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BioSimMER: Virtual Reality Based Experiential Learning

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BioSimMER: Virtual Reality-based Experiential Learning

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Application / Rationale

- **Medical first response training**
- **Augment current training methods**
 - **Live exercises used for PBL (experiential)**
 - **Expensive, complex,**
 - **Not done routinely**
 - **Moulage etc often has limitations**
- **VR**
 - **More accessible, affordable**
 - **Fill in gaps**

Research Goals

- Create realist training environments
- Incorporation and presentation of dynamic patient models
- Allow users to act upon and affect the state of their environment
- Manual manipulation required for emergency responder training
- Due to complexity, actions are limited
- Limitations based upon application-specific tasks

Development

- **System is prototype**
- **Effort was technical development**
- **8 years of overall development for underlying technology and medical application**
- **Initial acceptance study at National Emergency Response and Rescue Center**
- **Sponsors:**
 - **Sandia Labs, DOE, DARPA, NHRC**

Development

Team

Dan Shawver

Monica Prasad

James Singer

Lydia Tapia

Ron Hightower

Dave Rogers

... and others

Collaborators

Annette Sobel, SNL

Norm Badler, Upenn

Mike Zyda, NPS

Eric Allely, Tekamah

**Scott Thompson,
Tekamah**

... and others

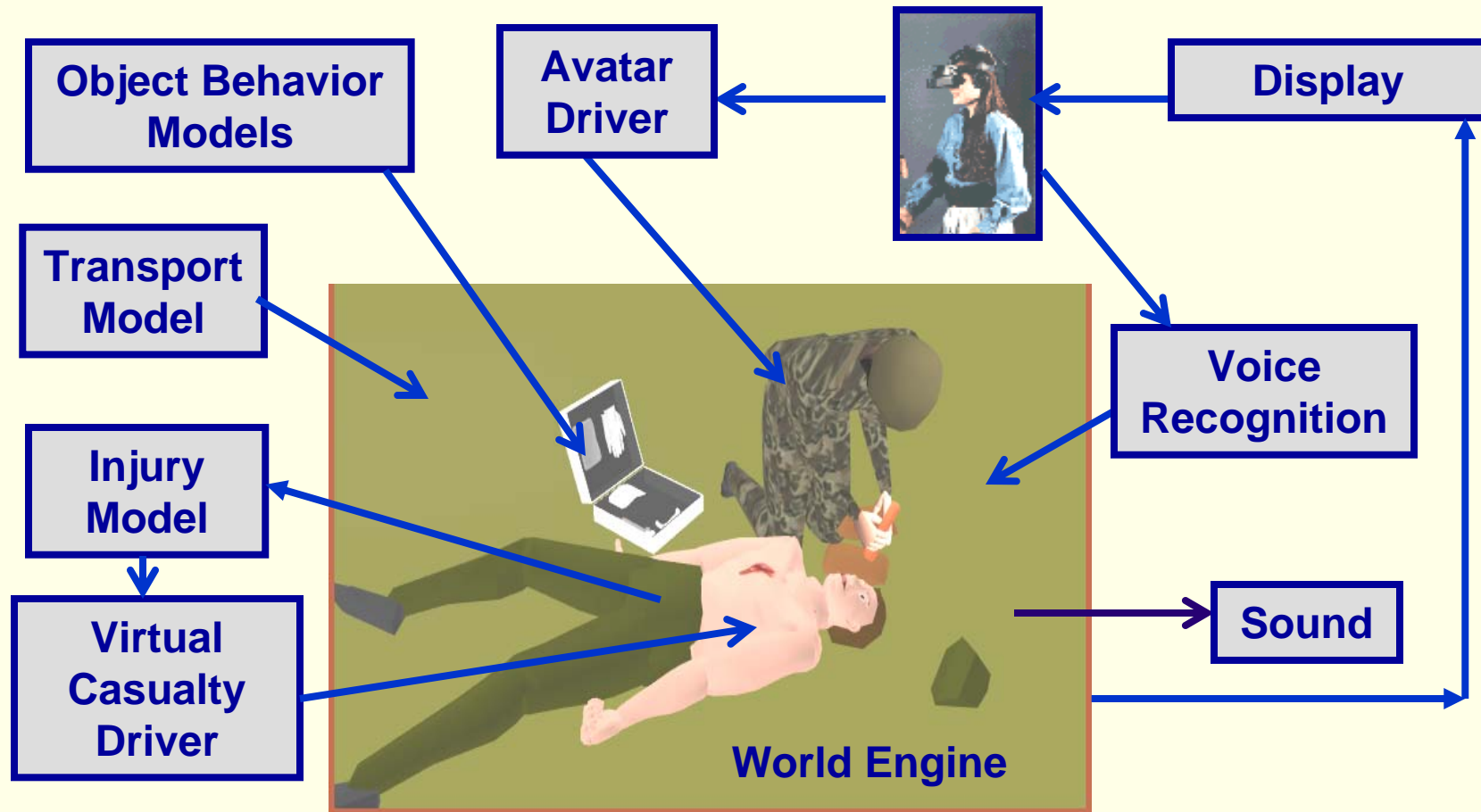
Training Scenario

- **Act of terrorism involving an explosion and release of a biological agent (SEB)**
- **Multiple casualties**
 - **Conventional injuries**
 - **Exposure to agent**
- **Training Tasks**
 - **Initial diagnosis and stabilization**

System Components

- **4 SGI Octane workstations**
 - **MXE hardware**
 - **Dual processor**
- **HMD**
 - **I-glasses, PT01**
- **Ascension flock of birds**
 - **8 trackers, extended range**
- **Entropic voice recognition**
- **SGI sound hardware**
- **Standard networking**

System Configuration



VR Platform

- **VR_Station**
 - **Multiple, independent users**
 - **Modular, distributed (networked)**
 - **Open, hierarchical architecture**
 - **Used for multiple applications**
 - **VRaptor**
 - **ViewPRO**
 - **COVRIP**

Representing the User: The Avatar



Geometry: MOPP
Protective gear

- **Trainees work as team**
- **Must be represented as individuals**
- **Real-time sensor driven**
- **Integrated approach:**
 - **Kinematics**
 - **Interpolation**
- **Semi-autonomous**
 - **reach vs. grasp**
 - **object handling / use**

World Engine

- **Provides overall infrastructure**
 - **Drives object-object interactions**
 - **Coordinates communication between VR modules and simulation modules**
 - **Avatar driver**
 - **Virtual patient driver (FSM)**
 - **Manages simulation steps (cycles)**

Virtual Objects

- **Virtual objects have the following:**
 - **The are manipulatable**
 - **Allow grasping, handling, application of one object to another**
 - **They are semi-autonomous**
 - **Invoke behaviors that simulate their dynamic state (grasped object moves with hand)**
 - **They are interactive**
 - **Change state in response to user actions**

Virtual Object Manipulation



Hand and J-tube cooperate during grasp.

Patient and J-tube cooperate during insertion.

- **Manipulation of virtual objects is based on object-object communication**
 - **E.g. grasping is a cooperative operation between the hand and the object being grasped**
 - **Likewise, application of object during task is a cooperative operation between (e.g.) the object and the virtual patient**

Virtual Patients

- **Initial injury set**
 - **Tension pneumo**
 - **Cerebral contusion**
 - **SEB exposure**
 - **Psychological trauma**
- **Consistent with scenario and training goals**
- **Chosen and developed with MD/training instructor**

Tension Pneumothorax



Virtual patient with chest wound resulting in tension pneumo

- **Symptoms/assessment**
 - **Respiratory distress**
 - **Drop in blood pressure**
 - **Changes in skin color**
 - **Loss of consciousness**
- **Intervention**
 - **Occlusive bandage**
 - **Needle aspiration**

Cerebral Contusion



Cerebral contusion
(wound may not appear to
be critical on first
inspection)

- **Symptoms / assessment**
 - **Loss of consciousness**
 - **Confused or no verbal response to questions**
 - **Lack of voluntary motor control**
 - **Unilateral pupillary response**
- **Intervention**
 - **Bandage wound**
 - **Keep airway open**
 - **Administer anti-convulsant**

SEB exposure



Exposure to SEB presents flu-like symptoms

- **Description**
 - Staphylococcal enterotoxin B
- **Symptoms / assessment**
 - High fever
 - Chills
 - Headache
 - Vomiting
 - Muscle aches
- **Intervention**
 - Supportive care only
 - Insert IV to keep fluids up
 - Mask to prevent further exposure

Psych trauma



Catatonic patient may confuse rescuers

- **Description**
 - **Catatonic patients may be confused for either head trauma or agent exposure**
- **Symptoms / assessment (catatonic)**
 - **No physical injuries or symptoms.**
 - **May not respond to questions or perform voluntary movement**
- **Intervention**
 - **None**

Virtual Patient: Simulation Engine

- **External simulation module**
 - **FSM driven engine produces state changes**
 - **Input: action of the user (tracked and interpreted by VR engine)**
 - **Spontaneous: progression of injury**
 - **Based on decision-trees mapping most likely outcomes for each injury**
 - **Communicates with VR simulation engine via text-based messages (SNOMED)**

BioSimMER Actions

Initial Exam

- Ask what happened
- Expose patient
- Squeeze fingertips
- Request vitals
- Test coherence
- Look for wounds
- Check capillary refill rate
- Blood pressure, respiratory rate, pulse rate, temperature

BioSimMER Actions

Neurological Exam

- Ask patient to move arms, legs
- Test ocular motility
- Test pupillary reflect
- Check voluntary motor control
- Voluntary eye motion
- Involuntary pupil response to light

Airway Intervention

- Insert J-tube
- Open Airway

BioSimMER Actions

Biological Agent Exposure

- Apply wipe to body
- Place mask over nose, mouth
- Decontamination
- Breathing barrier

Wound Care

- Apply sterile bandage
- Apply occlusive bandage
- Protect wound
- Prevent air intake

Medication

- Auto injection
- Inject sedative (head wound)
- Inject atropine (agent exposure)

BioSimMER Actions

Respiratory Intervention

- Perform needle aspiration
- Relieve pressure on lung

Circulatory Intervention

- Start IV
- Increase, balance fluids

Neuro-trauma Intervention

- Apply cervical collar
- Prevent spine damage

Initial Acceptance Study

- **Done at National Emergency Response and Rescue Center**
- **23 EMT and Paramedic Firefighters from area around TAMU**
- **Experienced the tension pneumo scenario or head trauma scenario**
- **Responded to questionnaire**
 - **Part I collected demographic information. Part II collected system assessment information.**

Acceptance Study

Part I: Demographics

1. Your occupation(s):

Primary:

Secondary:

2. Years of experience in job(s):

Primary:

Secondary:

3. Years of experience with computers/computer workstations:

4. Years of experience with flight simulators (if applicable):

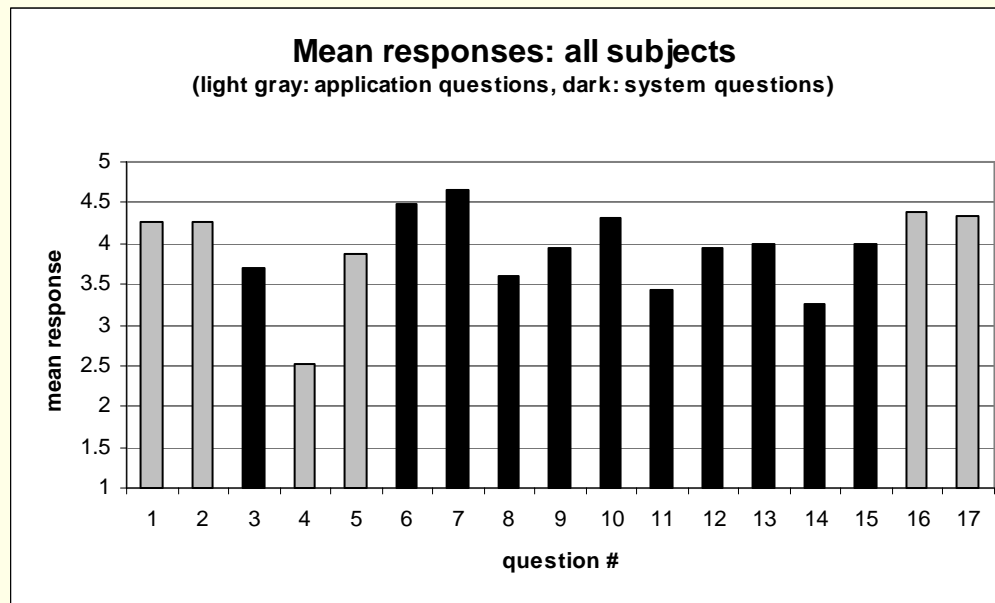
5. Experience with a "Virtual Reality" system (please describe):

6. Susceptibility to motion sickness (self-rated): LOW MEDIUM HIGH

Part II: System Assessment:

- 1. Applicability of this form of training (i.e. fully immersive Virtual Reality) to your activities as a first responder:**
- 2. Applicability of the selected scenarios to your responsibilities as a first responder:**
- 3. Fidelity of Virtual Environment (i.e. resemblance of this scenario/simulation) to the operational (first responder) environment:**
- 4. Level of difficulty of scenarios selected:**
- 5. Relevance of decision-making to your responsibilities as a first responder:**
- Importance of the following information/visual displays to your decision-making in the selected scenarios:**
- 6. Patient Appearance:**
- 7. Vital Signs:**
- 8. Environmental cues external to patient:**
- 9. Importance of tactile (touch-based) information to your decision-making in the selected scenarios:**
- 10. Importance of auditory information to your decision-making in the selected scenarios:**
- 11. Satisfaction with field-of-view:**
- 12. Satisfaction with visual/image updates:**
- 13. Satisfaction with image resolution:**
- 14. Satisfaction with ability to handle/use virtual objects**
- 15. Satisfaction with vocal commands/vocabulary:**
- 16. Confidence in this training system to support training-of-interest:**
- 17. Acceptance of this form of training system to augment existing training (i.e. field exercises, computer-based instruction):**
- 18. Suggested additions/modifications to the type of information presented that you believe will assist in decision-making tasks as a first responder:**

Results



Video

Show the BioSimMER video