Arts, Media and Engineering @ ASU



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What is AME?

- AME is a joint graduate education and research initiative for the creation of experiential media.
- Education: Formalized graduate concentrations within existing degree programs (CSE, EE, BioEng..).
- Research: context-aware sensing, information modeling, interaction interfaces, experiential construction





Talk Outline

AME @ ASU

biosystems, education, interactive arts and everyday systems

open problems

details

The need for experiential media

- The networked electronic world is fast becoming and integral aspect of our lived experience.
- Today, there is an emergent gap between computation and human experience:
 - Non-exploratory environments, simple interfaces
 - Isolation: in models for media consumption and knowledge creation
 - Context: meaning is an emergent, interpretive process, and is user dependent.





The framework

- An experiential media system refers to a physically realizable multimedia system
 - exists in the real world, is situated
 - part of the lived human experience
 - automated frameworks for sensing modeling and interaction
 - formal aesthetic procedures for engagement and immersion
- Some examples:
 - biofeedback systems
 - the networked, mediated home







Biosystems

- Patients with lack of proprioception are unable to receive information from their limbs
 - Unable to maintain internal models
- Bioengineering can sense many key variables
 - however, they can only present streams of data to the therapist and the patient.
 - By integrating bioengineering and arts expertise with medical expertise we were able to organize this information into a coherent multimodal experience







The fragmentation of knowledge

- Experiential media systems are complex – the knowledge required to create is fragmented across disciplines.
- Media engineering focuses on the analysis and modeling of information
- The arts play a critical role in creating the experience, through formal procedures of attraction, engagement and immersion
- Experiential media will be created by a new generation of hybrid artist engineers who excel in integration across media arts and sciences.





Interactive Arts



Experiential Education





Everyday systems







Research



Education



Research and Education Integration



Who are our students?















What do they do?



Core engineering research issues



Multimedia and the lived experience

- Should multimedia researchers still focus on the lived, sensory experience? [Dourish]
- There is an exponential decline in the cost of computation, storage, sensors / display elements. I conjecture three things will change:
 - The *nature of interaction* will change tangible / movement based interfaces
 [Ishii]
 - Computation will be *focused and integrated* with sensing; diversity of sensors (touch and body params)
 - The nature of media form, place of consumption we need to think beyond text, video / sound [Donath]
- These are complementary research directions

Situated Systems

- Situated systems are physically grounded systems, using real-time, context aware computational elements – sensors and presentation devices that are part of the same physical environment.
- What do we need?
 - A Multi-sensory primal sketch
 - Multi-sensory Context
 - New I / O frameworks
 - Computational resource adaptation
 - Rethinking semantics in physical space beyond the recognition of patterns
 - Dynamic media creation



Situated Systems – a comparison



Where is David Marr?

- Today, there is no multi-sensory computational model of the lived world.
 - Computer Vision [David Marr 1978]
 - Computational Auditory Scene Analysis- [Bregman 1990]
- Multimedia needs a computational framework for sensory integration – a *multi-sensory primal sketch* that correctly explains how the different sensory streams are sampled and hierarchically integrated.
- Machine learning gives us impressive results for certain domains – too generic to provide insight.
- Why hasn't this happened? [Stein 1995]

The I / O problem

- Sensing:
 - Distributed
 - Iow-resolution
 - Focused
- We will need to build the sensors we need!
 - Telecentric optics [Nayar 1995]
 - Cadioptric sensors [Nayar 1997]
- Presentation:



- Low-resolution distributed displays presentation networks, for focused media (activity, presence)
- Non-visual / auditory vibrations / chemical / heat
- Question cognitive stability constraints / form



Rethinking semantics

- The physical environment, increases the semantic space – meaning is now sensed through visuals, touch, heat, sound, chemicals.
- Three aspects of meaning [Dourish]:
 - Ontology (system of relations, emergent)
 - Inter-subjectivity (communicating the relations)
 - Intentionality (what is meant by the reference)
- Meaning will emerge, through action in the situated environment via consistent coupling between action and feedback – The system does not store explicit symbolic representations

Other Issues

- Cross-disciplinary nature physical space is interesting research area to many people
 - Architects
 - Engineers
 - Artists
 - Social Scientists
- Evaluation is hard
 - Ground truth now rests per user we need to evaluate the experience directly – new metrics are needed
 - Easier for computational elements of the situated system.

Details









User Context



Ankur Mani

What is context?

- Context: the interrelated conditions in which something exists or occurs [merriam webster]
 - Informs perception and interpretation
 - Affects user behavior
- Related work:
 - Liberman and Selker: specific applications
 - Anind dey: middleware
 - No model for multisensory information
 - Relations between concepts are limited
 - Maes : linguistic (OMCS, WordNet)
 - Benitez / Chang: bayesian
- Issues: static nature, poor relationships, lack of demarcation of user / environment and application context

Key Ideas

- User context plays a key role in the interpretation of multimodal data, as well as understanding user action
- Multimodal context models are needed – i.e. the knowledge representation framework is multimodal.
- Context emerges through interaction and evolves over time



Our Approach



Our Approach

- Context: the subset of the space of beliefs that affect the communication between two entities:
 - Dynamically evolving
 - Multi-sensory
 - Multi-scale (parameter space, time)



Toy problem: image retrieval

- Problem: What is the role of context, in image browsing applications?
- Knowledge representation: a network of concepts (multimodal and dynamic) and multiple relationships (common sense and low-level).
- Context: a subset of the knowledge in focus.
- Dynamics of context: Modeled as a linear dynamical system.





Results

- User studies with five graduate students
 - Initial profile is seeded with concepts
 - Fixed queries across users
 - Results are measured using a rank based metric
- Concerns:
 - Dataset small ~400 images
 - User study is too small to be significant





Hybrid Paper-Electronic Worlds



Harini Sridharan, Jennifer Brungart

Introduction

- We interact with documents in two separate worlds - electronic/workstation world and physical/the paper world.
- We choose one over the other depending on task because of their varying advantages and constraints.
 - Why do users interacting with documents in the digital world often prefer to print them out on paper for reading?
 - If you wanted to search for a word in a large document how would you prefer to search?





The Differences

Paper and electronic interactions are inherently different in their affordances.

Paper Affordances

- Flexibility of spatial layout
- Flip-ability / Fold-ability / Stacking
- - Portability

Tactility

- Interactions that take advantage of our natural cognitive skills
- Other advantages of TUI over GUI

- Electronic Affordances
- Ease of search
- Representation of audio/video
- Ease of storage and retrieval
- Easy Spell Check
- Numerical Calculations



Related Work

- PADD: (Guimbretière) Digital-penannotated paper document compared with the electronic version and synchronized. Annotations incorporated in the corresponding places in the digital document.
- Digital desk: (Wellner) A computer display projected onto the desk. Video cameras pointed downward at the desk feed an image-processing system that can sense what the user is doing.
- Limitations:
 - Interpretation of user intent (PADD)
 - Lack of user adaptation
 - Lack of Content synthesis
 - Focus on affordance transfer



Our Approach

- Goal: Reduce the existing gap between the electronic and paper worlds – demonstrated for a specific system.
- What we are proposing to do: Co-habitation of both worlds instead of trying to bring the affordances of one into another.
- Features:
 - Is real-time.
 - Is user-centric.
 - Allows user to choose one of the two medium to interact with and enables to switch to the other when she pleases.
 - A system that informs each world of the knowledge gained in the other.
 - Dynamically synthesizes (content selection, presentation etc.) each medium based on user's interactions.
 - Exploits affordances of each medium.



Why is this problem important?

- The current need is to switch between mediums depending upon task. A seamless interface between the two mediums is helpful.
- The idea of saving and using your "current state" when switching to another medium.
 - E.g.1: How would it be if an electronic document moved itself to the recycle bin when its physical counterpart was marked unnecessary and shredded ?
 - *E.g.2:* What about allowing the completion of half a 'piece-together' puzzle in the electronic environment and the rest of it on paper?









• Future of office environments – replacing the use of disconnected paper and electronic documents \rightarrow *faster* and more *efficient work practices*.

Overview

- The Electronic World : An automatic electronic presentation system that dynamically adapts the media presented, to user context.
- Generating the paper : Paper workbooks generated automatically based on interactions of user in the electronic environment.
- Analysis of User Interactions on Paper
 User interacts with the pages using commonly used interactions.
- Completing the electronic-paper loop : Automatic analysis of interactions of user on paper to inform the electronic world.



electronic world

automatic workbook

System Flow-Diagram



Generating the Paper Workbook

Concept and Media Selection:

As in choosing the next concept and the set of media elements belonging to that concept to present in the e-environment.

Automatic Design and Layout:



Barcode: encodes the user id and the page number Text Boxes: for users to take notes. 6-page workbook



A sample page that was generated automatically using principles of graphic design.

Graphic Design constraints

- Consistency of design maintaining an overall regularity across pages
 - Design elements font color, font style and grid layout structure chosen are retained across the design of all six pages
- Dominance importance or similarity of an entity to the goal concept to be learnt – visual prominence.
 - Text incr. font size / different color / bolder typestyle
 - Images incr. size / repetition
- Contrast from surrounding media
 - Contrasting color / typeface from surrounding media / misalignment with grid layout
- Proximity Similar media elements are placed in close proximity to one another
 - Also creates a visual puzzle

Tractors are the backbone of rural life; they help the rural population in farming. The most important step in farming is to prepare the earth by ploughing so that seeds could be sown.





Interactions on Paper

User can interact with the pages using commonly used interactions:-

- Handwritten notes
- Underlining / Highlighting / Circling what user things are important
- Moving the sheets around to arrange them in a way that helps her see relationships between the concepts of the different pages among others.



This farmer is using a tractor to prepare some fields in the lordan Valley, along the border between Israel and Jordan. These fields belong to a Ksibbutz or collective-settlement where everyone shares equally in the work and its profits.



The most important step in farming is to prepare the earth by ploughing so that seeds could be sown.

Annotations on the media

User independent handwriting recognition is still a very hard problem. Hence, rather than understanding the scribbles, we conjecture that the *presence of annotation reflects interest in the surrounding media.*

Changing the electronic environment

User annotations can affect the future interactions with the electronic world, in 2 ways

changes to user context

Words underlined, highlighted or circled are added to the user profile.

How can this help?

- 1) In this case, the changed user context affects media shown in the electronic environment.
- In case of annotations on documents, can be used for recommending documents user may be interested in.
- 3) Summarize document based upon what the user thinks is important.

changes to electronic environment by incorporating annotations into the environment

Scribbles and text in text boxes associated with corresponding media element and shown along with them.

Modified Images replace original images



Media-rich Social Networks



Preetha Appan, Belle Tseng [NEC]

Media exchange in a social network

- The Problem : Understanding the dynamics of a corporate network through emails exchanged between the members.
 - Creating visualizations to support exploratory querying of the corpus.
 - Summarizing corpus interaction
 - Summarizing the corpus predicated on a concept.
 - Visualization of activity patterns in the network.
 - Current work focus on purely structural analysis using graph based methods.
- Motivation:
 - Allow the user to query using (text / interaction) and gain insight.
 - Multi scale : start with entire network and narrow down to particular message.
 - Enables understanding relationships that change over time.
 - Reduces cognitive load easier to process visual data rather than text.



Exploratory Querying

- Tasks Enabled
 - When was a certain query concept prevalent in the network ?
 - *Who* were involved in it ?
 - What were the set of messages related to the query concept at a certain time , for a given user .



Visualization details



Interaction Summarization

Interaction Summarization :

- The interaction is very non-linear, so an interaction summary can be provided at the end.
- What are useful interactions?
 - interactions that led to the user spending time reading a certain message.
- How ?
 - Store all useful visual states that lead to the user spending time on a message and present it at the end of a session of interaction.







Topic based summarization

- Summarization- selecting entities of interest under certain constraints.
- How do topics propagate through the network?
 - 'spike' A limited number of nodes talk about a topic for a short duration of time.
 - 'periodic interest' The same set of people talk about this topic across different time intervals.
 - 'diffused' different people talk about the topic over a wide time span.
 - Depends on the granularity of time
- Algorithm
 - Identify all messages related to the given topic .
 - Identify the activity patterns to which these messages belong to.
 - Incorporate query 'memory' concepts importance in the past influences the query.
 - Develop a ranking scheme to order sets of messages within each activity pattern .
 - Pick the top 'k' of these message sets and visualize .

Spike





Periodic interest





Future Work

- Visualization of social network metrics [Freeman 1976].
 - Degree Centrality : Number of Direct Links
 - Group Degree Centrality: the number of non-group nodes that are connected to group members.
 - Closeness Centrality : How "well-connected" is the node to other nodes
 - Betweenness Centrality :Measure of the node's ability to control information flow in the network.
- All these measures can be computed
 - For the entire graph
 - For the graph predicated by
 - Time
 - A specific concept
- Open issue How do we visualize *change* in these metrics over time

Everyday Systems



Shreeharsh Kelkar, Nahla Mattar, Kelly Philips and David Birchfield

Situated Multimedia Systems

- Characteristics of a Situated Multimedia System
 - Situated (Uses the real world itself as the model), Embodied (Participates in the environment) Reactive (Reacts to changes in the environment)
 - Interacting with media using natural gestures and physical artifacts.
 - Multi-sensory input mechanisms and novel output representations. (such as networked distributed displays, ambient soundscapes, etc.)
 - Four aspects Sensing, Analysis, Interaction and Feedback – coupled to each other through User Context.
- Problems
 - Stability of the System
 - Novel Interaction-feedback mechanisms
 - Computational Architectures



Construction and Working

- Rationale
 - Construct a mediated interactive narrative that introduces visitors to the Arts, Media and Engineering (AME) program.
 - Make clear the relationships between people, places, projects, ideas (i.e. concepts)
- Physical Construction
 - Vision-based Sensing, Audio-Visual Feedback, Tangible Interaction with abstract blocks.
 - Interaction Surface = Presentation Surface
 - Artifacts of Interaction also a part of the presentation/feedback
- Content
 - Use of visual elements (brightness, color) to convey abstract information
 - Audio feedback in the form of soundscapes





Interaction and Visualization

- Interaction
 - Use of Tangible User Interfaces
 - Use of wooden blocks (abstract representation)
 - Block Operations translation, rotation, stacking, inverting, occluding etc.
 - Cognitive affordances e.g. simultaneous interaction with multiple artifacts.
- Visual Feedback
 - Use of 2-d space to represent concept relationships
- Characteristics of the Interaction
 - Embodied (part of the environment itself)
 - Implicit rather than command-based ("click", "double-click")





Soundscape Generation

- Sounds complement visuals in an immersive situated environment.
- Barry Traux's Soundscape model used for modeling people/places in terms of sounds (four classes)
 - Keynote tonal center of a soundscape (for instance, the hum of a computer for work environments)
 - Signal an infrequent, sometimes alarming sound (for instance, a police siren or an email alert), conveys some specific information
 - Soundmark acoustic equivalent of a land mark, distinguishes and identifies a particular sonic environment
 - sound romance inspires a feeling of nostalgia or longing in a listener.

Soundscapes

- Generated dynamically.
- Influenced by user interaction and context.

Future Work

- Architectures for Situated Multimedia Systems
 - Behavior-based Systems
 - Hybrid systems that incorporate long-term memory with behavior-based interactions
- Narratives in Situated Systems
- Summarization of Situated Experiences
- Evaluating a Situated Experience (QoE Quality of Experience metric)

Summary

- The physical world poses a significant intellectual challenge, for the development of multimedia systems.
- Experiential media systems can have tremendous impact in health, pedagogy, arts and everyday living.
- Open issues include a multi-sensory sketch, models for context, resource adaptation, interfaces frameworks for semantics, and creative expression.













Thanks to my colleagues and students