gatech.edu, jay.bolter@lcc.gatech.edu

Abstract

This demonstration will highlight the Designer's Augmented Reality Toolkit (DART), a system that allows users to easily create augmented reality (AR) experiences. Over the past year our research has been focused on the creation of this toolkit that can be used by technologists, designers, and students alike to rapidly prototype AR applications. Current approaches to AR development involve extensive programming and content creation as well as knowledge of technical topics involving cameras, trackers, and 3D geometry. The result is that it is very difficult even for technologists to create AR experiences. Our goal was to eliminate these obstacles that prevent such users from being able to experiment with AR. The DART system is based on the Macromedia Director multimedia-programming environment, the defacto standard for multimedia content creation. DART uses the familiar Director paradigms of a score, sprites and behaviors to allow a user to visually create complex AR applications. DART also provides low-level support for the management of trackers, sensors, and camera via a Director plug-in Xtra. This demonstration will show the wide range of AR and other types of multimedia applications that can be created with DART, and visitors will have the opportunity to use DART to create their own experiences.

1. Introduction

Over the past few decades, AR researchers have explored a wide variety of domains; most recently, we have been focusing on the use of *dramatic AR experiences* in education and entertainment settings. However, the primitive state of AR technology, and the lack of tools to support traditional design activities (such as rapid prototyping and incremental experience testing) has made this shift in focus from *task-focused* to *experiential* domains difficult. When working in task-focused domains, such as equipment maintenance and repair, it is feasible for a team of technology experts to work closely with domain experts to understand a particular problem, and build a solution to the problem using widely accepted HCI techniques such as iterative design. Unfortunately, in experiential domains, this separation between domain experts (e.g., designers and artists in this case) and technologists does not work; designers are most effective when working directly with a medium, and working through an intermediary seriously hinders (or even destroys) the creative process. Most instances of successful design using cutting-edge technologies have been slow, painstaking endeavors carried out by close-knit teams or technically sophisticated individual designers. By making AR more accessible to a wider range of designers, we can begin to achieve its potential to create powerful dramatic and educational experiences.

The primary purpose of our research, therefore, is to advance the state of the art in AR by enabling designers to work directly with AR as a new medium for dramatic experiences. The three main goals of this research program are: 1) identifying and supporting appropriate design activities for AR experiences, 2) creating design tools that support these activities, and 3) solving fundamental technical problems to support the creation of these tools. These three goals are intimately related, and should not be pursued independently; the requirements of, and progress on, each influence the others. Design tools must support an appropriate set of activities if they are going to be useful to designers. Without knowing how the design tools should work, we do not know what technical problems are important to solve. Conversely, as we solve technical problems, we can enhance the capabilities of the design tools, which can in turn open new possibilities for design activities.

DART currently focuses on supporting rapid prototyping of AR experiences. DART is built as a collection of extensions to the Macromedia Director multimedia-programming environment, the de-facto standard for multimedia content creation. Our long-term goal is to enable designers to rapidly develop and test their AR experiences, in the same environment that will be used to deploy the final experience. This last point is critical; while we are focused on supporting early design activities, designers can gradually evolve their prototypes as they see fit. Polished content can be mixed with crude content, elaborate narratives and complex behaviors can be tested as desired, and changes to "complete" experiences can be rapidly prototypes.

A guiding principle of our work is that DART should build on the existing design practices and tools used by experienced designers, rather than expect these designers to adopt radically new practices and tools. We are initially adapting existing design practices (e.g., storyboarding, informal prototyping, animatic video, etc.) and tools (e.g., from physical models and pencil sketches, to computer

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programs such as Macromedia Director, 3D Studio and Adobe Photoshop) to support experienced designers in the rapid, informal prototyping of AR experiences.

2. Motivation

During our work through the past years, the immaturity of AR technology (both hardware and software) has limited the exploration of ourselves, our collaborators and our students. We have found that even when working technology (accurate trackers, calibrated head-worn displays etc.) is available in Director, creating AR experiences is still prohibitively difficult. The extensive time required to create content and to write programs to handle all the components of an AR experience often means that there is a large amount of latency between the inception of an idea and its realization. The difficulty in creating these applications results in less experimentation with different approaches to an experience. Often the end result is not what was intended, but the resources are not available for further interation.

For non-technologists it is almost impossible to create AR experiences. For example, we have found in our "AR Design" class that students (especially the non-computer science students) resort to tediously creating video mock-ups of possible AR experiences instead of implementing prototypes, due to their lack of expertise in areas such as tracking and due to the complicated software development that would be required.

3. DART Architecture

The DART system consists of behaviors (extensions to the Director environment written in LINGO) and Xtras (plug-ins for Director written in C++). The DART Xtras provide AR services such as video capture, tracking (via VRPN), and fiducial registration (currently, via the ARToolkit) to Director applications. The user can place behaviors onto the Director score (an arrangement of channels that organize, display and control the application over time). These behaviors allow for the graphical creation of an AR application. Behaviors also represent the basic building blocks of any AR application: virtual objects to be placed in the 3D environment, tracker information, video input (for video mixed AR), and triggers that control the logic (state machine) of the application. The complex services provided by the Xtras are encapsulated by "low level" behaviors that present the user with simple abstractions for services such as VRPN trackers and camera parameters and configurations.

The user can add objects (3D models, 2D storyboards, video, audio) to her AR environment by placing "Actor" behaviors on the score. These actor behaviors present the user with simple input fields where she can configure such properties as the position and appearance of these objects. These "actors" can have their position linked to tracking information provided by the tracking and fiducial registration behaviors. DART provides a library of triggers that can be used to create the state machine logic that will control the behavior of the "actors" in the application. These "trigger" behaviors allow the user to specify "when X happens, do Y." For example, the user could place a trigger behavior on an "actor" that would move the position of the actor when a certain sensor value was received, or would start the video on a textured object when a certain time was reached. These simple triggers can be used to build up complex behaviors for an AR application.

The key feature of the DART behaviors is that they are not intended to provide comprehensive support for AR experiences: indeed, we believe an attempt to create such a library would be misguided and doomed to failure. Rather, they are designed to provide simple yet complete illustration of how to create AR experiences using the low-level AR services provided by the Xtras, and to integrate with existing Director behaviors and concepts. This allows experienced designers to adapt the behaviors to their own needs.

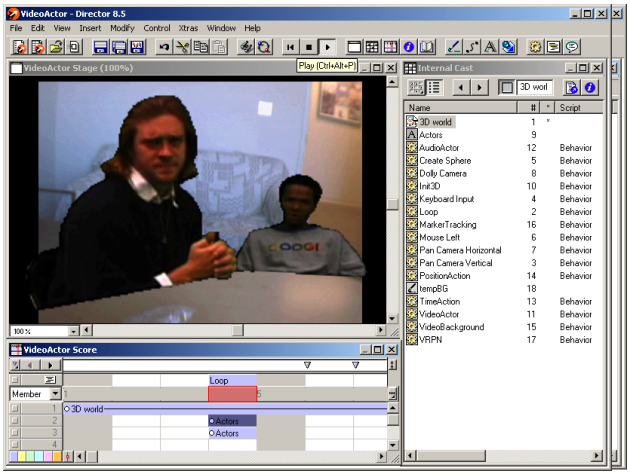

Figure 1. Screen shot of DART being used to create an AR application using video-based "actors".

4. Demonstration

In this demonstration we will be showcasing AR experiences built using DART. We will run the system on multiple laptops and HMDs in parallel, including one or more stations for visitors to try out the system (with our guidance). These applications will include one or more of the following (depending on available space): an experience where fiducials are used to control object positions, a dramatic experience using video-based actors, and, to show the flexibility of DART, a VR experience built with the toolkit. Visitors to the demonstration will be encouraged to use the toolkit for themselves to quickly create their own AR experience using a library of pre-made content we supply.

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