hci-reu

Proceedings of the First Annual Virginia Tech Center for Human-Computer Interaction Research Experience for Undergraduates (REU) Symposium

July 13, 2006

5 – 6:30 PM

Knowledge Works II, Blacksburg, VA

Virginia Tech's Center for Human-Computer Interaction presents the project abstracts for the REU ’06 symposium. The REU (Research Experience for Undergraduates) program provides undergraduate students from various universities with the opportunity to spend eight weeks at Virginia Tech, working with our faculty and graduate students on research projects using the state-of-the-art technology and laboratories assembled here. The REU program is sponsored by a National Science Foundation grant IIS-0552732.

REU Sites: Building Interfaces for Tomorrow's Technology

The Virginia Tech Center for Human-Computer Interaction Research Experience for Undergraduates

For more information, visit
http://reu.hci.vt.edu/

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Program at a glance:

- Eight week scholar-in-residence program
- CHCI faculty mentored research projects
- Extensive orientation session
- Weekly lunches with prominent HCI researchers
- Weekly research skills seminar
- Weekly design seminar
- Weekly fun team/community building activities in and around the New River Valley

Students and Universities represented:

- Ashley Peoples, Bennett College, Greensboro, NC
- Mark Velez, Brooklyn College, Brooklyn, New York
- Farid Sultani, California State University, Fullerton, Fullerton, CA
- Janine Hernandez, Norfolk State University, Norfolk, VA
- Daveta Henderson and Jovan Jacobs, North Carolina A&T State University, Greensboro, NC
- Anthony Judkins, University of Pittsburgh, Pittsburgh, PA
- Ryan Engle, Virginia Tech, Blacksburg, VA

Investigating Touch-Screen Interface and Interaction Design in a Car-Computer

Ryan Engle (rengle@vt.edu)
Advisor: Scott McCrickard (mccricks@vt.edu)

Car-computers provide the full functionality of a computer in a vehicle, but standard computer interfaces are very visually and cognitively demanding, taxing resources that cannot be spared while driving. Every second is vital for a driver and saving any time interacting with interfaces makes a huge difference in safety. Input alternatives like touch screens attempt to allow drivers to maintain concentration on driving and still access functions of their computer in a reasonable amount of time and with minimal distraction. However, touch screens require drivers to interact with the screen, taking their eyes off the road for a certain amount of time. This research investigates mathematical input models that maximize user ability to access the functionality most important to them, while maintaining the ability to access less frequently desired actions. By exploring and applying models like Fitts' Law, which suggests that as button size increases the time it takes to touch that button decreases, this work shows how designers can create interfaces to take advantage of button size in relation to more frequently used functions. Application of the results of this research can be used to factor the possible user inputs and approximate the possible next moves and their relative probability of being the user-selected course of action. An initial prototype embodies the ideas from this research, exploring how the size and position of on-screen buttons can combine with voice and other input methods toward a safer, more usable car-computer interface.

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chci
Virginia Tech
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Investigating Touch-Screen Interface and Interaction Design in a Car-Computer

Problem

- Drivers have to take their eyes off the road to interact with car-computer screens.
- Voice recognition can not be implemented well due to high ambient noise in the car.
- It takes too much attention to access all the functions that a car-computer has to offer.

Motivation

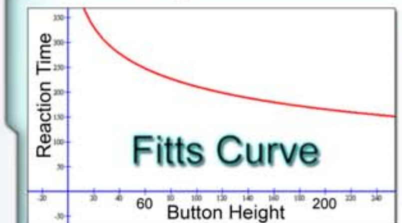
- Car-computers offer a lot of functionality for drivers such as ***media needs***, ***diagnostic tools***, and ***navigation***.
- Interfaces can be very distracting to drivers.
- Use button size information to help users react to their options more quickly and with less effort.
- To work towards developing safer, more easy to use car-computer touch-screen interfaces.

Rationale

As car-computers become more prevalent drivers will need a way of interacting with the interface without distracting themselves from driving. For every **two** seconds a driver takes their eyes off the road they are **seven** times as likely to be involved in an accident.

Designing What "Fitts"

Button height is determined by **Fitts Law**



What is Fitts Law?

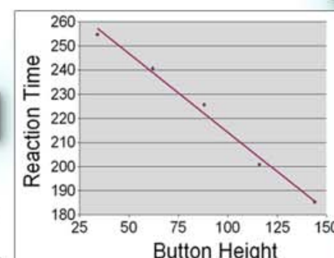
-Relates reaction time to an Index of Difficulty.

-Index of Difficulty is equal to log2(Distance/Size + 1)

As button height ***increases*** reaction time ***decreases***

Button Size Evaluation

How does button height relate to reaction time?

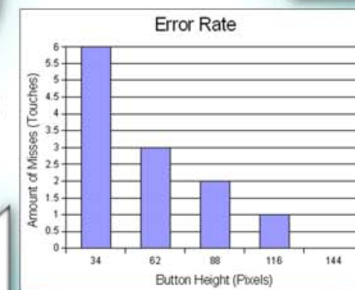


Data suggests as button height ***increases*** the user's reaction time ***decreases*** as evaluated by Fitts law.

Error Statistics

Button height ***increases***

Error rate ***decreases***



Results

- Fitts law suggests as the index of difficulty ***increases***, the user's reaction time ***increases.***
- The button size test suggests as button height ***increases*** the user's reaction time ***decreases***.
  - User error in the test suggests as button height ***increases***, error rate ***decreases.***

Next Step

- Use the information collected to develop interfaces with less distraction.
- Make car-computers a safe and useful alternative to media needs.
- Develop an interface that is a minimal distraction to the driver with maximum functionality.

Unleash Your Emotions

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Mentor: Jamika Burge (jamika@vt.edu)
Advisor: Dr. Deborah Tatar (tatar@cs.vt.edu)

Having researched emotions for over a decade, Ekman concluded that emotions are a deeply embedded part of human existence. Recognizing and understanding emotions is essential to improving communication between individuals. This research focused on investigating the effects of technology on communication in conflict resolution through one of the three communication media: instant messenger, telephone, or face-to-face. Finding a positive correlation between two kinds of facial displays using inter-rater reliability, it appears to be high for the anger/frustration emotion over the telephone media. The research on emotions is highly explorative. Future research requires more extensive analysis of video and transcript data. Identifying the affordance of each communication channel for expression of particular emotions is important in understanding how technology and communication work hand in hand.

"Unleash Your Emotions"

Daveta Henderson

Dr. Deborah Tater- Advisor assisted by Jamika Burge

Overarching Objective

- Investigating the effects of technology on communication in conflict resolution
- Study three communication media

Phone

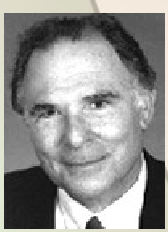
Instant Messenger

Face to Face

Research Goal

- Analyze video data and identify facial expressions displayed during controlled arguments between couples.
- Determine inter-rater reliability in data analysis

Background



Paul Ekman PhD.

- Pioneered study of emotions and facial expressions.
- Found that some facial expressions and corresponding emotions are universal to human culture.
- Eg: **anger, disgust, fear, joy, sadness, surprise, and contempt**.

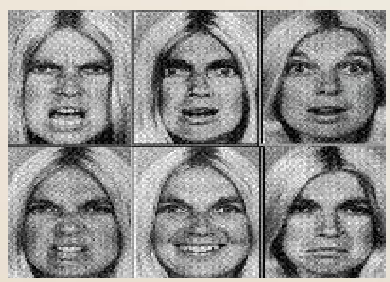
Definitions

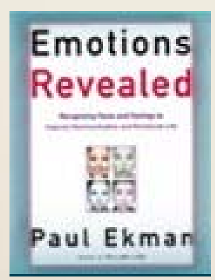
Coding?

- The act of transforming data with the aim of extracting useful information and facilitating conclusions.

Inter-rater reliability?

- Is the extent to which (two or more individuals) coders agree.
- Addresses the consistency of the implementation of a rating system.





Methodology

A. Observe two sets of Video tapes capturing two kinds of experiments:
   - 24 timed couples experiments (20 minutes)
   - 59 un-timed couples experiments (~ 30 minutes)

B. Identify and document high stake emotions **(Anger/Frustration, Contempt/Disgust, Fear, Relief, and Excitement*)*** on an Emotional Argumentation Coding Form.

C. Code for **five** high stake emotions from recorded video tapes.

Preliminary Results

- Found a positive correlation between two kinds of facial displays.
- Inter-rater reliability appears to be high for the Anger/Frustration emotion over phone channel

Future Work

Current research is highly explorative, requires more analysis of video and transcript data

Identify the affordances of each communication channel for expression of particular emotions

References

Eckman, P. (2003). Emotions revealed. Times Books

Tatar, D & Burge, J. D. (2005) Pragmatics of emotional computing: Emotion in mediated communication.

Talking Back to Government

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The level of technical sophistication of citizens should not limit the exchange of ideas on various issues between local government and its constituents. Technology exists today that will allow citizens to phone-in a comment to a government website. VoiceXML is a programming language that can be used for an interactive voice system, which allows users, who have access to a phone, television, and newspapers, to participate in local government by leaving voice comments for local policy makers. A menu driven VoiceXML interface prototype was designed for users to leave comments on current agenda items viewed on public television and listed online. This is a first step toward reaching an alternative method of communication between local government and the people it represents.

Talking Back to Government

Janine L. Hernandez

Dr. Andrea Kavanaugh,Dr. Manuel Perez-Quinones; Advisors with assistance from Hyung Nam Kim and Anthony Judkins

Problem

•What means of communication do most citizens have that can be used to connect local government and the community

Methodology

• Surveyed literature
• Prototyped a voice interface
• Conducted pilot tests with representative user

Concept

• Use the technology that is available to most citizen's (e.g phone, TV)

• Use VoiceXML scripts stored on a Web server through a remote VoiceXML portal

• Make existing content on your Web site available to the voice application

Future Work

• Test prototype on a small group and document results

• Use other technologies such as PHP and SQL to manage the VoiceXML files, more efficiently

Local citizen's

Got a phone?

Seniors, low income, technophobes

Partial VoiceXML Code

<prompt>
Welcome to the Blacksburg community comment line.
Pause. **Which agenda item would you like to comment on.**
Pause **Housing**
Pause **Neighborworks**
Pause **Kabrich Street**
</prompt>

Voice Server

Bevocal Café

Vocal Debugger

VoiceXML request

Presentation of data from a VoiceXML portal

Make a Comment

Government Site
http://www.blacksburg.gov

ARDEX: An Integrated Framework for Handheld Augmented Reality

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Augmented reality (AR) promises to advance user experiences in various fields. However, mobile AR systems to date have been cumbersome, costly and lacking in usability. We propose a handheld hardware/software framework called Augmented Reality-based Digitally Enhanced Experiences (ARDEX) that resolves these issues. We use Pocket PCs with mounted CF cameras and develop a real-time fiducial-based tracking and geometry rendering system. We implement a prototype of an interactive art exhibit guide and analyze the effectiveness of ARDEX in this environment and in other potential applications.

ARDEX

Augmented Reality-based Digitally Enhanced eXperiences

Integrated Framework for Handheld Augmented Reality

Mark Velez, Jovan Jacobs, Joe Gabbard

Center for Human-Computer Interaction, Virginia Tech

Motivation

Augmented reality promises to advance user experiences in various fields. However, mobile AR systems to date have been:

- Cumbersome
- Costly
- Lacking usability

We propose a handheld hardware/software framework that resolves these issues.

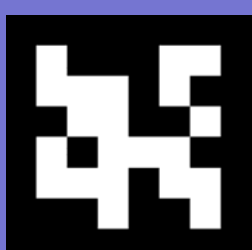
Approach

Integrate **commercial off-the-shelf** handheld, operating system and camera

Track fiducials using **real-time video**

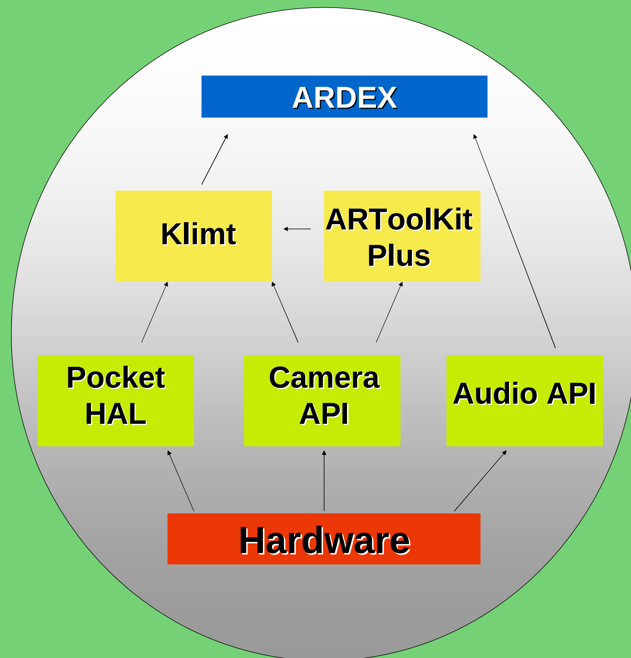
Access graphics hardware at **interactive framerates**

Construct software framework to support handheld AR research and application development



Fiducials used to calculate camera *position* and *orientation* in **real-time**

Software Architecture



Application Areas

Interactive Guide

System successfully used to provide registered location-aware information

Wayfinding

Overlaid 3D graphics can be used to enhance 2D maps

Lessons Learned

Handheld with mounted camera a viable solution to common mobile AR challenges

Fiducial-based compositing easily hindered by environment factors

Future Work

A handheld guided tour of the Virginia Tech campus

- **Global positioning** and **image processing** for more effective tracking
- **Speech recognition** for hands-free interaction

Acknowledgements

Daniel Wagner from Graz University of Technology and Thierry Tremblay without whose support and hard work this project would not be possible.

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Body Motion Detection System Using a Wireless Embedded Sensor Network

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At the university level, students are required to sit through many hours of lecturing. With tens and sometimes hundreds of students in a class, it is very difficult for an instructor to realize when the students are being inattentive. By creating a system in which a wireless sensor network is embedded into a classroom of chairs, an instructor will have the ability to monitor the attention level of the students and adjust the lecture accordingly. In order to understand how gestures in a chair correlate with human emotion, an existing data set of intense dialogue was used. After analyzing this data, a list of body motions was compiled using this footage, resulting in the creation of a conceptual design for the system. Force sensors will be placed at various places on the surface of the chairs to detect any changes in the students' body position. A two-axis accelerometer will be mounted beneath each chair to sense any movement caused by the chair rolling or spinning. Future work on this project will include exploring other places where this system could be useful such as in the medical field or in the workplace. The possibility of using data from tilt and heat sensors will also be investigated.

Body Motion Detection System Using a Wireless Embedded Sensor Network

Anthony Judkins
Dr. Deborah Tatar, Mentor
With assistance from Jamika D. Burge

Motivation

•Professors lecture tens and sometimes hundreds of students, but can't realize when the class is inattentive

•MIT's Media Lab used pressure mat on chair, but it wasn't wireless and it only tracked 9 static postures

•Yifei-Wang (Iowa State Univ.) used force sensors in sensor network to track human movement

•System will allow instructors to monitor the attention level of their students and adjust

Wireless Sensor Networks

•Network of small sensor nodes (motes) communicating among themselves using radio signals

•Motes are small computers that consist of a processor, memory, and radio

•Deployed in large scale to sense the physical world

•Takes readings from sensors and sends messages to base computer when pre-programmed events happen

•Sensors can detect temperature, light, sound, position, **acceleration**, vibration, stress, **force**, pressure, humidity, etc.

Current Uses:
- •Environmental/Habitat Monitoring
- •Military/Home Surveillance
- •Building Monitoring
- •Seismic Detection
- •Medical Monitoring

System Design

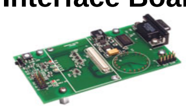
Amount of force being applied:
- Very High
- High
- Medium
- Low
- Very Low
- None

System Hardware Components

Motes

•MICA2DOT
•Battery operated computers with limited resources

Interface Board



•MIB510 Serial Gateway
•Used to program motes

Sensors

•Tekscan Flexiforce
•Sensing area less than in inch in diameter

Sensor Boards/Data Acquisition Modules

•MDA500 MICA2DOT Prototype and Data Acquisition Module (right)
•Allows user to connect external signals to motes
•MTS510 MICA2DOT Sensor Board (left)
•Contains light sensor, microphone, 2-axis accelerometer

Software

TinyOS

- Event-driven operating system designed to run on wireless sensor networks
- Sleeps waiting for events to save battery power
- Programming done in low-level extension C called nesC

TinyDB

- Included with TinyOS
- Takes care of networking
- Can do most of the programming in Java without knowing nesC

Future Work

• Purchase hardware, use TinyDB with larger database server to collect data from people seated in various postures

• Deploy sensor network in classroom to see correlation between body movements and attentiveness

Explore other useful sensor readings:
- •Tilt
- •Heat

Explore other possible uses for system:
- •Medical field
- •Workplace

Usability Guidelines for Group Decision Support Systems (GDSS)

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Since Heuber's 1984 article on Group Decision Support Systems (GDSS) the concept of GDSS has been researched by over 40 authors (Eom, 1999), yet the system itself has had little development. In an increasingly complex society in which groups, teams, and executive boards must disseminate information in the most time and cost effective way, it is important that the development of an effective and user-centered GDSS be undertaken. A review and synthesis of the applicable literature was conducted to identify and validate a new set of usability guidelines for GDSS. This paper seeks to address the current state of GDSS, issues in design of GDSS, and provide usability guidelines for researchers who will investigate and further the use of GDSS. It is the author's conjecture that this work could be used to construct a GDSS design framework.

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Usability Guidelines for Group Decision Support Systems (GDSS)

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What is GDSS?

A Group Decision Support System (GDSS) is an interactive, computer-based system that helps a team of decision-makers solve problems and make choices. GDSS are targeted to supporting groups in analyzing problem situations and in performing group decision-making tasks.[1]

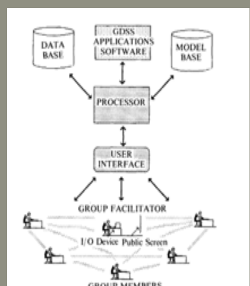

FIGURE 1. A Model of a GDSS.

Benefits of GDSS

- ➢ Enables parallel communication amoung group members.
- ➢ Offers equal and anonymous opportunity to contribute ideas and opinions.
- ➢ Prevents domination of the meeting by domineering people.
- ➢ Provides effective automatic documentation capabilities.
- ➢ Quickly identify common and divergent viewpoints.
- ➢ Helps to manage the schedule and agenda of the meeting.

Motivation

➢ Little domestic development since Heuber's 1984 article on Group Decision Support Systems (GDSS)

➢ The concept of GDSS has been researched, globally, by over 40 authors

➢ It is important that the development of an effective and user-centered GDSS be undertaken to respond to increasingly complex modes of information dissemination

Approach

➢ Literature review of Group Decision Support Systems (GDSS) from engineering and psychological perspectives

➢ Synthesis of literature to identify and validate a set of research-based usability guidelines for GDSS.

- ➢ Decision rule: replication of principles in reviewed sources

Result: Usability Guidelines

Guidelines for Information, Instruction, and Interface Design for Group Decision Support System

NO	Guidelines	Sources	Principles	Sources
1	Automated support systems should support anonymity during brainstorming phases of the group process	McLeod, P. "A comprehensive model of anonymity in computer-supported group decision making."		
2	Should help user define the problem that must be solved	http://www.managementhelp.org/prsn_prd/prb_bsc.htm		
3	Should help the user prioritize the smaller parts of the problem	http://www.managementhelp.org/prsn_prd/prb_bsc.htm		
4	Should help user identify potential causes of the problem	http://www.managementhelp.org/prsn_prd/prb_bsc.htm		
5	Should help user identify alternatives for approaches to resolve the problem	http://www.managementhelp.org/prsn_prd/prb_bsc.htm		
6	Should help the user select an approach to resolve the problem.	http://www.managementhelp.org/prsn_prd/prb_bsc.htm		
7	Should support the forming stage of the group's developmental process.	http://www.gmu.edu/student/csl/5stages.html	The forming stage allows for group members to feel safe and accepted within the group while orienting the members to the tasks and one another.	Tuckman, B. (1965) Developmental Sequence in Small Groups. Psychological Bulletin, 63, 384-399
8	Should support the storming stage of the group's developmental process.	http://www.gmu.edu/student/csl/5stages.html	The storming stage is filled with inner and outer conflict in group members as they must organize for the task and organization of the group.	Tuckman, B. (1965) Developmental Sequence in Small Groups. Psychological Bulletin, 63, 384-399
9	Should support the norming stage of the group's developmental process.	http://www.gmu.edu/student/csl/5stages.html	Cohesion takes place and group members engage in active acknowledgement of each members' contribution, community building and maintenance, and solving of group problems.	Tuckman, B. (1965) Developmental Sequence in Small Groups. Psychological Bulletin, 63, 384-399
10	Should support the performing stage of the group's developmental process.	http://www.gmu.edu/student/csl/5stages.html	Productivity. Members are task oriented and people oriented. Genuine problem solving takes place.	Tuckman, B. (1965) Developmental Sequence in Small Groups. *Psychological Bulletin*, 63, 384-399
11	Should support adjournment of the group.	http://www.gmu.edu/student/csl/5stages.html	Termination of task behaviors and disengagement from relationships, a conclusion of the process.	Tuckman, B. & Jensen, M. (1977) Stages of Small Group Development. *Group and Organizational Studies*, 2, 419-427.
12	Should develop the group members' shared mental model.	Yen, J. et. al. (2006) Agents with Shared Mental Models for enhancing team decision making. Decision Support Systems.		
13	Should help the user identify a clear and elevating goal	http://home.nycap.rr.com/klarsen/learnorg/#_Toc[illegible]		
14	Should help define and support the role of the facilitator/leader/coach.	http://home.nycap.rr.com/klarsen/learnorg/#_Toc[illegible]		
15	Should provide the option for users to use the technology in a task fit situation.	Zigurs, I. et. al. (1999) A Test of Task Fit Technology. *The Data BASE for Advances in Information Systems*, 30, 34-50.		
16	Should allow users to access multiple computer applications within the GDSS (i.e. word processor, spreadsheets, internet, databases, & project management) as seamlessly as possible.	DeSanctis, G. & Gallupe, B. (1985) Group Decision Support Systems: A New Frontier. DATA BASE.	"More than one application is indeed, used by decision makers. The significant mean number of applications used was 2.28"	Gessner, M. et.al. (1992) Computer assisted decision support systems: Their use in strategic decision making. ACM

Current State of GDSS

➢ GDSSs are developed primarily outside of the U.S.

➢ University of Arizona is the only university in the U.S. that has a GDSS laboratory.

➢ Some researchers still categorize GDSS research as experimental.

➢ City government and corporations have begun to use GDSS software to help make business decisions.

Industry	Percentage using GDSS
Financial Institutions	18%
Computer Service Bureaus	18%
Government and Military	16%
Trade	16%
Utilities	12%
Manufacturing	11%
Education	5%
Medical and Legal Services	2%
Petroleum	2%
Transportation	2%
	Total...100%

Figure 5. Percentage of Industries using GDSSs, in Rank Order

Future Research

➢ A design and evaluation framework for GDSS.

➢ GDSS design needs for multicultural groups.

➢ Empirical studies on the effects of GDSS on multicultural groups and decision-making.

➢ Field studies on the use of GDSS in large vs. small groups.

Conclusion

GDSS has the potential to help groups reach higher quality decisions, stimulate more equitable and useful interactions, and reduce the negative aspects of group decision making. These usability guidelines are a foundation for the development of GDSS in the U.S.

References
1. DeSanctis, G., and R. Gallupe. A Foundation for the Study of Group Decision Support Systems. *Management Science*, May 1987, 33(5).
2. Straub, D. W. and Beauclair,R. (1988) Current and future uses of GDSS technology: Report on a recent empirical study. *IEEE*

Exploring Task Structure Preferences of Users for 3D Virtual Environments

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Advisor: Dr. Doug Bowman (bowman@cs.vt.edu)

In most command line environments, task structures take on a verb-object form, where the verb or command is chosen before the object or parameter. In most 2D environments, however, task structures take on an object-verb form, where the object is chosen before the verb or command, such as in the common desktop. How then, should tasks be structured for 3D Virtual Environments (3D VEs). By observing user performances and preferences of various task structures in a longitudinal study, we hope to establish a guideline for designing applications for 3D VEs with respect to appropriate task structures. The longitudinal study utilizes an interior design application that allows a task to be completed using various methods. By observing which methods users prefer to complete these tasks over an extended period of time, as they progress from a novice user to an expert user, we learn more about how applications for 3D VEs should be designed.

Exploring Task Structure Preferences of Users for 3D Virtual Environments

Farid Sultani

Ryan McMahan, Mentor

Dr. Doug A. Bowman, Advisor

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Motivation:

In Command line environments, task structures are in verb-object form.
In 2D environments, tasks structures are in object-verb form.
How should tasks be structured for 3D Virtual Environments (VEs)?

Project Goals:

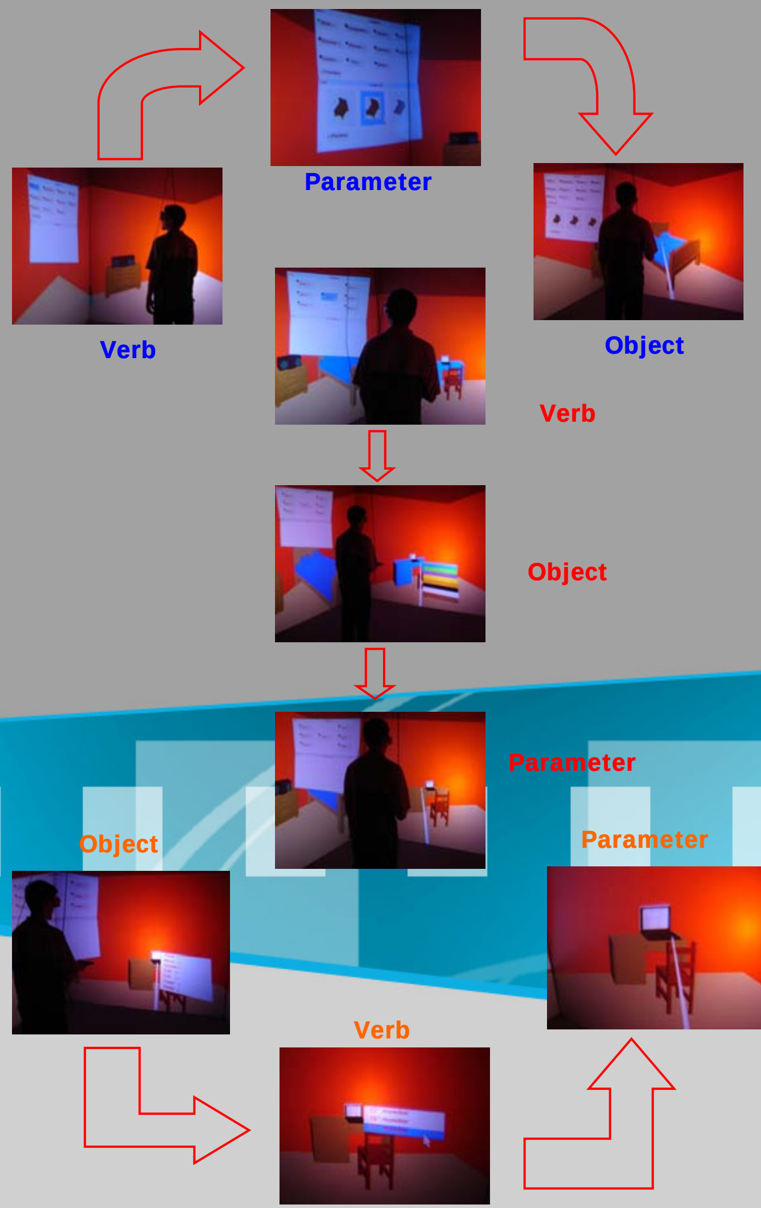
- Create and utilize a command-rich VE application
- Observe user performance over an extended period of time.
- Use the observations to create guidelines for developing user interfaces for future VE applications.

BIDAVE (Bedroom Interior Design Application Virtual Environment)

Application Features:

➢ *Place Bedroom items*	➢ *Rotate items*
➢ *Remove Items*	➢ *Cut items*
➢ *Move items*	➢ *Copy items*
➢ *Edit items*	➢ *Paste items*

User Interface



Implementation

Application created for use in the VT CAVE (http://www.cave.vt.edu/).
BIDAVE was developed using DIVERSE (http://diverse-vr.org/) and employed VEWL (Virtual Environment Windowing Library).

Proposed Experimental Design

- Longitudinal User Study
- Task Overview
  - Session 1: Introduction.
  - Session 2: Recreate room under specific guidelines.
  - Session 3: Recreate room under general guidelines.
  - Session 4: Recreate room without guidelines.
  - Session 5: Create any room the user wishes
- Variables
  - Dependent Variables: Time/Accuracy
  - Independent Variables: Task Structures
- Subjective Measures

Expectation Results

- Determine task structure preferences of users for 3D VEs.
- Results will support establishing task structures when designing applications with 3D VEs
- Enable the development of better future virtual environment applications.