Toward the Holodeck
Integrating Graphics, Artificial Intelligence, Entertainment and Learning

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ICT: Entertainment meets Technology
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Technology
- Artificial Intelligence
- Graphics
- Immersive displays
- Interactive media
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Entertainment
- Story
- Character
- Games
- Production
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Synthetic experiences so compelling that the participants react as if the simulation is real...
Toward the Holodeck...
The Holodeck: What’s Needed?

- Photo-real Graphics
- Immersive Environments that surround participants
- Virtual Humans that behave like real humans
- Compelling Story
Synergies from convergence

- From integration of diverse technologies
- From integration of content and technology
ICT Graphics
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- **Goal:** Advance state-of-the-art graphics technologies to produce:
  - Realistic virtual environments
  - Realistic virtual characters
  - Realistic integration of synthetic and real-world imagery
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  - Hollywood budgets
  - Hollywood production timelines
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*And do it in real time and make it rapidly reconfigurable*
Facade

- Most 3D computer models built by artists
- Could we use photographs to construct a 3D model rapidly?
Photos of building to model
Derived 3D model
Add image texture to model
Recording Light

- Assembled from ten digital images
- $\Delta t = 1/4$ to $1/10000$ sec
Real-World Lighting Environments
Re-Illuminated Faces

Photoreal, but *static*!
Lightstage 6

- Allows capture of live performance & re-illumination under arbitrary lighting conditions
Character Created Using Lightstage
Immersive Environments

Flatworld Project

Jarrell Pair
Diane Piepol
Tim Fescoe
Kip Haynes
Matt Liewer
Brad Newman
Joseph Nunn
Ramy Sadek
Anton Treskunov
Tae Yoon
Immersive Environment

- Create environment that:
  - Stimulates all the senses
  - Allows participants to move freely
  - Supports individuals and groups
Problems with current environments (Head-mounted display, CAVE, etc)

- Hard to walk around in virtual environments
- Virtual objects hard to grasp and manipulate
- Hard to rehearse groups of people
Flatworld: Key Idea

- Combine computer-generated imagery and sound with traditional stagecraft techniques (flats, props, scenery)

- Result: highly flexible and navigable virtual environment...
Imagine a simulated world with characters that are almost human...
Virtual Humans: The Vision

Imagine a simulated world with characters that are almost human specifically they:

– Are unscripted
– Fully perceive their environment
– Interact in a fluid, natural way using verbal and non-verbal communication
– Manipulate and interact with environment
– Exhibit emotions
– Model their own and other’s beliefs, desires and intentions
– Do it all in a coherent, integrated fashion
Where we started: State of the art (1998)
A trainer for shipboard tasks
Virtual Humans: Mission Rehearsal Exercise Project
MRE Project

• **Supporting Research Projects**
  • Speech Recognition
  • Natural Language Understanding and Generation
  • Dialogue Management
  • Speech Synthesis
  • Task and Domain Reasoning
  • Emotions
  • Gesture generation
  • Perception
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Appraisal Theory
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Smith and Lazarus91 cognitive-motivational-emotive system
Appraisal Theory

Smith and Lazarus'91 cognitive-motivational-emotive system

Environment

Desirability
Expectedness
Controllability
Causal Attribution

Goals/Beliefs/Intentions
Deriving emotions...

“Conventional” emotions (anger, sadness, fear, etc) derived from appraisal variables:
- undesirable, not controllable, uncertain = fear
- undesirable, certain = sadness
- undesirable, causal attribution = anger
Sgt’s Appraisal of Accident from his perspective
Sgt’s Appraisal of Accident from his perspective
Sgt’s Appraisal of Accident from his perspective

Perspective: Self (Sgt)
Desirability: -80
Likelihood: 100%
Blame/Credit: unresolved

Distress: 80
The Value of Integration

- Integrating a broad range of components that support human behavior
  - Speech Recognition
  - Natural Language Understanding and Generation
  - Dialogue Management
  - Speech Synthesis
  - Task and Domain Reasoning
  - Emotions
  - Gesture generation

...is daunting BUT it brings together needed knowledge not otherwise available
Example: Resolve Question Focus
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What Happened Here?

- Possible answers:
  - You just drove up, sir.
  - The medic started treating the boy.
  - We got out of our humvees.
  - I assembled the troops at the rendezvous point.
  - There was an accident.
Use Recency
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Integration provides additional knowledge...

- Use emotion model
  - \textit{SGT is upset about accident}
Use Emotion

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*Synergy from integrating emotion modeling and natural language processing*
Moving beyond Mission Rehearsal.....
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Could we use virtual humans to teach negotiating skills?
Demo: Negotiate location of clinic

- **Background:** Operations are planned in area of relief clinic
- **Your mission:** Persuade doctor & town elder to re-locate clinic (without revealing operational plans)

Intended as integrated research prototype, not full training system
A Compelling Story

- A good story is more than an event list
- **Elements of a good story**
  - Emotional engagement & identification
  - Dramatic arc: dilemma presented, developed and ultimately resolved
  - Surprises (things go wrong)
Function of a good story
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  - Makes virtual humans feasible
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  – Multi-party NL; Uncooperative communication
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  - Spanish doctor: lowers expectations for fluency in English
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Stories in Interactive Environments: Issues

- Many story telling techniques assume traditional linear story (movie, drama, etc)
  - Writer controls everything

- Interactive environment: immersed participant needs freewill

- How can we be sure participant has appropriate pedagogical experiences?

- Active direction (Riedl, Young)
  - Computer agent uses environment, non-player characters and coach to limit participants options
  - Example: *The Truman Show*
What have we learned from Hollywood?

- **People want to believe**
  - Creating the right expectations is critical

- **The whole is greater than the sum of its parts**
  - Graphics, sound, behavior and story all work together to create experience

- **A hybrid approach is often most effective**
  - Don’t have to model everything the same way, e.g.
    - Live action
    - Models
    - Computer graphics
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