INTEGRATION OF TODAY'S INTERACTIVE TELEVISION & DIS INTO TOMORROW'S EDUCATIONAL SOLUTIONS

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ABSTRACT

Distributed Interactive Simulation (DIS) Synthesis with Interactive Television (DISSIT) is a technological quantum leap made possible by combining two existing network technologies. DISSIT is an entirely new and innovative method for harnessing the power of video compression (i.e., MPEG/JPEG), DIS, and network systems to deliver high quality simulations to homes, schools and military personnel. The key concept to emphasize is that the DISSIT system allows EXISTING Simulations and Computer Applications (military and commercial) to be utilized across EXISTING communication networks including the prototype Interactive Television (ITV) systems. This concept leverages already spent dollars to be reused to a larger, wider, more diverse consumer base and provide a new foundation for future Training Development and Delivery paradigms. The expansion of DIS in this fashion will allow enhanced distance learning including hands-on user interaction and remote simulator training. Further, this use of DIS compliant simulators fulfills the promise of distance learning by providing a cooperative interactive environment that enables large numbers of participants to team train or interact together.

The objective of this research was to demonstrate a synthesis of the DIS & ITV network technologies. The case for DISSIT is supported by theoretical calculations, design, and most significantly by prototype implementations of DISSIT. The implementations presented in this paper include a low-cost PC / MPEG solution and an innovative method DIS Stealth Visual Solution. Both methods enable existing analog cable, telephone, and satellite links to be utilized. Future implementations will run over Time Warner Cables Full Service Network (TWC-FSN) and be included as one of the new technologies being tested by TWC-FSN.

Application of DISSIT to Multi-Channel, Virtual Reality, World-Wide Distribution and Tele-presence issues are demonstrated, plus the actual design and implementation details. Discussion of the key software concepts and structures of the MPEG Virtual Disc, and Server-Pass-Through-Commands are presented along with design calculations. The results of the pilot implementations are given with discussion to improve performance in future versions. Future Research and Applications for Military, Civilian, and Education are discussed in the context of Training Development and Delivery including:

- Automatic integration with Real-World Data via the DIS Interactive Playback Unit
- Revolution of simulation architecture and paradigm, using Interactive Television Networks to allow low cost mass produced simulators. (The local simulator requirements become the I/O system, and TVs for the visual displays, with the expensive computational and image generation systems being shared across the ITV network)

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INTRODUCTION

Existing Interactive Television Networks (ITV), such as Time Warner Cable's Full Service Network (TWC-FSN) and FutureTel's VIDDIV MPEG Broadcast Network, function by encapsulation and transmission of MPEG compressed video. Both ITV systems have the same functional requirements, differing in that TWC-FSN utilizes an ATM network to deliver a wide variety of services across large geographic areas and FutureTel utilizes ethernet networks to deliver specialized services across local areas. These existing ITV systems allow video to be MPEG compressed and stored on hard drives and other storage media for later replay to remote users as an "on demand" service.

The ITV technology has been successfully demonstrated and implemented in a number of applications. The challenge becomes to evolve our distance learning concepts to utilize the power of this new technology. DISSIT is a logical extension of existing and proven ITV demonstrations. The reader is provided the following three examples to illustrate the logical progression of demonstration that lead to DISSIT:

- Example 1

TWC-FSN or FutureTel subscribers can use the movie on demand service to view current movies whenever they desire. Both systems allow control of the movie in an analogous manner to a VCR remote control, the home user can rewind, fast-forward, pause or play the video as desired.

- Example 2

Any interactive Television subscriber can watch a live camera input across the network. This allows one-way video transmission from the central site to as many remote sites that desire to view the live input. Both systems allow control of the movie in a partially-analogous manner to a VCR remote control (the home user can rewind, or pause or play the video as desired) (No Fast-Forward as the live feed events have not yet occurred.)

- Example 3

Imagine a live video camera feed pointed at the video output display of a high-fidelity simulator. The remote user's commands that previously controlled rewind, fast-forward, pause, start, etc., are re-mapped to control the inputs of the simulator, left, right, up, down, faster, etc.

In fundamental terms, the reader can now understand the basis of the proposed DISSIT network. As far as the existing ITV network is concerned, it's just delivering another Movie on Demand Service. The existing simulator doesn't care one iota that its' controller is remote and not present at the centralized location. Many have spoken of the future potentials of ITV, the authors claim that the future is here now! We can not over emphasize that the **EXISTING** ITV networks can deliver **EXISTING** simulations for remote home and school interaction.

Consider now the selection of DIS compliant simulators as one of the types of simulation available on the ITV network. This paper suggests the Distributed Interactive Simulation Synthesis with Interactive Television (DISSIT) concept is a logical combination of two powerful developing technologies.

The significance of this paper is it expands current efforts beyond the utilization of the remote set-top box (or PC) as a graphics generator. We suggest the additional utilization of powerful centralized graphics generators coupled with MPEG compression, DIS, and existing ITV control structures. Current thinking of loading video game information from the server to the set-top unit is slow and the graphics are of only normal video game quality. Further, this existing scheme requires that custom applications be written for the set-top's current hardware. The DISSIT concept circumnavigates all these problems. No download occurs; and, as far as the set-top unit is concerned, it's just playing back another movie on demand or producing graphic images as a remote DIS Stealth. Further, the DISSIT system does not require that custom applications be written for the set-top box. DISSIT allows you to use existing DIS simulations and, as the charter of DIS states, each node brings its own resources allowing scalability and most importantly in this application, upgradablity. Graphic's performance has been doubling every two years for the last 10 years, the economic benefit of MPEG based DISSIT is obvious, upgrades will only be required at the centralized simulators, not the thousands or millions of remote set-top boxes. The authors are not claiming that down-loadable games and applications don't have a niche of use, we are suggesting that DISSIT is a much larger concept that has greater potential.

PLANNED DISSIT IMPLEMENTATION

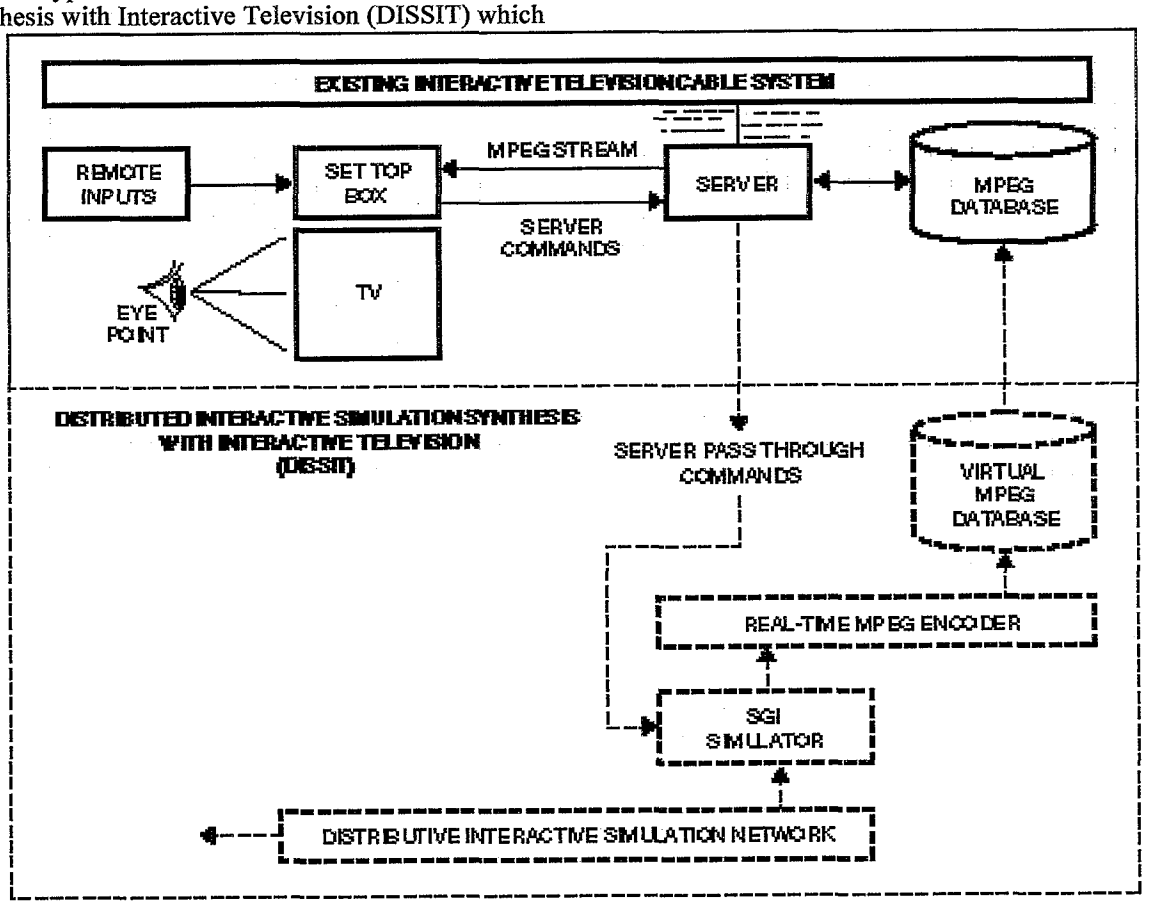
The Advanced Research Project Agency (ARPA) reviewed a white paper on Time Flexible Training for the COMPUTER AIDED EDUCATION AND

TRAINING INITIATIVE and invited the authors to propose. ARPA has not yet selected the awards for this program. As a portion of the proposal we designed a successive prototype approach to demonstrate the time flexible training concept. One of the prototypes suggested included DISSIT. In that proposal we went even farther than DISSIT and proposed the Generic Server concept which allows any computer application to be delivered across existing ITV networks. Three descriptions of the suggested prototypes follow.

A prototype of Interactive Television of Existing Simulations, (ITV_SIM) which demonstrates dual use of existing military simulations and educational simulations across ITV networks, thereby allowing distance learning by controlling high fidelity simulations from TV remote controls. (e.g., simulations that are time flexible.)

A prototype of Distributed Interactive Simulation Synthesis with Interactive Television (DISSIT) which demonstrates the scalability of the prototype ITV_SIM discussed above with Time Flexible Training and ARTT enhancements (TFT-DISSIT). This technique would leverage the US Government's previous investments in DIS technology that have already been made.

A prototype of Interactive Television Generic Server (ITVGS), this prototype leverages off the previous prototype. The same technique of a MPEG-Virtual-Disc and Server-Pass-Through Commands can be used for a generic interface which allows any existing computer application to be controlled from the remote controls of interactive televisions. An example would be an expensive vocational training program controlled from remote controls of student's homes and classrooms This enables the power of playback of multi-media to reach all remote sites that have an ITV cable connection. DISSIT (MPEG Version) is shown in Figure 1 below.



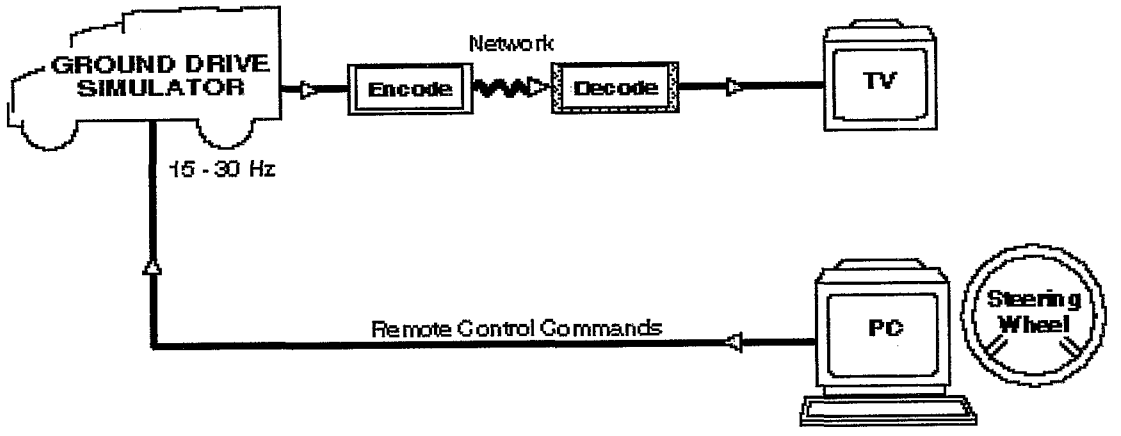


Fig. 2 DISSIT REMOTE DRIVING SIMULATION

DISSIT Prototype

The authors implemented a pilot DISSIT network utilizing 2 SGI workstations, FutureTel's MPEG compression boardset, 2 PCs and 2 MPEG Playback boards (Sigma Design & Cin-Magic). Utilizing SGI's Driving simulation, "Performer Town" as the initial Drivers Education Kernel, the pilot DISSIT allowed remote driving. See Figure 2 for design details
The results were some what disappointing due to the large buffers required by the PC based MPEG decode cards. The Driving Simulation could only be characterized as a "Drunken Driving Simulator" with latency on the order of 700 milliseconds. The FutureTel MPEG compression board set only induces a 100 millisecond delay, therefor our efforts to improve performance centered on reducing the buffer delays on the PC MPEG decompression boards. The default settings on the decompression boards induce a 3 second delay. Calls to the API allows the buffers to be reset to smaller values that allowed us to cut the delay to 600 milliseconds. Work in progress with Sigma Design is planned to cut delay to the 200 to 300 millisecond range.

Our next MPEG implementation platform is planned as Time-Warner Full Service Network's Experimental Net where performance of Movies on Demand is already below the 500 millisecond performance level. Given the flexibility and raw performance power of the TWC-FSN SGI hardware confidence is high that we will be successful in meeting or exceeding our design goal of 300 milliseconds. It should be emphasized that once these pilot implementations are successful the Training Systems & Educational Community can immediately start implementing existing simulations and education / training programs across networks, thus allowing a much large user base.

Server-Pass-Through-Commands are a class of software commands the ITV server routes from the remote user's input to the desired simulator's input. You can consider it as just another normal ITV application that encapsulates the user's input down an ethernet or ATM network branch that the simulator inputs are connected to. The authors suggest an entirely new class of DIS PDUs be created to specifically handle the encapsulation of server-pass-through-commands WITHIN ITV networks. The new DIS Server-Pass-Through-Command PDUs could be used for remote control of DIS simulators across other types of networks and may have utility for enhancing and enlarging Simulation Management (SIMAN) control, the authors have demonstrated the initial viability of remote control via DIS (Guckenberger, Whitney, Anschuetz, and Hall 1995)

MPEG-Virtual-Disc is a software object that makes the real-time MPEG encode stream look like a previously recorded MPEG file. That is, it makes the real-time MPEG encode data stream look like a normal file to the server. Essentially, the Virtual-Disc is a circular queue where the write pointer of the encode stream stays ahead of the read pointer for the transmit process. FutureTel's John Anderson has a working prototype of the MPEG Virtual Disc. Anderson, whose applications run on a PC, originally built the prototype for another reason, he built his virtual disc just to save disc space during live feeds to the network. When the concept was explained to Anderson he immediately saw the utility and was excited that his prototype might have utility far beyond his original goals. Further, the authors have some very straight forward implementation methods that use existing Silicon Graphics OS services.

DISSIT requires the integration of existing applications and already prototyped software objects. No technological breakthroughs are required to bring DISSIT into reality.

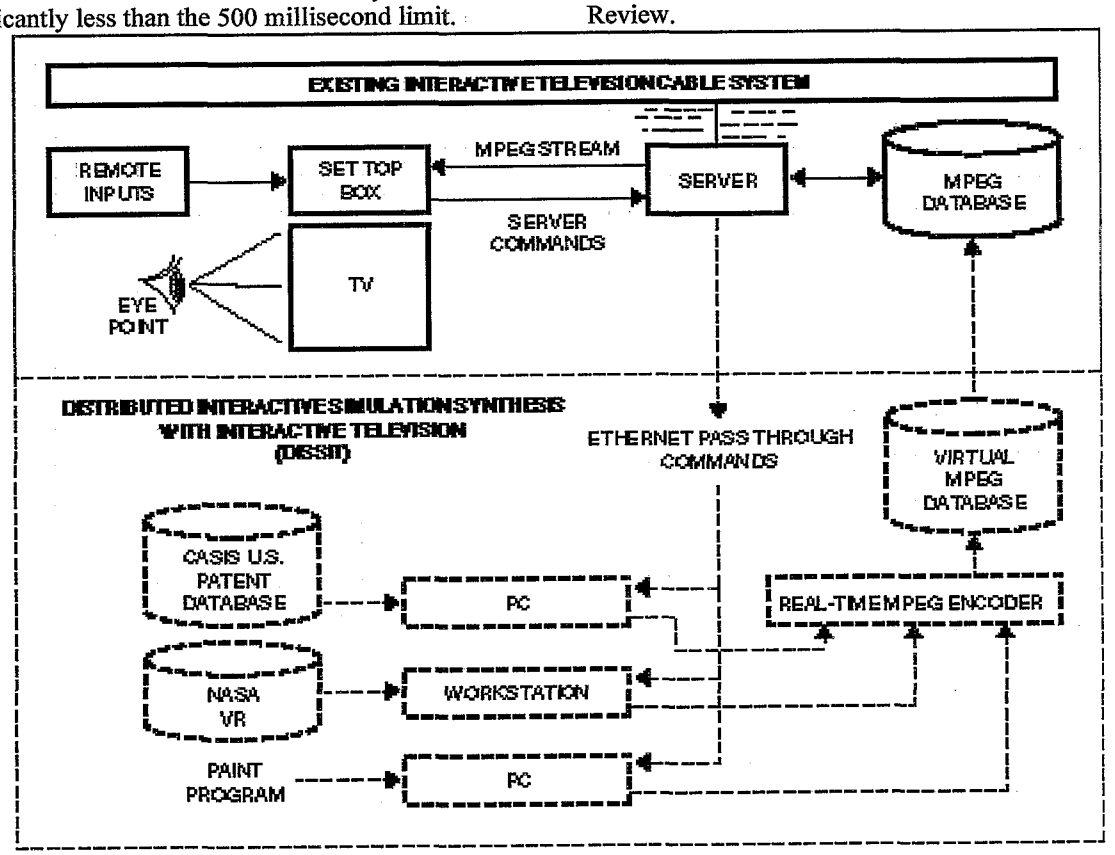
Back of the envelop calculations of the time delays associated with encoding & decoding MPEG, coupled with time delays associated with typical network transmission time have convinced the authors that DISSIT should perform at the approximate long-haul DIS standard of 300 milliseconds.

The existing movie on demand, ordering by remote control inputs across ITV networks gives an order of magnitude approximation (500 milliseconds, worst case upper bound). TWC-FSN provides the movie on demand service in 500 milliseconds or less, this includes remote transmission time, finding the desired movie file, opening a movie MPEG file, ATM transmission, setup MPEG Decode and TV transmission to the screen. DISSIT continuous operation will not require the lookup of the file location nor the opening of the file after the start of use. Therefor it seems obvious that the delay time will be significantly less than the 500 millisecond limit.

The resolution limit of the TV will be a limit on the fidelity that the remote user actually views. However, the improvement in the source image and computation models should manifest itself in higher quality simulations.

As mentioned earlier, the DISSIT technology could be expanded to the more general case of any computer application, that is any computer application could be operated across the ITV network. See Figure 3 for an illustration of the proposed Generic Server.

The current prototype's latency does not meet driving training requirements, however, many education and training applications are deliverable and desirable even with latency. Specifically, remote delivery of simulator graphics for visualization (fitting molecules together), mission planning (terrain walk-throughs), broadcast of live DIS nodes simulator training, After Action Review.



The authors were invited to submit a proposal to ACT II BAA to research and evaluate the different potential technologies for remote delivery of Simulator Training. The proposal was titled Universal DIS, readers interested in further details may obtain same from the authors.

As part of the proposal effort a proof of concept R&D prototype produced exciting results that eliminated the latency problem. ECC, Motorola, Coryphaeus Software, and NAWC/TSD teamed to produce the prototype and plan on publishing detail results in future papers. A short description of the technology follows.

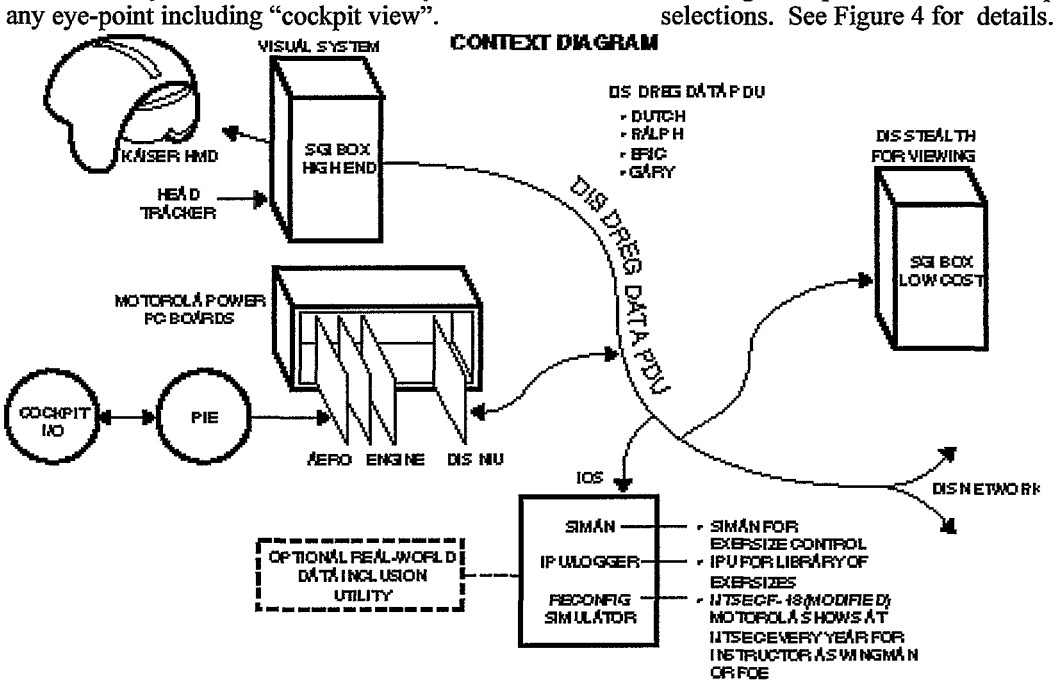
DIS Stealth Visual Prototype

The idea for the prototype came from research aimed at developing methods to add Virtual Reality visuals to existing simulators and methods to allow Computer Image Generator independence.

The prototype avoided the latency problems by the invention of a new variant of the DIS Data PDU we have designated as the DREG PDU. The DREG PDU enables any DIS simulator to produce visuals for remote simulators via attached DIS Stealth. The concept was tested utilizing ECC's ACE'EM F-16 DIS simulator and a Coryphaeus DIS Stealth running on a SGI Onyx. The Stealth allows you to attach to any eye-point including "cockpit view".

The development plan was aided by prior experience and already proven technologies. Specifically, ECC's ACE'EM F-16 simulator uses the Network Interface Unit (NIU) developed by Motorola and NAWC/TSD and we have successfully used Coryphaeus Stealth on a variety of SGI platforms, making the implementation very straight forward. The team altered the NIU to send ownship information at 30Hz in a DIS Data PDU and decoded the same Data PDU packet on the Stealth side.

We coined the term "DIS Stealth Visual System" to refer to the use of DIS Stealth Technology to substitute as the visual system for DIS simulators. DIS Stealth Visual System technology suggests an interface that abstracts the control of competing computer image generator systems to a DIS Stealth Standard. Consider that rather than writing custom code for each simulator to run its own image generator, that each simulator's code be structured to write to a DIS Stealth Visual System standard. This abstraction will hide the problems and headaches associated with selecting and updating image generators. Imagine actually being able to make a side by side comparison of SGI - E&S - CompuScene - and any other computer image generation system you might be considering. Further, the standard would mean that purchase of today's system does not lock you in for years to come, thus allowing competition to drive pricing and future selections. See Figure 4 for details.



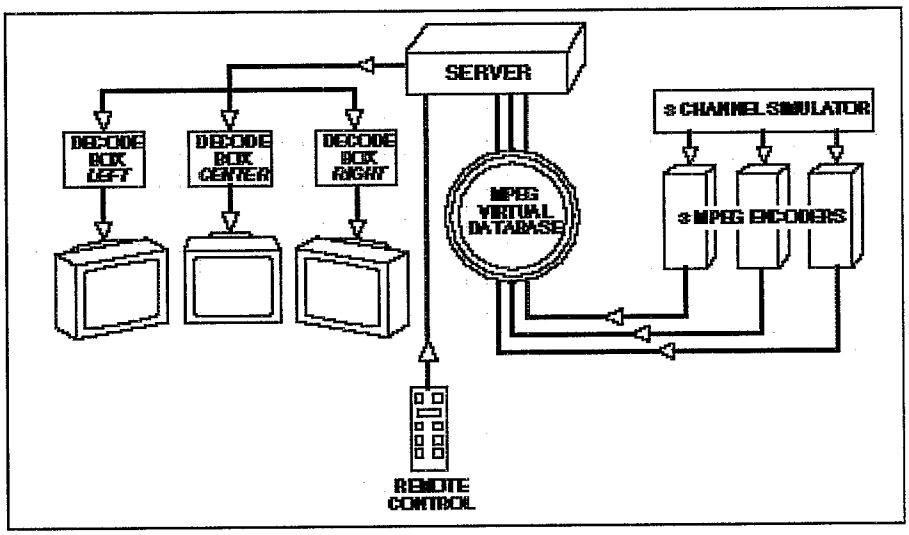


Fig. 1 MULTI-CHANNEL SIMULATION

Future Military Applications and Research

- **Multiple Channel Support**

Simulations that require multiple channels are also a simple application for DISSIT as it just requires multiple set-top boxes at the location. (See the following diagram for an illustration of a three channel system.) We prototyped this by using three video cameras, three long coax cables, and three TVs side-by-side. It was a bit tricky getting the field of views just right and keeping the zoom constant, but the results were not really difficult to obtain. We also hooked up the three video cameras to the inputs of ECC's ACE'EM F-16 Simulator and were able to obtain a seamless wrap-around, 3 screen presentation. It is very impressive with 37" monitors. (See Figure 5.)

- **Lower Cost Simulators**

If the temporal fidelity of DISSIT is found to be sufficient, then the possibility exists for an entirely new way of building simulators. Specifically, the expensive image generation and computational resources can be shared by many remote simulators. The remote simulators would not even have to have computers, merely a method to gather inputs with TVs to display the video to the user. That is, inexpensive simulator shells that allow the centralized DIS simulator to be a shared resource. Instead of building a low number of expensive simulators and expensively moving the men to the training locations, DISSIT allows you to take the training to men using low cost TV technology. There are further obvious advantages and economies of updating the graphical and computational resources with the DISSIT method. The status quo is the tens to hundreds of simulators in the field need to be updated, modified or rebuilt. The DISSIT system would allow the upgrades in a cost-effective manner.

- **Virtually Unlimited DIS Simulator Audience**

Consider another important point, specifically the multi-watch capacity of such a system. Let's say the central location can support 30 live nodes for training at a time. Platoon A uses the live nodes to hook into a DIS exercise. What is unique is that Platoon B, C, D, etc., can watch on low-cost ITV TVs all over the service area. The simulator performance of platoon A can then be used to expand the learning experience of the watching platoons and allow all to critique their performance. Thus, a virtually unlimited audience can experience platoon A's action, and be better prepared for their turn as the live platoon. This new aspect expands the utilization of each simulation exercise as a simultaneous lesson for viewing groups to learn from and critique.

- **Enhanced After Action Review & Real World Data Link**

The authors have already demonstrated Above Real-Time MPEG playback which allows a new method of enhanced After Action review. (Note: STRI-COM's Major Joe Schwabb first suggested Above Real-Time Utility in enhancing After Action Review). Additionally, all DISSIT simulators could use the DIS Interactive Playback Unit (DIS-IPU) developed by the authors (funded by US Army STRI-COM). Recall that the DIS-IPU allows faster than real-time and slower than real-time playback of DIS log files. Further, version 1.0 of the DIS-IPU allows you to kill the "scripted" targets as they moved through the recorded DIS exercise. The current version of the DIS-IPU was built to improve repeatability in a DIS environment for Above Real-Time Research. We are discussing with Motorola the possibility of using data from the National Training Center (NTC) and JSTARS in the DIS-IPU, this would allow a number of improvements including:

Automation of the setup procedure for exercises by SIMAN resources at the node and remotely; Scripted Targets recreating actual human behavior driving through the terrain and in the case of NTC using real former Soviet Tactics. The version 2.0 of the DIS-IPU will substantiate the scripted entities to real CGF entities when they meet engagement criteria (i.e., range or LOS, etc.) DISSIT would be able to use this DIS technology as it would all other DIS advantages.

World Wide Training

Consider the opportunity for world wide training opportunities. Satellite transmission of DISSIT would allow training to go to the unit no matter how far away or how forsaken the desert. Imagine how much better it would be for the IRAQ war personnel to have access to TVs to practice the perishable skills to say nothing of relieve the boredom. FutureTel has already demonstrated transmission of MPEG video on a satellite link; and, of course, Time Warner Cable is no stranger to satellite communications.

- **Mission Rehearsal**

Consider also the opportunity for mission rehearsal. The high-end simulators are many times also employed as their own development station. For example Coryphaeus Software and MultiGen allow you to grow terrain from Defense Mapping Agency DTED and DFAD data in a matter of minutes. Imagine if the flight leader is assigned to bomb an enemy's headquarters. He phones up the satellite or land line link to the central location, the intelligence operator texture maps the latest satellite photo onto the DTED data of the desired area. Control of the DataBase is then given to the flight leader across the DISSIT connection and he looks at his objective from any desired angle; flies his simulated mission; replays the simulation from the eyes of the enemy defenders; refines his plan; and then phones his commander for his approval. The commander uses his DISSIT connection to review the flight commander's plan from his headquarters, refines, and/or approves the plan. Once the flight commander has approval for the plan, he replays the mission flight while recording it on a $3.00 video tape. He then shows the video tape to the men who will fly the actual mission, allowing them to see what they will see from their perspective as they fly the mission. God's eye and enemy eye-points can be shown, too, so as to impress upon the men the known dangers and how to avoid them.

- **Poor-Mans DISSIT**

The ITV networks are in a growth mode currently. In order to meet the short term gap, we have designed a lower performance version of DISSIT that runs on existing analog cable TV systems using telephone lines as the remote location up-link to control the centralized resources. Readers who are interested should contact the authors for further details.

- **Tele-presence**

NASA has demonstrated remote control of robots in Antarctica from school rooms in the United States over a modified Internet Connection allowing tele-presence. It's obvious that DISSIT can be applied to tele-presence as well. **That is, you can DISSIT train for your tele-presence mission followed by operating the real robot from the same remote DISSIT node you trained on!!** It has been the first author's life-long dream to enable the United States military to send robots, rather than people, to war. DISSIT can be an important milestone to that end.

FUTURE CIVILIAN APPLICATIONS AND RESEARCH

Many obvious applications should suggest themselves to the reader. As an example consider the way driver's education defensive driving is taught. The instructor could give his classroom presentation followed by asking Susan in her home to take control of the car simulator. Susan would drive from her home remote control or PC. The instructor would be able to comment, suggest and critique her performance. Other members of the class would see what Susan saw and hear the instructor talking. In fact, Susan or other students, could phone in and conversationally interact with the instructor. The low cost method would bring driver's education to more people in a economical method. Maybe we could actually improve some of the very poor drivers we have on the highways today. Imagine being able to train for dangerous events in the simulator that no one would suggest be tried with real cars. The uses are many. Consider that currently disadvantaged and disabled persons are tested in real cars on real streets. DISSIT may be a method of testing that improves safety for the testing persons, the evaluators, and the rest of us who are on the same roads.

Imagine being able to use your TV remote control to fly, drive, or visualize how two molecules fit together, or cooperate in DIS environments. The goal of DISSIT is to put existing simulations into homes and schools and empower students to become hands-on participants in the educational process.

This paper describes a method of combining existing DIS simulations with Interactive TeleVision (ITV) to empower ITV homes and schools to share in the synthesis of two powerful network technologies. DISSIT also allows expansion of ARTT to the widest possible consumer base. For readers unfamiliar with the ARTT technology this last section is included below.

- **Time Flexible Training**

Above Real-Time Training (ARTT) Research has demonstrated that humans are time adaptable and capable of sustained performance and learning at much higher levels than conventional theories predict (Guckenberger 1992, 1993 a, b, c, Matin & Boff 1990, MacLachlan 1978, 1979, 1980, & Lane 1994). In fact most current theories of software design and human-computer interaction completely neglect time flexibility as a means of adapting the machine rate of information presentation to the human. The simplest and most straight forward argument for time flexible training is the dynamic nature of a student's needs as his proficiency develops. The status quo is the original software developer arbitrarily selects and hard codes the rate of information presentation in most computer-aided systems. This may frustrate the student as a novice and bore the same student when he has become expert in its use. Time flexible computer interfaces are user-centered, dynamically adapting to a specific student's current needs--slower when the student is a novice; faster as proficiency is gained, culminating in an optimal rate of information presentation based on the level of the user and the task at hand. Further, this initiative can, potentially, dramatically help disabled and disadvantaged students. Currently there exists a small library of expensive custom software for the use by disadvantaged students. Time flexibility can be applied to allow slow presentation of information on a wide range of existing applications opening the door to the use of main-stream software by disadvantaged students. Potentially, time flexible training can be used to over-train disadvantaged students in same domain areas where their performance exceeds normal parameters, improving their employability, and more importantly, their own self-esteem. In fact, Jenkins and Merzenich have demonstrated that adapting a multi-media presentation to match the temporal disorders of students with learning disabilities has had astounding results. **Jenkins and Merzenich were able to improve their test group of students by 1.5 grade years in a four month period!**

The potential advantages to the educational paradigm can not be over-emphasized. This proposal will lay the ground work for a pervasive paradigm shift and an expansion of the student attributes to include time adaptability.

The fore-runner to Time Flexible Training is Above Real-Time Training (ARTT) Research. ARTT applications have been restricted to simulator based training, however the ARTT theoretical support and working model are applicable to Time Flexible Training. Therefore, the innovative nature of this proposal requires substantial explanation of Above Real-Time as a basis for understanding the technology. ARTT theory is based upon principles of neuroscience, cognitive psychology, human computer interaction and learning theory. A comprehensive discussion is available in "ARTT Theory: Implications of Neuroscience, Cognitive Psychology, & Learning Theory in Simulator Training" (Guckenberger 1994) for readers requiring greater detail. ARTT theory identifies relationships between the plasticity of sensory phenomena and visual maps used by neuroscientists, the model of the human information processor from cognitive psychology / human factors, and learning theory as depicted in the above mentioned paper.

The purpose of the DISSIT and TFT programs are to dramatically improve the learning performance of students by leveraging successes from ARTT research. Increase of the teaching productivity and effectiveness of instructors will result from the TFT integrated architecture. Delivering to classrooms and homes, world-class instructors and instructional multi-media, simulations for learning by doing, Distributed Interactive Simulations for remote cooperation and team building, and a user centered information highway connection. The application of TFT in this integrated architecture will serve as a "proof of concept prototype development and evaluation of advanced computer-based technology. TFT expands and customizes intelligent access and integration of digital educational resources; customizing by empowering the students, instructors, or intelligent software tutors to control the rate of information presentation on and across networks focusing on individualized learning where each student proceeds at their own pace with CBT and TFT letting the students progress at their own rate. TFT by design is learner user centered altering the rate of information presentation for each learner's current needs, adapting as that learner's needs change. TFT goals include being collaborative by supporting DIS and Internet, authentic by enhancing existing resources, and interactive by supporting CBT simulations, regardless of a student's location. Specifically providing capabilities and software architectures that are affordable using the install base of resources. TFT is scaleable and an easily maintainable system building upon the successful networked technologies of ITV and DIS.

Each modular phase will feature participation by students and personnel in the assessment of the products. Due to the ARTT origins of TFT the TFT technology and integrated architecture is ideally suited for transitioning to meet the needs of educating adult and training the active forces, reserves and the National Guard.

CONCLUSIONS

The MPEG version of DISSIT and can be economically applied on all existing Digital TV systems (i.e., Cable and satellite). However, the latency of this method limits viable applications to CBT, visualization, and walk-through applications. The remote user cost per node is extremely low and may be optimal for in classroom use.

The DIS Stealth Visual system overcomes the latency limits and enables real-time simulator from remote sites. In fact this method enables Computer Image Generator independence. Imagine using your home TV and cable set-top box as a DIS Stealth Visual system! Simulation for the masses is upon us.

Both methods seems to have merit and bear further investigation.

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