(2)

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
AND COMPUTER SCIENCES

BERKELEY, CALIFORNIA 94720

7 January, 1992

Dr. Teresa McMullen
800 North Quincy Street
Code 1142PS
Room 823
Division of Cognitive Neurological Sciences
Office of Naval Research
Arlington, VA 22217

Dear Dr. McMullen,

This is our semiannual report of activity on Grant N00014-91-J-1333 during the period is 1 Jul 91 through 31 Dec 91.

The personnel working on project N00014-91-J-1333 during the reporting period were E.R. Lewis (PI), B.H. Bonham (doctoral student, research assistant), B.R. Parnas (doctoral student, research assistant) and W.J. Lee (junior specialist). As estimated in the previous semiannual report, the SUN SPARCstation II (SPARC II) for this project arrived early in July. The codes for the cochlear- and VIIIth-nerve modules and the graphics display functions were transferred with little difficulty from our SUN 3/80 workstations and all of the work on those elements since July has been carried out on the SPARC II. We were joined by Mr. Bonham who is working primarily on the self-organization component (IV.B.) of the original proposal. He had developed his original code for the SUNVIEW windowing system, so he spent some time during the current project period modifying it for more general operating environments and transferring it to the SPARC II and to the NeXT. His work is continuing on both of those machines. In the original proposal, we expressed our intention to enhance the speed of the SPARC II by addition of accelerator boards. The proposal specified boards by Mercury. Subsequently, we found that superior specifications were available with the Supercard-S board from CSPI. Lee and Bonham spent one month evaluating the performance of the system with that board in place. Based on the published specifications of the CSPI board, we expected to decrease computation times by as much as a factor of 25. Owing to the intrinsic speed of the SPARC II and the nature of our computations, the increase in speed (approximately two-fold) derived from the board was much less than our expectation, not worth the price of the board. Instead, we hope to invest the money in a second SPARC II, additional memory for the first SPARC II, and in personnel (the project is proving to be labor intensive-- in software development).

Software development over the past six months included the following steps: (1) Transport of the self-organization software to the SPARC II. (2) Installation of image processing and plotting packages on the SPARC II. (3) Testing of FFT-based cochlear modules. (4) Development of improved filter functions for the the cochlear module. (5) Modification of the VIIIth-nerve module to make it a general spike-initiator module that can be used for other neuronal structures (AVCN, MSO, LSO, etc.)

Up to now, the self-organization software has been used for modeling the development of neural connections in structures with monaural input; but it is ready to be used for modeling development of structures with binaural input. The developmental algorithms for modifying the strengths of synaptic connections are adapted from Linsker and are modified versions of that proposed by Hebb. They are based on the degree of correlation among the converging presynaptic inputs to individual neurons. The packages installed in step (2) are general-purpose utilities designed at Lawrence Livermore National Laboratory. They provide powerful, easily used tools for displaying and manipulating the acoustic images generated by the various modules of our model, as well as the structures and acoustic images generated by the self-organization software. The testing of FFT-based cochlear-filter modules, step (3), was a relatively small effort. Although we found that such modules work perfectly well-- and in fact could operate at very high speeds on the accelerator board, overall design considerations strongly favored cochlear filter modules based on temporal convolution. Increasing the speed of the filter module has little effect on the speed of the overall model, which is limited primarily by the computation times for the spike initiator modules (which are not significantly reduced by the accelerator board). Using temporal convolution requires considerably less memory and has the added advantage of allowing the individual filter functions to be modified in real time (and there is considerable evidence that this happens in real cochleas).

Task (4), development of improved filter functions for the cochlear module is ongoing. We presently are running the module with a set of antisymmetric FIR functions that yield realistically steep high-frequency and gradual low-frequency rolloffs, but share the problem of filter functions used in previous models-- having too large a spread in the delay times from the low-frequency filters to the high. Task (5) involved the largest effort over the past six months. In our pilot effort, we had integrated a cochlear model and a spike-initiator model into a single cochlea-VIIIth nerve module. Task (5) required decomposition of this module into truly independent cochlear filter module and generalized spike initiator module, which can be used for the VIIITH nerve module and for AVCN, MSO, LSO, etc. modules. The goal here was to remain true to our original plan, which emphasized adaptability and flexibility through modularity.

During the coming period, we plan to develop the modules for the AVCN, the MSO and the LSO and to begin to present and view spectrographic maps (i.e., those from the various modules) in groups, in order to gain intuition about how they might be integrated to yield sound source segregation. We plan to improve the cochlear filter function. Presently we are beginning to test REVCOR-derived responses (from gerbil cochlea) that have been smoothed to eliminate the effects of noise and truncated to yield FIR filter functions. We also have been developing algorithms for modifying FIR filter functions to better match our specifications. We also plan to work intensely with self-organization, attempting to determine whether Linsker-like algorithms will lead to monaural receptive fields similar to those in the cochlear nuclei, and binaural fields similar to those of the MSO and LSO.

Sincerely yours,

Edwin R. Lewis

cc: Administrative Grants Officer
Director, Naval Research Laboratory
Defense Technical Information Center