AN ARTIFICIALLY INTELLIGENT-HUMAN INTERFACE FOR TEST/DIAGNOSIS

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ABSTRACT

The field of artificial intelligence has rapidly expanded with the discovery of new approaches to machine intelligence including intensive use of knowledge and heuristic, domain-specific problem solving strategies. Artificial Intelligence systems exhibit the characteristics we associate with intelligence in human behavior, particularly the ability to respond flexibly to situations, to make sense out of ambiguous or contradictory messages, to recognize the relative importance of different elements of a situation and to find similarities between situations despite differences which may separate them.

This AI methodology for test/diagnosis allows sharing Expert Knowledge, Knowledge Representation, Knowledge Acquisition, Documentation Control, Paper-Less Environments, Self-correcting Software (User maintainable software), analysis of test results, Self-training Software, and human interaction technologies & requirements. This paper discusses AI applications for the Human Interface of the Test/Diagnosis environment.

INTRODUCTION

We are making a transition in the Test/Diagnosis environment,one in which computers are reasoning with knowledge. Information about the unit under test will guide the human to a specific repair action to correct problems. Integrated diagnostic information management will allow repair by facts without wasting critical human resources.

The availability and the acquisition of human knowledge are critical in AI applications. The human interface is a key-link to the knowledge domain. This interface is critical for high-speed human interaction techniques which can significantly reduce operator testing and improve human performance.

HUMAN TO MACHINE INTERFACE

The areas of focus for the human interface include:

* Human interface AI functions
* Human functions required to interact with the AI system and obtain information from it (Interactive Troubleshooter)
* Computer vision, visual, and video perception
* Computer speech, recognition, understanding & response
* Contact sensory
* Audio
* Mechanical communications e.g. touch-sensitive displays
* Text
* Tables
* Graphics
* Graphic types e.g. schematics
* Dialogues
* Administrative functions
* Warnings & alerts
* Multiple skill-level tracks
* Virtual functions e.g. zoom
* Hypermedia
* Menus & displays
* Browsers
* Navigation
* Services
* Barcode reader
* Security

and a myriad of the associated subtopics.

COMPUTER SPEECH AND VISION

AI technologies, such as speech and vision, which are related closely to human capabilities maximize the computer/human interaction. The human interface can contain both speech recognition, understanding & response and visual perception of the test environment.

Computer speech interaction with the human improves ease of access, speed,manual freedom, ease of data entry, problem solving human/computer conversations and security control. Computer vision allows reading oscilloscope displays and digital voltmeters. Computer vision in the test environment can perceive when an operator action is complete and further directions are required. Computer vision allows for precise human monitoring and help. Vision can also be very beneficial should the human need medical assistance or need notification of a potential hazard. Vision can aid the operator in pre-test inspection by identifying potential problems prior to test. Vision can also be used to guide a robotic device.

INTELLIGENT FUNCTIONS

The intelligent diagnostic functions available at the human interface provide complete automated test/diagnostic data entry and evaluation to the human. The Intelligent Diagnostic functions which could be available to the human include:

* Actual failing test/defective part entry and part failure frequency information for a given test failure
* Output pin measurement entry with part failure frequency information based on the measurement
* Actual test point/measurement used to determine defective part entry with guided probe information and part failure frequency based on the measurement
* Identifying the defective part prior to ATE testing using higher system failure data

* Interactive data logging
* Predictive diagnostics:
  - At any point during testing
  - Based on known testing results
  - Based on operating hours failure rate
  - Based on uncertainty
  - Based on skill level and interactive information
  - Based on test criteria
* Select test sequence based upon symptoms
* Provide test execution sequence based on part failure frequencies
* Provide test execution sequence based on test failure rates
* Provide trace capability
* Provide verification steps to the human with the minimum number of steps necessary to verify the isolated failure
* Components, replaceable units, and multiple failures no longer being considered
* Why a specific test was selected (explanation)
* Identify to the human potential missing dependency links in the diagnostic model
* Sequential or signal tracing to perform a directed search in a known bad signal path
* Identify to the human failures which should not have occurred and provide possible causes for the failures
* Provide the percentage of time expected to isolate to n or fewer components
* Alter fault trees in real-time with known failure frequencies
* Inform the operator about "Which tests are not needed and where extra tests are required"
* Inform the operator about multiple failures occurring, are their interrelationships
* Inform the operator about multiple failures occurring, and alternative combinations that can provide the same symptoms as an unrelated single failure
* Identify components whose functionality cannot be validated by the ATE

The system provides entry and analysis of test failures, test-resequencing, test-dependency analysis, diagnostic results, integrated test data, measurement value histories, graphical displays, functional block diagrams,guided-probe information, symptom-based information, predictive diagnostics, Expert know-how, time-stress environmental failure factors and test program interaction. This will provide the human with a streamlined effective diagnostic strategy.

MULTIMEDIA ENVIRONMENT

The human interface of the AI system shall be a multimedia environment as shown in Figure 1. The hypermedia will contain electronic bookmarks, guided tours, audit trails, and global topic search. The Data/Knowledge Management System will contain failure history, technical support data, note-pad, knowledge-base browser, configuration management,and object definition & management. The Data/Knowledge base contains models of information, rules for data, and rules about procedures. Verbal commands and man-machine/machine-machine interaction along with automatic analysis and self-training modes are included. Touch-sensitive screens, instead of keyboard commands, provides quick interaction. The visual aspect allows UUT examination and highlighting with an added feature of human perception. The Reasoner provides analysis, evaluation, and system flow.

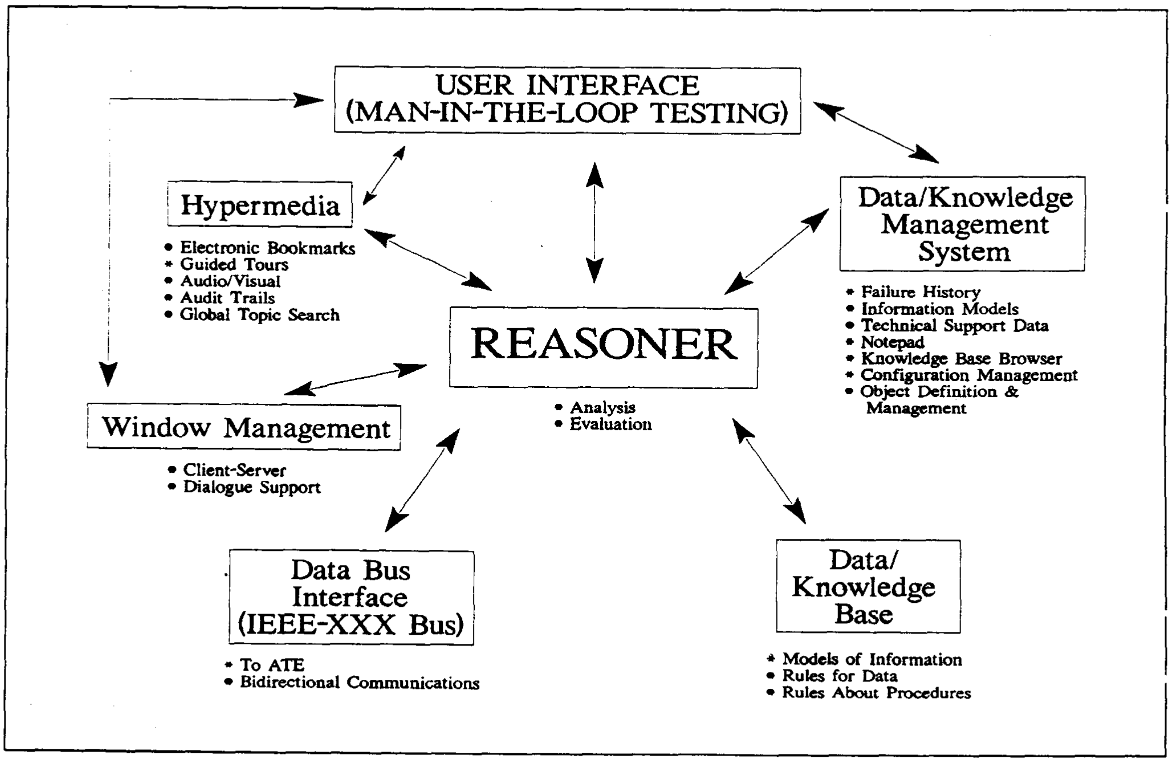

Figure 1 Multimedia AI System

INTERACTIVE TROUBLESHOOTER

The interactive troubleshooter provides a sequential diagnostic test flow with associated services. The selective functions of diagnostics test flow are problem start-up, diagnosis, repair, and after-action status. Within each function the human can request services like Explain, On-Line Documents, Help, Predictive Diagnostics, History, Back-up, Override Automode, etc. Predictive diagnostics can be performed at any time during testing. History files will be filled at the operators discretion. Historical knowledge pertaining to the UUT will be readily accessible at the operator's work station.

INFORMATION HANDLING AND CONTROL

The system would be of the greatest benefit in a local area network configuration. The development data for any given unit under test can be stored and altered as maintenance data is obtained. The updated development data can then be used for fault-diagnosis and test sequencing. Test program cause of failure call-outs will reflect what actually corrected the failures. The alterations made to the development data eliminates the necessity to make test program changes. This automatic correction approach will lower software support requirements and fix test program problems in real-time. An AI system for a local area network is shown in Figure 2.

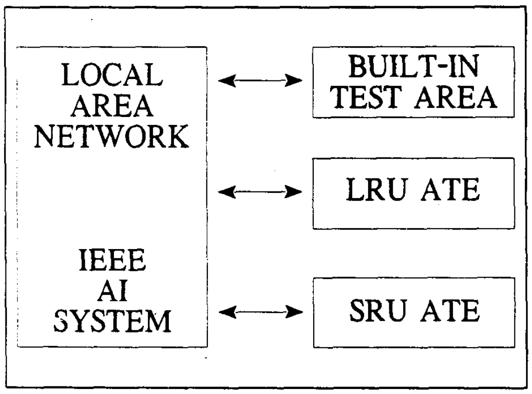

Figure 2 Integrated Diagnostics Layout

Figure 3 illustrates how dynamic failure detection can be obtained by passing information between different levels of testing. The generic AI system shown in Figure 3 indicates information flow from the unit under test.

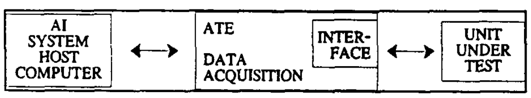

Figure 3 Generic AI System for ATE

The system requires a Data Manager and/or Expert operator. The manager performs periodic data review, since human factor errors occur from time to time. Validation and verification must be done to maintain a functional baseline. The manager needs a set of procedures to follow, experience in data handling and configuration management. Data integration from all using sites for any given UUT completes the database. The manager requires start-up and restart procedures for the system. Configuration should be performed at frequent intervals.

SUMMARY

The Integrated AI system shown in Figure 4 promises to facilitate ease in long term support. This is accomplished by moving the information domain into a user-oriented configuration. What specifically happened to a unit when it failed will determine the repair action. Expert know-how will reside in a usable knowledge sharing domain. Arbitrary testing-diagnosing philosophies will no longer exist. Only the part(s) which is defective will be tested and repaired.

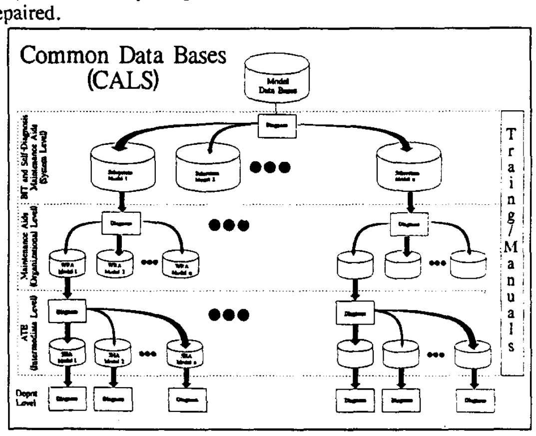

Figure 4 A Hierarchical Integrated Maintenance Architecture

The human interface contains all of the functions critical for human interaction support. Modeling human performance allows for precise real-time interaction between the human and the computer. This interface and its functions are critical to create a time effective, quality performance human working environment.

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