ICAT2004 Tutorial Proposal:

An Introduction to Augmented Reality

Submitted By:

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Proposed Length: Half Day (3 ½hours)

Learning Objectives

1/ Introduce participants to the fundamentals of Augmented Reality (AR) technology

2/ To provide hands-on experience with Augmented Reality demonstrations

3/ To provide an introduction to open-source software tools that can be used to build AR applications

4/ To give participants an overview of unexplored areas in the AR field that may prove fruitful domains for future research

Justification of this tutorial for the ICAT2004 Audience:

As computers become more and more invisible, Augmented Reality (the overlaying of virtual images on the real world) is becoming an increasingly important application area for computer graphics and user interface design. This tutorial will provide a detailed introduction to the field of Augmented Reality, as well as the open-source software tools needed to get started building their own AR applications. It is particularly designed to provide a cutting edge introduction to research on Augmented Reality, so that attendees will leave knowing which are the key unexplored areas for AR research.

Topics List:

Attendees will be given a detailed introduction to AR technology and current areas of AR research, with reviews of important topics as such as tracking and registration, interaction techniques, wearable AR systems and hybrid AR interfaces. They will also be able to try several AR demonstrations to experience the technology for themselves, and will be given an introduction to ARToolKit, a software library that enables developers to easily build their own applications. The content covered will include:

- Augmented Reality Interface Technology
- Tracking for AR

- Interaction techniques for AR
- Collaborative AR Applications
- Heterogeneous AR User Interfaces
- Mobile AR
- Developing AR applications using ARToolkit

Course Syllabus (3 ½hours):

Overview

Elapsed Time	Topic	Time
0:00	Introduction to Augmented Reality	30:00
30:00	Tracking for Augmented Reality	30:00
60:00	Interaction Techniques for AR	20:00
80:00	Break	10:00
90:00	Collaborative AR	20:00
110:00	Heterogeneous AR + Hybrid User Interfaces	20:00
130:00	Mobile AR	20:00
150:00	Developing Applications with ARToolKit	30:00
180:00	Discussion/Demos	30:00
210:00	Finish	

Introduction to Augmented Reality (30 minutes)

- Definition of Augmented Reality
- History of Augmented Reality / Past Research
- AR Systems Overview
- Input and Output Devices for AR
- Optical vs. Video See-Through AR
- Sample Applications – medical, military, manufacturing
- Research Directions – tracking, interaction techniques, outdoor AR, etc
- Introduction to the Course Sections

What Participants will Learn: A broad foundation of the components and terminology used in developing AR systems so that they can read the current research literature and understand what the authors are referring to. They will also gain an appreciation for how AR technologies can be applied in their own applications and what are the promising future research areas.

Tracking for Augmented Reality (30 minutes)

- The Importance of Accurate Head Tracking / The Tracking Problem
- The Choice of the Tracking Technologies
- Registration + Calibration – static and dynamic
- Real Time Performance Characteristics - spatial, temporal, system robustness
- Scheduling and Fusing Sensor Information
- Approaches to head motion prediction.

- Promising Research Directions

What Participants will Learn: Attendees will be given with some intuition, theory, and practical advice for using and developing tracking systems for AR. Topics will range from the relevant characteristics of the fundamental technologies, to the fusion of technologies for hybrid tracking, to calibration and motion prediction. Following this section attendees should have the knowledge to select or research the appropriate tracking system for their particular application.

Interaction Techniques for Augmented Reality (20 minutes)

- The Importance of Effective AR Interface Design
- Basic Properties of AR Environments used in Designing AR Interfaces
- Interaction Techniques Based on Traditional Tracking Techniques – magnetic, etc
- Novel Input Devices - InfoPoint device from Sony CSL
- Tangible and Graspable Interaction Approaches - ARgroove
- Augmented Reality Information Browsers
- AR Widgets and Graphical Interface Elements
- Evaluating AR Interfaces
- Basic Unsolved Problems and Research Directions

What Participants will Learn: The fundamentals of good interaction technique design for AR environments as well as an overview of a variety of techniques tried in the past. This should give them the knowledge to evaluate and develop interaction techniques suitable for their own specific AR applications.

Collaborative Augmented Reality (20 minutes)

- Introduction to Computer Supported Collaboration
- AR Collaboration vs. Traditional Computer Supported Collaborative Work
- Methods for Developing Collaborative AR Interfaces
- Case Studies:
    - Face-to-Face Collaboration – Shared Space
    - Remote Collaboration – AR Conferencing, Wearable AR Conferencing
    - Seamless Collaboration – The MagicBook
- Research Directions in Collaborative AR

What Participants will Learn: How to develop and evaluate collaborative AR applications, including the factors that must be considered from a communications viewpoint, and the affect AR technologies can have on existing face to face and remote collaboration.

Heterogeneous AR User Interfaces (20 minutes)

- Flavors of augmented reality: video mixing, optical blending, projection devices, spatially augmented reality

- Combining AR with other user interface metaphors: Immersive virtual reality, desktop metaphor, mobile/wearable computing, ubiquitous computing, tangible user interfaces, computer supported collaborative work
- Distributed graphics
- Sample Application Areas
- Research Directions

What Participants will Learn: How to integrate AR technologies into their existing applications and user interfaces, including projection and desktop display systems and ubiquitous computing environments. Attendees will also learn how to develop heterogeneous AR interfaces that do not rely on head mounted displays.

Mobile AR (20 minutes)

- Introduction to Wearable and Situated Computing
- AR in a Mobile Setting
- Current Implementations/Examples – Outdoor AR
- Tracking a Mobile User
- Mobile Display and Computing Hardware
- Environmental Modeling
- User Interface Issues
- Example Solutions for Mobile Applications
- Research Directions

What Participants will Learn: The basics of AR interfaces for wearable and mobile platforms, including tradeoffs in hardware selection, mobile tracking technologies, and interface development for wearable devices.

Developing Applications with ARToolKit (30 minutes)

- Overview of ARToolKit
- Computer Vision Based Tracking and Registration Methods used in ARToolKit
- Steps for Developing a Simple AR Application
- ARToolKit-based Interaction Methods
- Future Developments with ARToolKit
- Demonstrations: MagicBook, VOMAR, ExView, SimpleTest

What Participants will Learn: An overview of the ARToolKit software. ARToolKit is an open source, non-proprietary, academic software toolkit for computer-vision based AR. Participants will also be given a copy of the ARToolKit software, so with a desktop computer and camera, participants will have everything necessary to begin developing AR applications when they leave.

AR Demonstrations

During the break and as the final session of the tutorial, hands-on demonstration applications will be shown. Participants will be able to try these demonstrations for themselves. These demonstrations include the following:

The MagicBook – a transitional AR interface that allows participants to move seamlessly between AR and VR scenes
AR Pad – a handheld AR display that facilitates face-to-face collaboration
VOMAR – a tangible AR interface that uses a Tangible User Interface metaphor to allow physical manipulation of AR scenes.
WearCom – a wearable communication space
AR Space – an AR scientific visualization application with speech and pen-based input

Course Presenter's Biographies:

Mark Billinghurst

Mark Billinghurst is a research scientist at the Human Interface Technology Laboratory (HIT Lab) at the University of Washington, Seattle, and Director of the HIT Lab (NZ) at the University of Canterbury, New Zealand. He is active in several research areas including augmented and virtual reality, conversational computer interfaces and speech and gesture recognition. His most recent work centers on using wearable computers and augmented reality to enhance face-to-face and remote conferencing. He is manager of the HIT Lab's wearable computing and augmented reality research projects and has collaborated on projects with the US Navy, ATR Research Labs in Japan, British Telecom and the MIT Media Laboratory. He has presented tutorials at the VRAIS 96, VRST 96, Visual 98, HUC 99, Siggraph 2001, CHI 2001, VR2002, CHI 2004 and VR 2004 conferences and has authored or co-authored more than 70 peer reviewed journal and conference papers.

Technical Requirements

There are minimal equipment requirements for this tutorial. A data projector will be needed for showing powerpoint slides from a laptop, and a VCR for NTSC videos (connected to the projector). The instructor will bring a range of different AR technology for demonstration, including headmounted and handheld displays and wearable and laptop computers. Several tables will be needed to set up these demonstrations and for easy access by the attendees.