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SPACE COMMUNICATION ARTIFICIAL INTELLIGENCE FOR LINK EVALUATION TERMINAL (SCAILET)

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ABSTRACT

A software application to assist end-users of the high burst rate (HBR) link evaluation terminal (LET) for satellite communications is being developed. The HBR LET system developed at NASA Lewis Research Center is an element of the Advanced Communications Technology Satellite (ACTS) Project.

The HBR LET is divided into seven major subsystems, each with its own expert. Programming scripts, test procedures defined by design engineers, set up the HBR LET system. These programming scripts are cryptic, hard to maintain and require a steep learning curve. These scripts were developed by the system engineers who will not be available for the end-users of the system.

To increase end-user productivity a friendly interface needs to be added to the system. One possible solution is to provided the user with adequate documentation to perform the needed tasks. With the complexity of this system the vast amount of documentation needed would be overwhelming and the information would be hard to retrieve. With limited resources, maintenance is another reason for not using this form of documentation.

An advanced form of interaction is being explored using current computer techniques. This application, which incorporates a combination of multimedia and artificial intelligence (AI) techniques to provided end-users with an intelligent interface to the HBR LET system, is comprised of an intelligent assistant, intelligent tutoring, and hypermedia documentation. The intelligent assistant and tutoring systems address the critical programming needs of the end-user.

INTRODUCTION

A software application to assist end-users of the link evaluation terminal (LET) for satellite communications is being developed. This software application incorporates artificial intelligence (AI) techniques and will be deployed as an interface to LET. The high burst rate (HBR) LET provides 30 GHz transmitting/20 GHz receiving, 220/110 Mbps capability for wideband communications technology experiments with the Advanced Communications Technology Satellite (ACTS). The HBR LET can monitor and evaluate the integrity of the HBR communications uplink and downlink to the ACTS satellite. The uplink HBR transmission is performed by bursting the bit-pattern as a modulated signal to the satellite. The HBR LET can determine the bit error rate (BER) under various atmospheric conditions by comparing the transmitted bit pattern with the received bit pattern. An algorithm for power augmentation will be applied to enhance the system's BER performance at reduced signal strength caused by adverse conditions.

The HBR LET terminal consists of seven major subsystems:

- Antenna subsystem
- Radio frequency (RF) transmitter subsystem
- RF receiver subsystem
- Control and performance monitor (C&PM) computer subsystem
- Local loopback subsystem at RF
- Modulation and BER measurements subsystem
- Calibration subsystem

The C&PM computer controls and monitors all the other subsystems through an IEEE488 interface. HBR LET experiments with the ACTS satellite will be initiated by users through the C&PM experiment control and monitor (ECM) software. The ECM software was developed on a Concurrent 3205 minicomputer in FORTRAN, which provides the end-user with the following capabilities:

- Individual instrument control
- Interactive interface used to communicate with the digital ground terminal
- Ability to conduct BER measurements
- User-controlled data acquisition

Programming scripts, defined by the design engineer, set up the HBR LET terminal by programming subsystem devices through IEEE488 interfaces. However, the scripts are difficult to use, require a steep learning curve, are cryptic, and are hard to maintain. The combination of the learning curve and the complexities involved with editing the script files may discourage end-users from utilizing the full capabilities of the HBR LET system.

The following SCAILET features will improve the HBR LET system and enhance the end-user's ability to perform the experiments:

INTELLIGENT ASSISTANT

An intelligent assistant is a software program that will aid the user in operating of the HBR LET components. Friendly human interfaces shield the user from the script and complexities of the HBR LET system and furthermore aid performing iterative setup tasks. Any intelligent assistant also contains sufficient information about the HBR LET system to alert the user to erroneous actions.

The intelligent assistant uses a personal computer to provide a dynamic schematic diagram of the overall system . The schematic diagram provides a graphic user interface which serves as a "front-end" to the HBR LET system. The user can control the system by interacting with the schematic diagram. An expert system handles requested changes in the system. The changes will then be reflected dynamically on the schematic diagram.

The dynamic graphics are implemented using the Choreographer Graphical User Interface toolkit, developed by GUIdance Technologies Corp. The expert system shell used for this project is KAPPA PC developed by Intellicorp Corp. KAPPA PC is a hybrid expert system shell which has both a complete object oriented programming system and a rule based expert system. All HBR LET devices are implemented in KAPPA PC objects. The devices are connected to one another using message passing to create a dynamic model of the system. Rules are used to create programming scripts.

MULTIMEDIA DOCUMENTATION

Multimedia is a software package that applies a combination of text, graphics, voice, and video technologies in a computer application tool. The combination of these technologies provides a more powerful tool than any one medium alone. Text and graphics information can then be combined within the application. Similarly, associated voice and video information can be integrated into the application. This module is implemented using the ToolBook hypertext shell developed by Asymetrix Corp.

The documentation for the HBR LET subsystems is being developed by different design engineers. However, the end-user will need to see the association among the subsystems. Multimedia allows the user to look at a graphic image of a schematic diagram, and request written specifications of the components, more detailed images, or actual assembly diagrams. Multimedia allows the users to follow schematics' links and visit subsystems within the circuitry. Using printed documents would be less friendly and require much more time and effort to understand. This module is connected to the intelligent assistant so the user can access relevant documentation anytime during system programming.

FUTURE DIRECTION: INTELLIGENT TUTOR

Computer assisted instruction (CAI) is a traditional computer based training program which takes the user through a predetermined set of lessons. The advent of artificial intelligence technology and advances in cognitive psychology gave rise to intelligent tutoring systems (ITS) as an improvement to CAI. In an ITS environment, the curriculum designer determines what concepts the student should learn in a lesson. The student is then taken through subjects to see which concepts he/she is lacking. The program then determines the curriculum depending on the needs of the student.

For HBR LET, an initial overview of individual system components is necessary to aid in understanding the complete system. Concepts important to the operation of each HBR LET subsystem will be identified for SCAILET after the multimedia documentation and intelligent assistant tasks are completed . A guided learning process, which incorporates the use of a simulator, will be developed to provide ITS instruction on the operation of the HBR LET system.

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