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Quarterly Technical Report PQTR-1033-79-5
Contract MDA903-76-C-0241
ARPA Order No. 3200
For the period January 1, 1979
to April 1, 1979
Report Date May, 1979

APPLICATION OF ADAPTIVE MODELS TO INFORMATION SELECTION OF C3 SYSTEMS

Prepared For:

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Office of Human Resources
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Arlington, Virginia 22209

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report highlights technical progress on work centered on the demonstration of innovative applications of adaptive modesl to support human information selection and processing in command, control, and communication (C) systems. The research and development tasks include: (1) a real-time supervisory system (i.e., multi-man model) for effectively routing messages to a group of cooperating information processors; (2) transfer of an adaptive information selection (AIS) aid, based on a single-man model for multi-attribute information, to the Marine Corps' Tactical Combat Operations (TCO) System; (3) demonstration of an

ITEM 20.

advanced information presentation (AIP) terminal for TCO involving improved message typography and ultra-rapid text presentation; (4) demonstration of the automatic generation of detailed, highly realistic three dimensional visualizations from available map databases to support terrain-related planning and training. Progress in each of these areas is summarized over the reporting period.

QUARTERLY TECHNICAL REPORT

TASK(1)

During this reporting period, work centered upon comprehensive examination of the training and adaptive behavior of user-based parameters which control the pattern of information distribution among operators. This examination took the form of a structured study of model dynamics and performance involving a series of planned simulation runs and analyses. The first stage of evaluation involved the study of the adaptive behavior of the multi-attribute information utility models, whereas the second stage focused on the training of influence coefficients (C weights) for each operator in the group network.

The first stage of evaluation tested the information distribution model's capability to adapt to various configurations of individual information preference strategies, each configurations consisted of nine separate multi-attribute information utility models. These strategies reflected each individuals preference with respect to himself/herself and to the other two hypothetical operators in the group--for information type [military (M), intelligence (I), economics (E), or negotiations (N)], message specificity [summary (S) or detailed (D)] and view history (message seen or not seen by each of the participating operators). The predictive performance of the information selection models with respect to each combination of joint strategies was tested under nearly ideal conditions. That is, each strategy was carried out by the respective simulated subject with almost perfect consistency throughout the complete experimental run.

The results of the first-stage evaluation successfully demonstrated the ability of the compounded multi-attribute information utility models to adapt to various combinations of operator message-selection behavior (for themselves and for others in the same communication network). In other words, the models were able to collectively predict which messages would be selected and routed as a function of their header designations. As examples, Figures 1 and 2 show weight training curves for eight different message attributes (i.e., those involving all pair-wise combinations of message type and specificity). Figure 1 depicts changes in the relative weights that operator X has for himself for receiving messages; and Figure 2 graphs changes in the relative weights that operator X has for sending messages to operator Y. As seen in the figures, the weights in both cases converge to stable, ordered values after a number of trials.

The results of the evaluation of the dynamic behavior of the algorithm for training influence coefficients suggested some difficulties with the mathematics of the originally formulated procedure. An analysis of the problem determined its relation to certain assumptions made concerning the measurement and scaling properties of multi-attribute utilities, when they are compared and/or aggregated across different individuals. Therefore, further theoretical and empirical work was required to modify the measurement base for the influence algorithm, implement a new algorithm into the system of programs, and test its operator within the task domain.

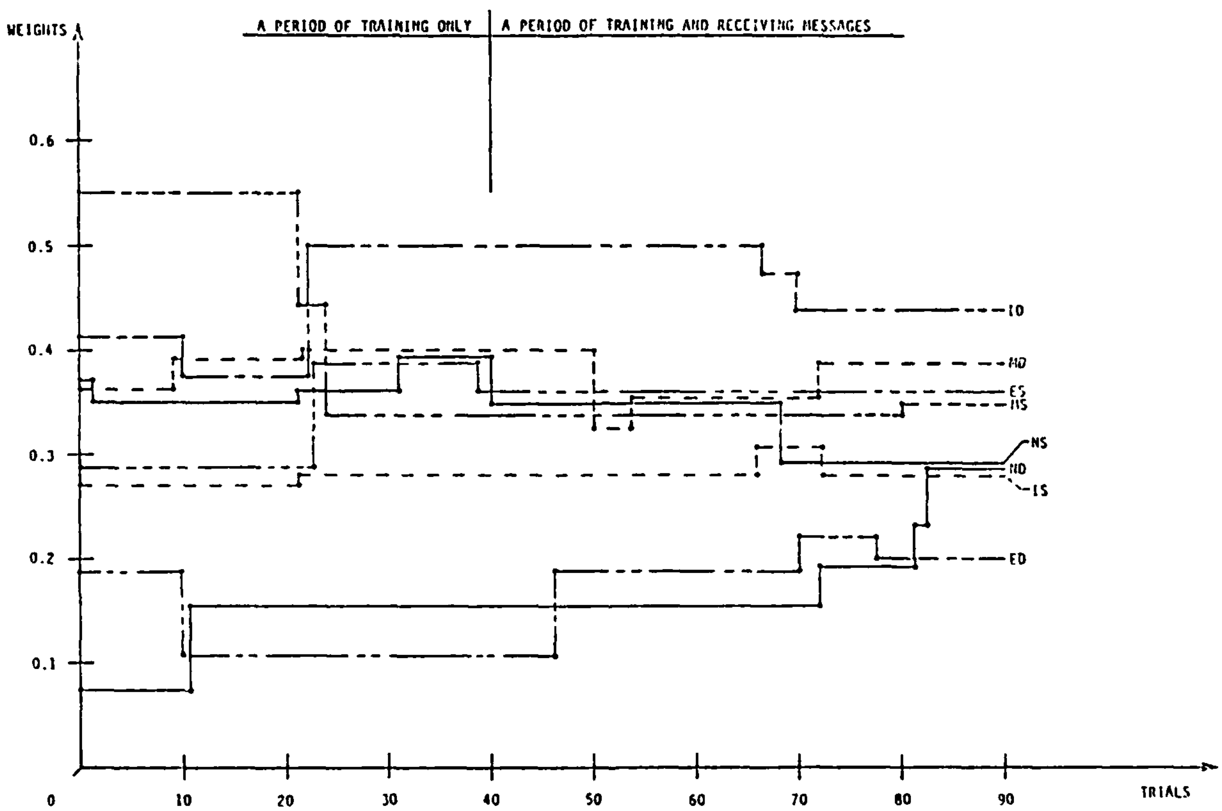

FIGURE 1.
A TRAINING GRAPH OF SUBJECT X FOR RECEIVING MESSAGES

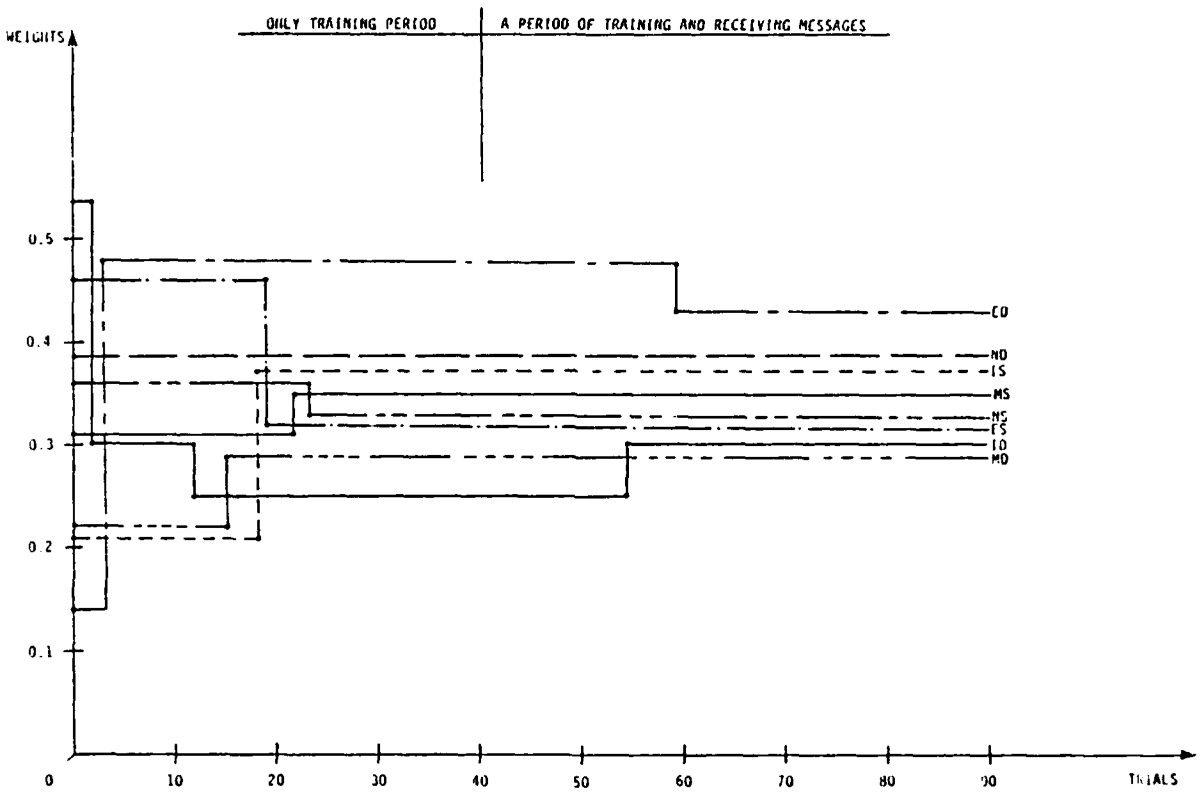

FIGURE 2.
TRAINING OF SUBJECT X MODEL FOR SENDING MESSAGES TO Y

TASK (2)

During the second quarter of the project, several important milestones were reached in Perceptronics' AIP terminal project. All major hardware and software purchases for the final system were made. During this period the necessary software modifications resulting from hardware differences between the simulation system and the final system were performed. Additional software changes were made to reflect the optimal values of several system parameters that were defined in the course of the preliminary sensitivity analysis performed during the system simulation phase.

The messages 'Glaserized' during this period included a TCO system situation, a report, and an ARPA free text message. Multiple cues suggested by Glaser were developed, color-coded and implemented to portray the essential messages attributes. The attributes displayed using multiple cues included message category, procedence, age and classification.

The TCO message display at the end of this phase possessed the necessary message control modes i.e., the page mode and the ultra-rapid reader (URR) mode. In the page mode, the user control options incorporated thus far included color control, character font control, and intensity control. In the URR mode the user control options were totally incorporated. These options included full rate control, proportional spacing, color and intensity control and upper/lower case 'glaserized' character set.

TASK (4)

During the second quarter of project activity, several major milestones were reached in the AIS transfer project. These milestones included reconfiguration and expansion of the AIS system model to reflect and incorporate the latest information available from TCO message headers, development of AIS evaluation plans and transfer of the calibration phase software to Camp Pendleton.

The AIS model attributes were reconfigured to maintain compatibility with the current TCO message header content. The calibration phase software was modified, debugged and transferred to the U.S. Marine Corps' ITF.

Modification of the AIS testing phase software for the Interim Test Facility (ITF) implementation was started and plans for AIS testing and evaluation procedures were developed. Two different AIS implementation possibilities were considered. The first called for imbedding the AIS software as part of the TCO software and executing and evaluating it as part of TCO exercises. The second option called for using the ITF only as a 'backdrop' and evaluating the AIS software independent of existing TCO exercises. In view of the numerous hardware and software problems at the ITF, and also because of the inherently greater exercise control provided by the second alternative, the second option was selected for demonstrating the efficacy of the AIS in a typical TCO setting.

TASK (5)

During the second quarter of project activity several important milestones were reached in Perceptronics' Computer-Based Mapping Project. Among the major milestones were design and implementation of a Frame Buffer graphics driver, preliminary specification of data base feature extraction and visualization rules, full operation of the Terrestrial Visualization System picture generating software, and preliminary design and implementation of automatic data base procedures.

Output from the TVS software producing run-length encoded digital files was made viewable through the development of a PDP 11/70 UNIX driver for the the Evans and Sutherland Raster scan Frame Buffer located at the DARPA/CTO Development and Demonstration Facility. Necessary software was also designed and implemented to display TVS files on the Frame Buffer.

A data base design was produced and implemented as a framework of implementating feature extraction and visualization rules. These rules provide for the automatic extraction of selected DMA DLMS data base information and its translation and augmentation as input to the TVS programs. Rules were implemented to produce visualization of both terrain and areally described feature-class data.

Using automatically produced data files pictures protraying terrain and significant areal sections were produced using the DMA data and the visualization system software. These pictures verified the operation of the picture generating system software and the validity of the picture specification rules.

Additional work during the second quarter centered on rule specification for the definition and automatic placement of digitally described areal