**VSApc: a C++ package for quantitative extracellular single-cell electrophysiology**

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Abstract—VSApc is a suite of DOS programs that was developed to measure spatiotemporal frequency responses and to collect maintained discharge from retinal ganglion cells of cats and monkeys. The operation of the programs is described and their details summarized.

INTRODUCTION

Central to the goal of understanding visual information processing at the neuronal level lies the need to characterize the noise statistics of the resting discharges, and the spatial and temporal filtering properties of the receptive fields of visual neurons. In higher mammals, especially at peripheral levels of the visual system, neurons can follow relatively high rates of flicker, necessitating specialized hardware and software to measure visual responses. We have developed a system that permits one to make such measurements, using an IBM-compatible PC. Our contribution has been in the development of a software package which we call VSApc. It runs under DOS and maintains master control over and directs the actions of a VSG2/2 visual stimulus generator card and an AS-1 data collection card, both from Cambridge Research Systems (CRS: Rochester, Kent, UK). The Cambridge cards are intelligent devices with their own processors running on-board programs. VSApc specifies and integrates the actions of the cards, provides a friendly interface to the user, performs on-line analysis of data, and outputs results as the experiment proceeds.

STIMULUS PRESENTATION

VSApc makes available, through an easy-to-use menu system, the VSG library of standard waveforms and parameters. Menus can easily be altered for new features.

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As currently installed, VSAPc instructs the VSG2/2 to produce visual stimuli on a Sony Multiscan 17se Trinitron color graphic display monitor (Sony Electronics Inc., San Jose, CA) with a frame rate of 153 Hz. This high frame rate and the monitor’s wide availability were primary factors for our selection of this monitor.

**DATA COLLECTION**

In our experiments, the action potentials of single cells, in the presence of background noise, are recorded extracellularly by a microelectrode. When the rising edge of the amplified action potential exceeds a threshold voltage set to be significantly greater than the noise, the amplifier produces a TTL pulse which is fed to the AS-1 card’s digital input. Through a program component of VSAPc loaded onto the AS-1, this card registers the time of each TTL pulse and makes these times available to the PC. VSAPc includes separate programs, utilizing the CAOS libraries provided by CRS, that run on the AS-1 to provide an assortment of data-collection strategies. VSAPc stores the time of each action potential in an ASCII file and performs a Fourier analysis on the action potential train.

**AVAILABILITY**

The source-code and a user manual are available, as is, provided the code is not distributed without permission of the first author.

**APPLICABILITY**

Although most users will have to modify VSAPc to accommodate their specific hardware, VSAPc should prove useful to anyone wishing to control the VSG and AS-1 in visual electrophysiology experiments. As there are no commercial packages available, anyone about to begin development of similar software for the CRS boards would benefit from this working example with an extensive, ready-to-use interface. The newer VSG2/3 would probably work well with the software, after some modifications, and the suite can easily be adapted for use with other monitor configurations.

**PARAMETERS**

Experimental parameters available to the user include a unique identification number for the current experiment, the animal species, the monitor’s viewing distance, screen luminance, pupil diameter, density of neutral filter (when attenuating the luminance), epoch duration, and page number for the hardcopy output. Unit parameters include a unique identification number for the current cell, the cell’s center type (on, off, other), the cell’s classification (e.g. X, Y, M, P) and an identification number for each epoch of data.