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# NPSNET-human: inserting the human into the networked synthetic environment

Zyda, Michael J.

Monterey, California.  Naval Postgraduate School

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# NPSNET-HUMAN: INSERTING THE HUMAN INTO THE NETWORKED SYNTHETIC ENVIRONMENT

**Michael J. Zyda\*, David R. Pratt, Shirley Pratt, Paul Barham & John S. Falby**
**Naval Postgraduate School**
**Department of Computer Science, Code CS/Zk**
**Monterey, California 93943-5118**
**E-mail: { zyda, pratt, pratts, barham, falby }@cs.nps.navy.mil**
**\* contact author**

## KEYWORDS

Humans in the DIS synthetic environment, synthetic environments.

## ABSTRACT

The NPSNET Research Group is working in the area of robust representations of humans and real-time interactions in the DIS synthetic environment. Our focus is on building the software bed for applications such as medical corpsmen rescue training and dismounted infantry in the DIS environment. In conjunction with our academic, government and industry partners, recent work has included novel hierarchical networking of multi-resolution humans in the DIS synthetic environment, accurate articulated human viewpoints, simple networked wounding, networked autonomous evacuation units, real-time arm articulations and realistic wounding model investigations.

Planned work over the next two years includes networked Personal Status Monitors, multi-resolution view switching, networked autonomous air evacuations units, accurate wounding model integration, dynamic object networking, physiological model integration, energy extraction input device integration, and the completion of the full-up human in the NPSNET/DIS synthetic environment.

## INTRODUCTION

The representation of the human figure in a real-time, interactive 3D virtual environment (VE) is a sought for goal of the VE research community [1]. Significant work has been done in animating human figures for single-frame animations [2]. As our workstations have become faster and more capable, both graphically and computationally, the integration of articulated human figures into our real-time VEs has become possible.

For the DIS community, the integration of human figures has become an extremely important issue. To date, the primary usage of DIS has been for vehicles, both ground and air, with few articulations. Accurate human figures require an order of magnitude more articulations and put a significantly larger load on the DIS network.

The NPSNET Research Group over the last two years has begun looking at the complete set of issues regarding integrating the human figure into the DIS synthetic environment. The driving problems of our current efforts are the integration of dismounted infantry [3] and medical corpsmen into the DIS virtual environment. Some of the major issues we face are: the robust representation of humans in the DIS synthetic environment, the multi-resolution networking of human interactions, and the addition of physical, wounding models into the DIS synthetic environment. This paper presents a progress report on some of the efforts to date of the NPSNET-Human project.

## PROJECT GOALS

The robust representation of a human figure in a VE means that we have an instrumented human whose movements and interactions are accurately reflected in that environment such that a particular set of tasks or training become possible. Such a system would allow medical corpsmen, for example, to move to the site of a wounded soldier, bend down over that soldier and utilize full hand and finger movement, with that movement affecting the downed soldier. If we carry this further, we would like to be able to see accurate wounds, have the medical corpsman practice treating the particularly diagnosed wound, with eventual access to physically-based underlying organs. Since we want this training to occur in a networked VE, we want all finger, hand and body movements to be reflected across the DIS network and visible, in some fashion, at other nodes in the DIS VE.

In order to achieve our project's goals, there are many hardware and software research avenues to explore and technologies to test and develop. We present below some of the areas we are investigating.

## RECENT ACCOMPLISHMENTS

### Accurate Articulated Human Viewpoint

One of the first things that one needs in putting a human figure into a VE is the ability to display an accurate, articulated human viewpoint. The NPSNET-Human project has recently completed work on this so that view

position/orientation are now computed based on body posture and joint articulations. This means that one's virtual body parts are clearly visible and the user's eyepoint is updated intuitively while the head is tracked with an HMD sensor. This viewpoint improvement allows for realistic viewing at close range, e.g. when a medic looks downward to attend to a victim. It replaces the earlier approximated view which was based solely on posture and assumed only small deviations in head/neck angles.

## Simple Networked Wounding

In early versions of NPSNET, a wounded human was a dead human, with a dead 3D icon displayed for that figure. We have recently begun an effort to provide an intermediate display. We now have networked simple wounding of soldiers in the virtual battlefield. Soldier icons display simple networked wound representations on their body when and where they are hit. In the lower resolution battlefield environment, the wounds adequately indicate the need for medical attention and the location of the injury. Multiple hits cause multiple wounds to be displayed. Currently, only a ballistic type of wound is displayed.

## Networked Autonomous Evacuation Unit

For the medical corpsman scenarios we are developing in NPSNET, we have begun prototyping a networked, autonomous evacuation unit. Companion software has been developed to dispatch a networked, autonomous ambulance to the location of a wounded soldier in NPSNET. Upon reaching the victim, a two man stretcher team disembarks from the rear of the ambulance, walks to one side of the victim and kneels to pick him up. The wounded soldier (for now) is instantaneously transferred to the stretcher and is carried back to the ambulance. The ambulance returns to the aid station from which it was dispatched.

## Real-Time Arm Articulations

Work underway in the NPSNET-Human project towards the goal of instrumenting the human body is currently focused on real-time arm articulations. An interface has been developed to give a user with Polhemus magnetic sensors attached to his arms the ability to control an icon's arms in real-time. This is a low-cost alternative to the Sarcos ISMS and Sensor Suit. A user can interact with the synthetic environment independent of limited scripted animations. Efficient multicast networking means have been developed to receive/send high frequency data from the user interface tracking real-time upper body motions. The networking of the arm articulations is carried out by a "high resolution" parallel-to-DIS network. This parallel network is needed to reduce the amount of articulation data placed onto the net as would be required were standard DIS utilized.

## Realistic Wounding Model Investigations

We have started work on investigating the use of realistic wounding models for the human figures in NPSNET. We have begun to identify what models exist and are readily available, and their interface requirements, i.e. parameters regarding weapon type, firing range, projectile's direction of travel, as well as the soldier's posture and his protective equipment.

## MILESTONES

We envision that the full integration of a human into the DIS synthetic environment is a project that requires at least five years of steady funding. In the following section, we outline our expectations of accomplishment for the next one to three years should steady funding be provided.

### Near-Term (within a year)

### Networked Personal Status Monitors

There is a plan in the US Army to equip each soldier with a personal status monitor (PSM), a device that indicates the health, well-being and location of the soldier in the battlefield. Before the full deployment of that device, there is a requirement for its simulation in the DIS VE. This simulation requirement directly impacts our medical corpsman scenarios as it provides cues for our medics and soldiers. We plan to look at the networked communication of each soldier's PSM data while in the battlefield for triage training. We plan to build a networked medic GUI prototype to monitor and manage PSM data for soldiers who are under a particular medic's care and responsibility.

### High/Low Resolution View Switching

In the project goals described above, there is the eventual goal of being able to accurately display and interact with the internal organs of the wounded soldier. To do so requires a seamless capability to switch view resolutions from the low resolution battlefield environment to the high resolution medical, internal organs environment. We hope to begin work on this over the next year. This is a significant multi-year effort requiring the acquisition of an accurate, physically-based internal organ model.

### Networked Autonomous Air Evacuation Unit

Besides having an autonomous ground evacuation capability, we also need a networked autonomous air evacuation unit for our scenarios. We plan to show the usage of the evacuation pod or other equipment as required. This is also work we expect to begin over the next year.

### Wounding Model Integration

We have been looking at low-complexity wounding models for use in NPSNET. Once we have identified

such a model, we will begin integration of that interim wounding model(s). We desire a model that can adequately describe the major battlefield injuries desired for medic training. We are looking for a model that has varied low resolution wound representations based on type of injury.

### Dynamic Object Networking

A full-up human in the networked VE has the ability to pick up arbitrary objects in the virtual world and to operate on those objects, and pass those objects to other humans in the VE, similar in fashion to what humans in the real world can do. In the next year, we begin work on the networked representation of dynamic objects in the VE, with the goal objects that can be picked up, passed between entities, or left behind. We need to develop improved collision detection techniques to support this capability.

### Longer-Term (1-3+ years)

The full development of the human in the networked VE with hierarchical networking (DIS and multicast), rendering and collision detection schemes to support both a high resolution medic environment and a concurrent low resolution battlefield environment is a significant multiple year effort. This effort includes fundamental VE hardware and software development efforts. Our plans include the following areas of research.

### Accurate Wounding & Physiological Model Integration

The initial efforts we plan for NPSNET-Human include the usage of relatively low-level wounding models. The long term plan is the integration of detailed wound representations, physiological models, high resolution medic with fully articulated fingers, and scripted animations for the high resolution semi-automated medical corpsman. The NPS work on this task is to integrate into NPSNET the wounding and physiological models developed by others as indicated by the ARPA Biomedical Technology Program Manager.

### Energy Extraction Input Device Integration

A key component to all humans in the VE work is the human body instrumentation hardware. Over the years, the NPSNET Research Group has built software interfaces to NPSNET for any input device provided to that group. We continue this policy today and will accept the loan/donation of any human body instrumentation hardware for our humans in the VE effort. In the past, we have supported the Sarcos ISMS aka ARL I-Port and will be supporting the newer Tread-Port device. The purpose of the Sarcos devices is to fatigue the medic and infantryman in the virtual battlefield. We are also examining lower-cost alternatives to this platform such as the Polhemus Ultratrak and a hybrid system of the Polhemus and the BioControl BioMuse device. We are also performing a study for ARPA on BodySuit alternatives,

with a focus on immediate-term, near-term (1 - 3 years) and long term (3 years to 7 years).

### Full-up Human in the Synthetic Environment

The ultimate goal of the NPSNET-Human project is real-time interaction with entities and objects in the VE with input devices allowing high resolution human motions and force feedback. The NPS work on this task is a synthesis of all the pieces previously developed so that the NPSNET-Human system can then show a full-up, interactive human in the NPSNET synthetic environment. Our driving problems, again, are specific for the medic and infantryman but our software is general in nature.

### Task Completion Caveat

Time of completion of all aspects of the NPSNET-Human project is influenced by many factors outside our control, including availability of high resolution models/ behaviors and input devices. Parallel efforts will proceed where possible to insure a timely completion.

### Technology Transition Plan

The software developed for this effort will be integrated with the core NPSNET software bed. NPSNET is currently under configuration management for the DoD by the technical staff of the NPSNET Research Group at the Naval Postgraduate School, Monterey, California. The configuration management efforts are carried out via reimbursable contracts with the faculty of the NPSNET Research Group. Over 100 DoD laboratories and contractors currently utilize NPSNET. The NPSNET software developed from this effort is demoed all the time. The next major demonstration is for the Oct 95 AUSA conference in Washington, DC, where the NPSNET-Human efforts will be a highly visible part of the simulation demonstrations.

### Project Coordination

The work on this contract is joint with the University of Pennsylvania (Norm Badler & Bonnie Webber), Sandia National Laboratories (Sharon Stansfield), US Army Research Laboratory (Ron Spencer), and Sarcos Research Corporation. The efforts detailed above are carried out in cooperation with these organizations, though the funding to NPS is separate.

# REFERENCES

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# RESOURCES

All papers from the NPSNET Research Group are available via the NPSNET Research Group's web page:

http://www.cs.nps.navy.mil/research/npsnet

The full source code to NPSNET is also available at that location. NPSNET is currently under configuration management for the DoD by the technical staff of the NPSNET Research Group at the Naval Postgraduate School, Monterey, California. The configuration management efforts are carried out via reimbursable contracts with the faculty of the NPSNET Research Group.