AD-779 062

BIOCYBERNETICS PROJECT

Jeffrey M. Hill

Computer Corporation of America

Prepared for:

Advanced Research Project Agency

31 December 1973

DOCUMENT CONTROL DATA - R & D

AD-779 062

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

Computer Corporation of America
575 Technology Square
Cambridge, Massachusetts 02139

2a. REPORT SECURITY CLASSIFICATION

Unclassified

2b. GROUP

None

3. REPORT TITLE

Biocybernetics Project Semi-Annual Technical Report

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Semi-Annual Technical Report July 1, 1973 through December 31, 1973

5. AUTHOR(S) (First name, middle initial, last name)

Jeffrey M. Hill

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
	8	0

8a. CONTRACT OR GRANT NO.

DAHC15-73-C-0320

b. PROJECT NO.

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES

None.

12. SPONSORING MILITARY ACTIVITY

Director
Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia

13. ABSTRACT

During this period, hardware was purchased and installed. Initial programming for experiment and data analysis was done. At the end of the period, experiments were being run, and data analysis was begun. Regarding coordination of biocybernetics contractors, a meeting concerning method and data sharing was sponsored by CCA. Equipment was ordered for contractors to start using the ARPA network.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Biocybernetics						
Closely coupled systems						
Arpanet						
Man-machine communication						

Computer Corporation of America
575 Technology Square
Cambridge, Massachusetts 02139

BIOCYBERNETICS PROJECT
SEMI-ANNUAL TECHNICAL REPORT

July 1, 1973 to December 31, 1973

This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by the Defense Supply Service-Washington under Contract No. DAHC15-73-C-0320. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or the U.S. Government.

Table of Contents

1. Overview

CCA's Biocybernetics Project has two goals. The first of these deals with various support activities for the ARPA Biocybernetics Program. Secondly, CCA carries out its own research into closely coupled systems, i.e., enhancement of human activities through direct linkage between biological and computer systems.

2. CCA Biocybernetics Research

2.1 Selection and Installation of Equipment

The project requires hardware facilities for presenting stimuli, recording subject responses, digitizing and storing bio-electric signals, and program development and data analysis. At this time, the biocybernetics project uses the CCA-Tenex facility for program development, data analysis, and file storage. The original equipment specified in the contract was investigated and it was decided that it provided too much display capability at the expense of more general purpose processing power and convenient analog/digital interface. After reviewing several possible minicomputer-display combinations, the Digital Equipment GT40 was chosen. The GT40 is a PDP-11 (Model 11/05) combined with a rudimentary independent display processor. The display hardware leaves much to be desired, but the selection of peripherals available for the PDP-11 and the ease of programming it were compensating factors.

Along with the GT40, the PDP-11 extended arithmetic element and a DEC analog-to-digital subsystem was ordered. After analyzing the data gathering and needed storage rates, it was decided that additional mass storage would also be necessary. Since DEC prices for PDP-11 peripherals are high, core memory and mass storage were ordered from independent suppliers. 24K of 16-bit words were purchased from Cambridge Memories. A 1.25 million word disk was originally ordered from International Memory Systems, but they failed to deliver. System Industries offered an equivalent unit, and were willing to back their delivery committment with a penalty clause. The disk was finally delivered in November, 1973. Lack of the disk hampered program development.

Four Model 113 preamplifiers were obtained from Princeton Applied Research.

The only piece of hardware yet to be delivered is an information collector-relay device, which was held up due to unavailability of IC's. It has been promised in the first quarter of 1974.

2.2 Laboratory Software

2.2.1 Software Summary

The PDP-11 system is used in conjunction with CCA's PDP-10. The PDP-11 is used for running the experimental programs and for gathering data. The data is stored on the PDP-11 disk for later transmission to the PDP-10 for analysis. The PDP-10 is used for data analysis and for file storage and program development. Software was written for communication between the PDP-11 and PDP-10.

2.2.2 System Development Software

The CCA Biocybernetic Project develops programs for the GT40 using a package of routines running on the CCA-Tenex facility. This package includes assemblers, loaders, editors, a mini-exec for the GT40, and routines for loading the GT40 from the PDP-10. Some of this software was already available on the PDP-10, other parts were gathered from various network sites and modified, and some had to be written from scratch. The mini-exec contains extensive debugging facilities as well as a package to use the GT40 as a normal terminal for communication with the PDP-10.

2.2.3 Data Transfer Routines

The GT40 is not connected directly to the PDP-10 but rather interfaces to the PDP-10 via an ARPA Network TIP. The TIP is designed primarily for interfacing terminals to the ARPA Network, and has only rudimentary commands for allowing transmission of binary data. Furthermore, the TIP is biased for bursts of data directed at the terminal, but only expects data at human typing speed coming from the terminal. Since we intended to use the low speed TIP interface (2400 baud) both for loading programs from the PDP-10 and for transmitting data from the GT40 to the PDP-10 for analysis, we had to develop a set of "mini-protocols" for data and program transmission between the CCA Tenex facility and the GT40.

2.2.4 Experimental Software

A goal of the CCA research project is to set up the laboratory so that it is easy to implement and test out various experimental ideas. In order to do this, a variety of software "modules" were written to do graphics work, sample data, record data, and display results. Especially in the graphics support area, we have developed numerous subroutines and macros for menu display and selection, light pen tracking, figure generation and display, and interaction with the terminal. Work is continuing on that package.

All of the software used in running the first experiment (described below) is composed of modules which can easily be adapted for use in subsequent experiments.

2.2.5 Data Analysis Software

The analysis package is also constructed in this modular fashion. There are a number of modules for doing various analyses, such as Fourier transforms, digital filtering, cross and auto correlation. In addition to these modules, there is a command interpreter which allows the experimenter to make up various analysis procedures to be performed on the data. A graph package for using the line printer for hard copy output was also developed.

2.3 Description of First Experiment

For our first experiment, we have focused on detection and measurement of attention indicators in the EEG. The subject is instructed to follow a ball moving on the screen with the light pen. The ball moves in a path determined by the sum of three sine/cosine curves with variable parameters. A tracking cross is displayed and the subject is instructed to keep the tracking cross as close to the center of the moving circle as possible at all times. Electrodes are placed currently on only two sites, the parietal and the occipital cortex. Differential readings are sampled at rates between 100-200 times per second from both channels. The subject is allowed to familiarize himself with the apparatus, and a series of baseline measurements of EEG are made. Each session generally consists of several trials, each followed by a rest period. During the trial, data is gathered continuously on the two EEG channels, and on the subject's performance. The continuous difference between the subject's pen and the moving ball are sampled and stored along with the data.

The task is designed to be boring and repetitive with the idea that the subject's lapses in attention will be reflected in his performance and that these lapses can then be correlated with the digitized EEG data. Due to the large amount of visual processing the task requires, we have focused on looking at the subject's alpha rhythm (8-12 cps). After filtering the data, the power in the alpha band is computed and smoothed and compared with a smoothed performance curve. The results we have obtained so far have been inconclusive in that they indicate problems in the task itself. Subjects do not seem to find the task boring, and in fact appear to be paying too much attention since they perform admirably at the task making few errors. The feedback given by the continuous display re-enforces the subject and the motor activity gives him something to do and thus decreases his boredom. We are currently looking at ways that the tracking experiment can be modified and also at other task environments.

3. Co-ordination with ARPA Biocybernetics Community

During this first year, CCA has initiated several efforts directed at supporting the ARPA Biocybernetics community. CCA has arranged meetings and workshops, arranged for increased biocybernetics use of the ARPA Network, and performed a variety of minor administrative tasks ranging from making travel arrangements to payment of consultants.

3.1 Data and Method Sharing

A data and method sharing conference was arranged by CCA on December 14, 1973. The focus of the meeting was on how to use common computer facilities for data storage and analysis. There was common agreement that the ability to use common facilities for data analysis would benefit each contractor. Most of the contractors collect the same type of data, differing primarily in minor formatting details. Furthermore, most of the contractors used the same basic set of analysis procedures. There was less agreement on the usefulness of actually sharing data, but this would be a benefit coming out of the use of common facilities and methods.

Several approaches toward the goal of sharing data and analysis facilities were discussed. CCA presented the concept of using the datacomputer system for data storage and sharing within the ARPA Biocybernetics community. This system, being developed by CCA for ARPA, is intended to serve as a large, on-line data storage and data management resource for Arpanet computers. The CCA Biocybernetics Project is itself planning to use the datacomputer system.

It was proposed that the community could use the datacomputer as a common data storage and retrieval node, and a facility such as UCLA/CCN as an analysis center. Most of the commonly used analysis packages are already available at that site, and a large part of the individual contractors' analysis routines are in Fortran so that transferring them to a common site would not be difficult.

Independent of selection of an analysis center or a data center, a major problem was how to get the data stored initially. The quantities involved are huge, with 40-50 megabits per contractor being the minimum that would be useful. Bulk or offline storage of several times that would be desirable. CCA does not have adequate facilities for large volume tape transfer and most of the contractors are not yet connected to the ARPA Network. At the conclusion, it was decided to investigate the following plan: a standard tape format would be defined for biocybernetics data. Tapes in this format could be sent to the datacomputer from any network site. Alternatively, tapes could be sent directly to the analysis center. Programs at the analysis center would have to be modified to accept data in the standard format.

3.2 Increased Biocybernetics Use of the Arpanet

CCA felt that communications among the biocybernetics research groups would be enhanced by the use of various additional Arpanet computer facilities, notably SNDMSG for the exchange of administrative messages. Toward this end, CCA is providing portable terminals for the biocybernetics contractors and will provide assistance in their use. For those contractors who do not already have access to an Arpanet host computer CCA is setting up an account at MIT-Multics and will administer this account.