Simulation & Learning using Gesture-based Computing and Brain Computer Interfaces

Sridhar Natarajan, Ph.D.
Advisor Information Technologies

Schawn Thropp
Advisor Technologist

Alan Hoberney
Executive Director, Information Management & Technologies Capability
CTC Overview

- 501(c)(3) nonprofit established in 1987
- Staff of 1,400+ professionals
- More than 50 locations
- 900,000 sq. ft., including labs & demonstration space
- Top 100 Government Contractor
- Quality/EH&S Management System comprised of industry-best models: ISO 9001 (Quality) and 14001 (Environmental), AS9100 (Aerospace), and CMMI-SE/SW (Systems/Software Engineering)
- Nationally recognized security capabilities with 300,000+ sq. ft. of Top Secret/Sensitive Compartmented Information Facility Space, JWICS, SIPRNet, and NIPRNet access
Overview

• Participants in this session will:
  – Learn about:
    • Gesture-based Computing Interface Technologies
    • Brain Computer Interface Technologies
  – Understand the “art of the possible”
    • Current and potential simulation & learning “low cost”, “high impact” technologies
  – View a demonstration
  – Participate in “ideation”
CTC employees demonstrate progress on a research and development project using human computer interface technology.
Key Message

• Gesture-based Computing and Brain Computer Interface technologies are:
  – **Affordable**: Systems are <$1000
  – **Supported**: Open source “ecosystem”
  – **Mature**: Available commercially
  – **Intuitive**: Low cost human capital requirements

• We are seeking opportunities for collaborative research and technology development for applications in Learning & Simulation

To accelerate progress towards the Next Generation Simulation/Learning & Human Performance Systems!
CTC desires to move the market this way!

Market Pressures
- Budget Shifts
- Paradigm Shifts

Goal/End-state
- Economies of Scale
- Lower Dev Costs

Next Generation L&HPS
- Personalized
- Adaptive
- Ubiquitous
- Modern Platforms (Computing, Communication, Device)
- ...
Gartner Hype Cycle: July 2011

Source: Gartner Inc.
Demonstrations

- Avatar Training
- Google Earth User Interface
- Quadricopter Drone Control
- Humanoid Robot Control
## Ideation: Potential Applications

<table>
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<tr>
<th>Application</th>
<th>Description</th>
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<tr>
<td>Neurofeedback</td>
<td>Practice generating the state of mind most beneficial to their sport, art or desired behavior</td>
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<tr>
<td>Adaptive Peak Performance Trainer (APPT)</td>
<td>Real-time analyses of EEG and heart rate to provide automated feedback of trainees’ psychophysiological state in relation to an expertise profile</td>
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<td>Neurostimulation</td>
<td>Modulation of the nervous system and electrically activate neurons in the body – including sight and sound</td>
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<tr>
<td>Thought Pattern Recognition</td>
<td>Mental state identification to deliver dynamically adaptive training, gauge operator readiness</td>
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<tr>
<td>Gesture-Based Avatar Training</td>
<td>Train avatar by recording realistic human behavior instead of via code. Intelligent reaction of avatars, avatars that behave in a realistic way through gestures and body language - Kinesics</td>
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<td>“Touch Free” Interfaces</td>
<td>Operators in sterile and/or hostile environments who cannot use their hands</td>
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CTC is seeking opportunities for collaborative research and technology development for applications of Gesture-based Computing and Brain Computer Interfaces in Learning & Simulation!
QUESTIONS
Technical Points of Contact:

Sridhar Natarajan, Ph.D.
Advisor Information Technologies
814-269-6220
nataraja@ctc.com

Schawn Thropp
Advisor Technologist
814-269-2579
thropps@ctc.com

Business Development Point of Contact:

David A. Kingston, P. E.
Director, Learning and Human Performance Solutions
573-329-8548
kingstod@ctc.com
Backup Slides
Brain Computer Interface Example

• Application: Neurofeedback
• Audience: athletes, musicians, dancers, ADD
• Result: Practice generating the state of mind most beneficial to their sport, art or desired behavior
• Technology Enabler: presentation in real time of information about the state of the brain
• References: Desney S Tan, Anton Nijholt
Brain Computer Interface Example

• Application: Adaptive Peak Performance Trainer (APPT)
  – Performs Real-time analyses of EEG and heart rate to provide automated feedback of trainees’ psychophysiological state (in relation to a psychophysiological profile of expertise).

• Audience: Archery, Golf and Rifle Marksmanship

• Outcome: Marksmanship learning trajectories improve significantly when novices train with the APPT as compared to controls.

• Technology Enabler: measurements of electroencephalographic (EEG) frequency bands of theta (3-7 Hz) and alpha (8-12 Hz)

• References: Chris Berka, Adrienne Behneman, Natalie Kintz, Robin Johnson and Giby Raphael.
Brain Computer Interface Example

• Application: Neurostimulation
  – Modulation of the nervous system and electrically activate neurons in the body
• Audience: Hearing & Sight Disadvantaged, Epilepsy
• Outcome: Improved Hearing, Sight
• Technology Enabler: Cochlear Implants, Visual Prosthesis
• References: Jobst BC, Darcey TM, Thadani VM, Roberts DW
Brain Computer Interface Example

• Application: Mental state identification to deliver dynamically adaptive training, gauge operator readiness
• Audience: Drivers, surgeons, first responders, military personnel
• Outcome: Recognizing thought patterns
• Technology Enabler: Neuroimaging, Functional magnetic resonance imaging (FMRI) brain scans, Emotiv Systems headset
• References: Just, Marcel, Mitchell, Tom, Nishimoto, Shinji
Gesture-based Computing Interface Example

- Application: Avatar training
- Audience: Game developers
- Outcome: Train avatar by recording realistic human behavior instead of via code
- Technology Enabler: Kinect
- References: Demonstration
Gesture-based Computing Interface Example

• Application: Interrogation or Interviewing Training
• Audience: New hires, focus groups, therapy session, criminal investigations – Observing Kinesics of a person
• Outcome: Intelligent reaction of avatars, avatars that behave in a realistic way through gestures and body language
• Technology Enabler: Microsoft 260 Kinect Gesture Recognition system, Unity, Omek and OpenNI
• References: Demonstration
Gesture-based Computing Interface Example

- **Application**: “Touch Free” Interface
- **Audience**: Operators in sterile or hostile environments who cannot use their hands
- **Outcome**: Use of more natural movements in training situations, augmented learning situations
- **Technology Enabler**: Motion detection system (Kinect)
- **References**: Institute of Forensic Medicine – University of Bern in Switzerland: hands-free way to review radiological images
**Summary:**
Combining Neuro-Technology along with synergistic technologies*, CTC is ushering in a new paradigm of “Human-Machine” interactions within current & future applications to meet and exceed the Healthcare needs of US Veterans.

* such as Gesture Recognition, Haptics, Facial Expression Recognition, Voice Recognition and Advanced Data Visualization

**Details:**
- Neurotechnology is the application of medical electronics and engineering to the human nervous system
- Off the Shelf (COTS) technologies that can read and interpret Brain Activity, Brain States and Emotions; and integrate with external software and hardware systems/devices/appliances
- Partnerships with research organizations and technology vendors
- CTC’s Internal Research & Development (IR&D) ongoing efforts: 3-5 Year Outlook for applications in DoD and VA

**Applications:**
- Prosthetics
- Treatment of paralysis
- PTSD/TBI monitoring, analysis and treatment
- Pain Management
- Quality of Life Control (e.g. wheelchair, automated home)
- Re-habilitation: Game-based Learning

**Relevant VA Initiatives**
- Veteran Mental Health (IVMH) Initiative
- New Health Care Model (NHCM) Initiative
- Research & Development (R&D) to Enhance the Long-term Health and Well-being of Veterans