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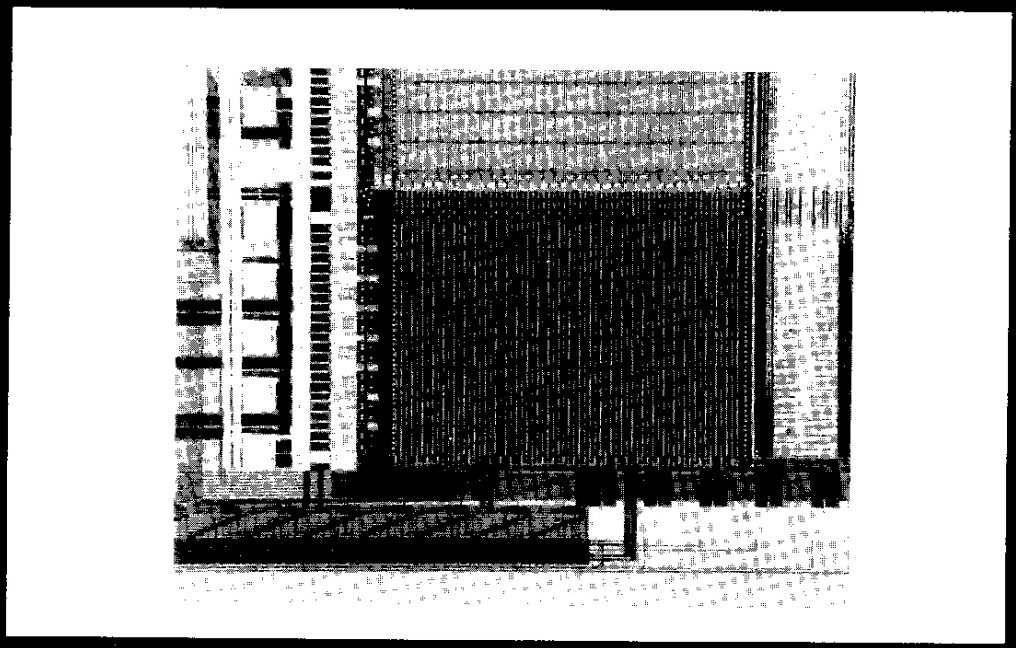

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Turbo Spike Grabber: Data Capture and Analysis Software

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Editor's Note: The following article on the new Turbo Spike Grabber software was written by the authors of the product.

Overview

The Turbo Spike Grabber (TSG) is a versatile software package useful in a variety of data acquisition and analysis situations. The program fills the niche of the typical chart recorder while adding many new capabilities for manipulating and storing electrically transduced data.

The program features real time capturing and filtering of dynamic voltage events, auto-recognition and categorization of multi-unit records, and built-in counting, instantaneous frequency, and low pass filtering algorithms. The program can also be configured to activate external devices and capture data at discrete intervals in accord with specific experimental protocols.

Data capture

TSG can be run in an oscilloscope emulation mode (Figures 1 & 2) to display simultaneous input from four analog channels. Keyboard input allows full control over trace speed, amplitude, and position.

The program also has an adjustable filtering algorithm, tolerant of DC shifts in baseline, which can be set to filter salient events from background noise (Figure 1). Filtered events can be stored as either a high density 64 point voltage profile or as a two point representation of peak to peak amplitude.

Each stored event is referenced by its occurrence in time. Long term captures are possible by intermittent dumping of data to disk. In this mode, capture duration, number of captures, and inter-capture interval can be pre-programmed by the user as can the time and duration of switching of specific external devices.

Filtering Features

The program has built-in counting, instantaneous frequency, and low pass filtering features useable on both raw and categorized data (Figure 3, page 5). Data stored to diskette is importable to a variety of spreadsheet/graphics packages. Data captured by TSG can be replayed and subjected to additional analysis.

TSG has two built-in algorithms which can be used to separate discernable units from a multi-unit complex. One algorithm uses a unit vector calculation to autoclassify units into separate categories as determined by a user set threshold level (Figure 4, page 6). The second

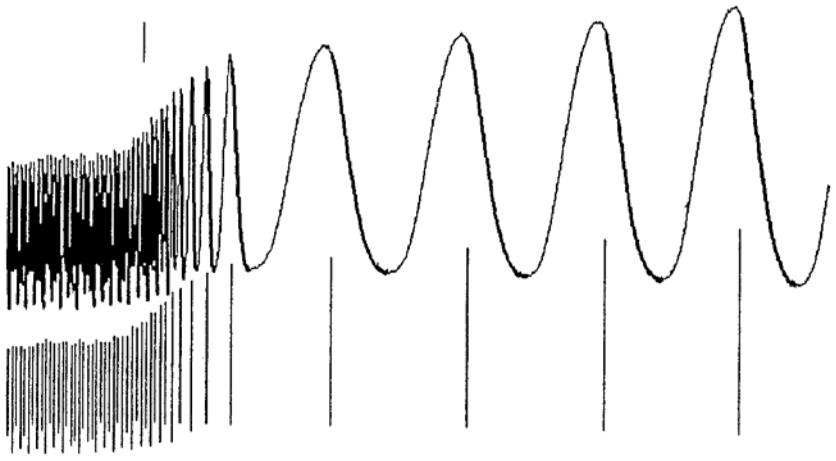

Figure 1. Rate and amplitude data from a molluscan heart monitored by the oscilloscope emulation feature. The top trace shows raw data input at increasing trace speeds while the lower is a filtered peak-to-peak representation of the same information. The line at the upper left is a stimulus marker which has been detected on a second analog channel.

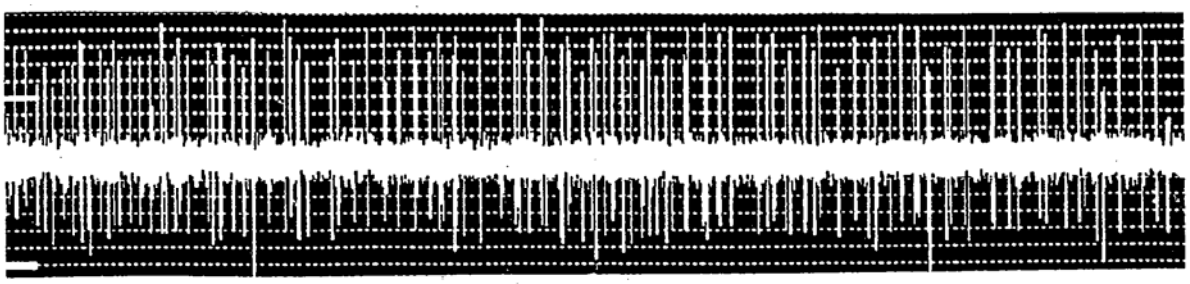

Figure 2. Unfiltered extracellular recording of sensory neuron firings from a scorpion pectine as obtained via the oscilloscope emulation mode.

algorithm superimposes captured units on the screen and allows the user to "tag" those which belong to separate categories (Figure 5, page 7).

Once specific categories are defined, units can be "played off" of each other to examine the time proximate effects of unit firings on the probability of other events.

Specifications

The Turbo Spike Grabber is written in Turbo

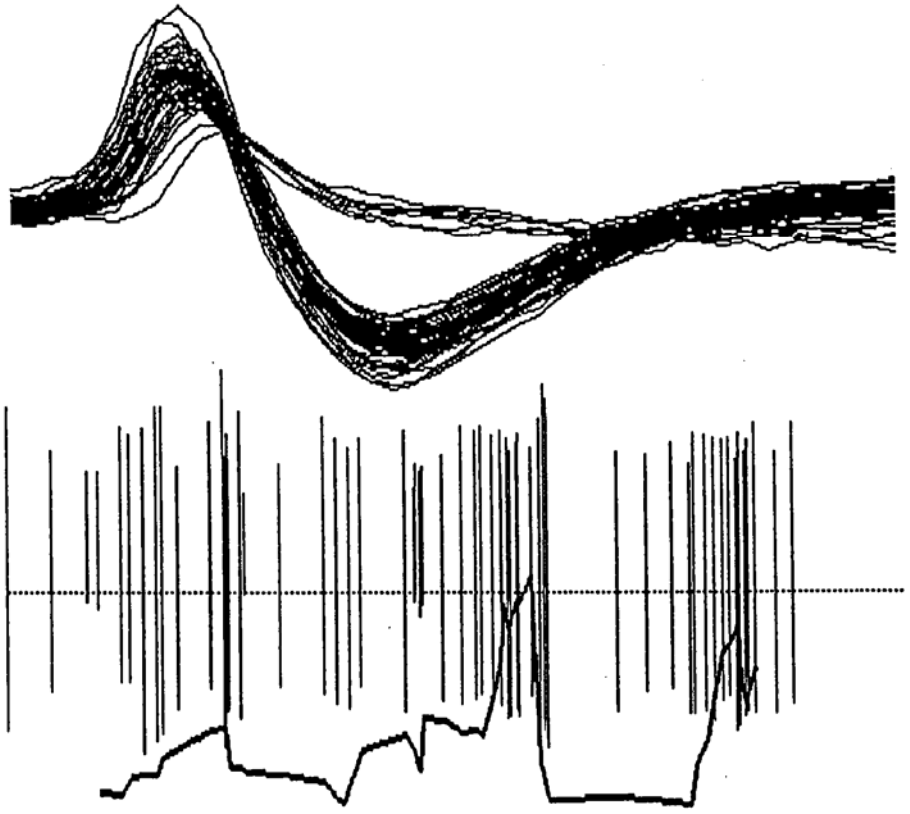

Figure 3. Instantaneous frequency analysis of filtered sensory action potentials. The superimposed curve represents a user adjustable low pass filter (here a 6 point running average) of the instantaneous frequencies of the recorded spikes. This analysis can be applied to either grouped (as in this case) or categorized data records.

Pascal 5.5, and accesses an IBM DACA board (or compatible) for external data acquisition and device control. It is designed to run on an IBM 286 machine (or better) or compatible.

Settling Time

When used with a 10 MHz machine and an A to D board with a settling time of approximately 30 microseconds, the program has a capture speed of about 35 microseconds. For fast changing voltage events such as action potentials of sensory neurons (approx 2.5 msec duration) this allows a density of about 64 points per event. The duration of capture is pendant on the frequency of spiking events, for example, a record with a spiking frequency of 10 Hz will allow a continuous capture of about 60 seconds. The IBM DACA board has a 12 bit range in signal resolution.

Applications

The examples in the figures on these pages show some of the ways we have applied TSG in our own laboratory at Oregon State University.

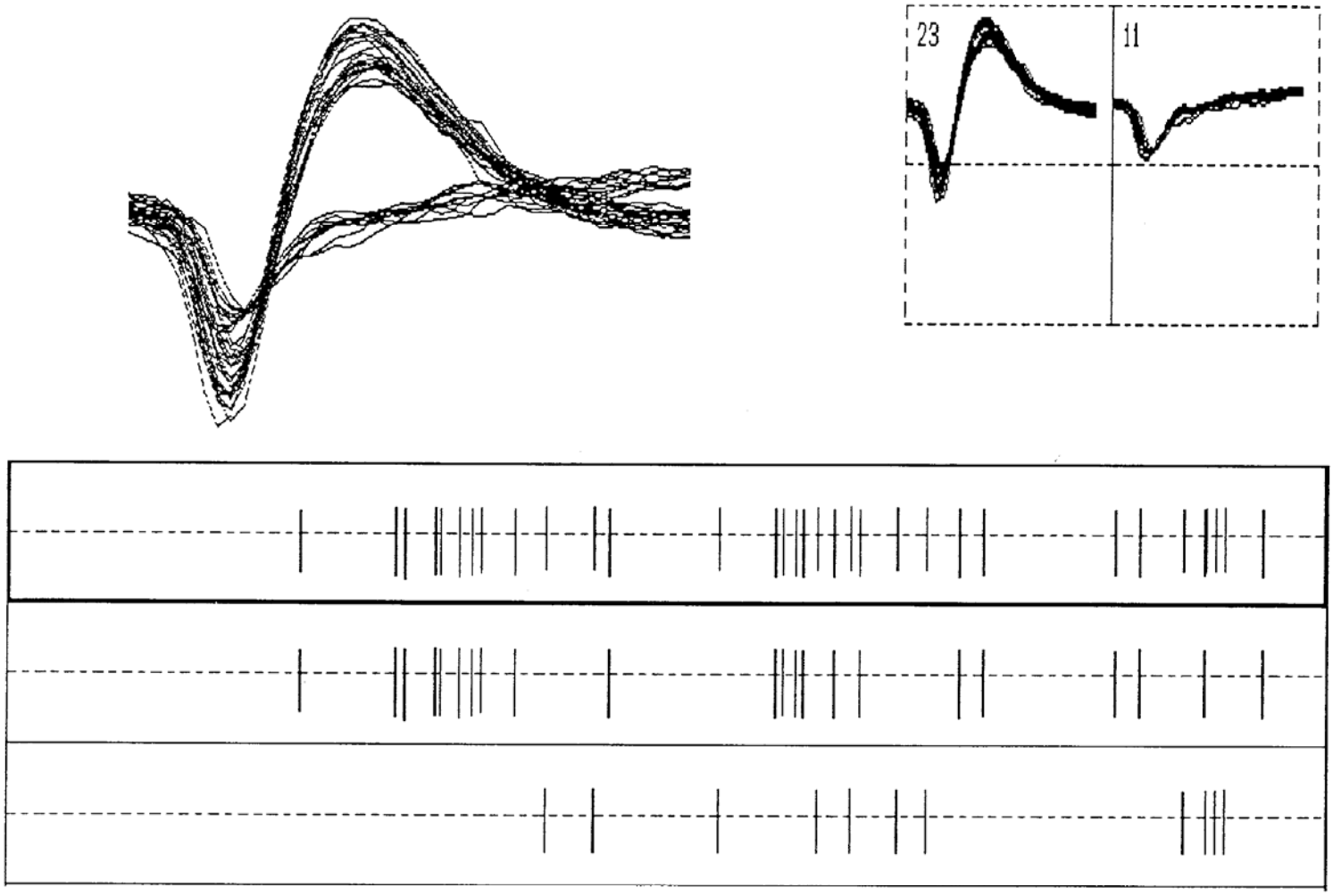

Figure 4. Auto-classification of multi-unit record into individual unit tracings. The composite spiking activity of the upper left panel has been decomposed into two separate categories and counted in the upper right panel. The bottom panel shows the occurrence in time of each spike as both multi-unit (upper trace) and single-unit records (lower two traces).

For more information on this product, please contact the authors directly at

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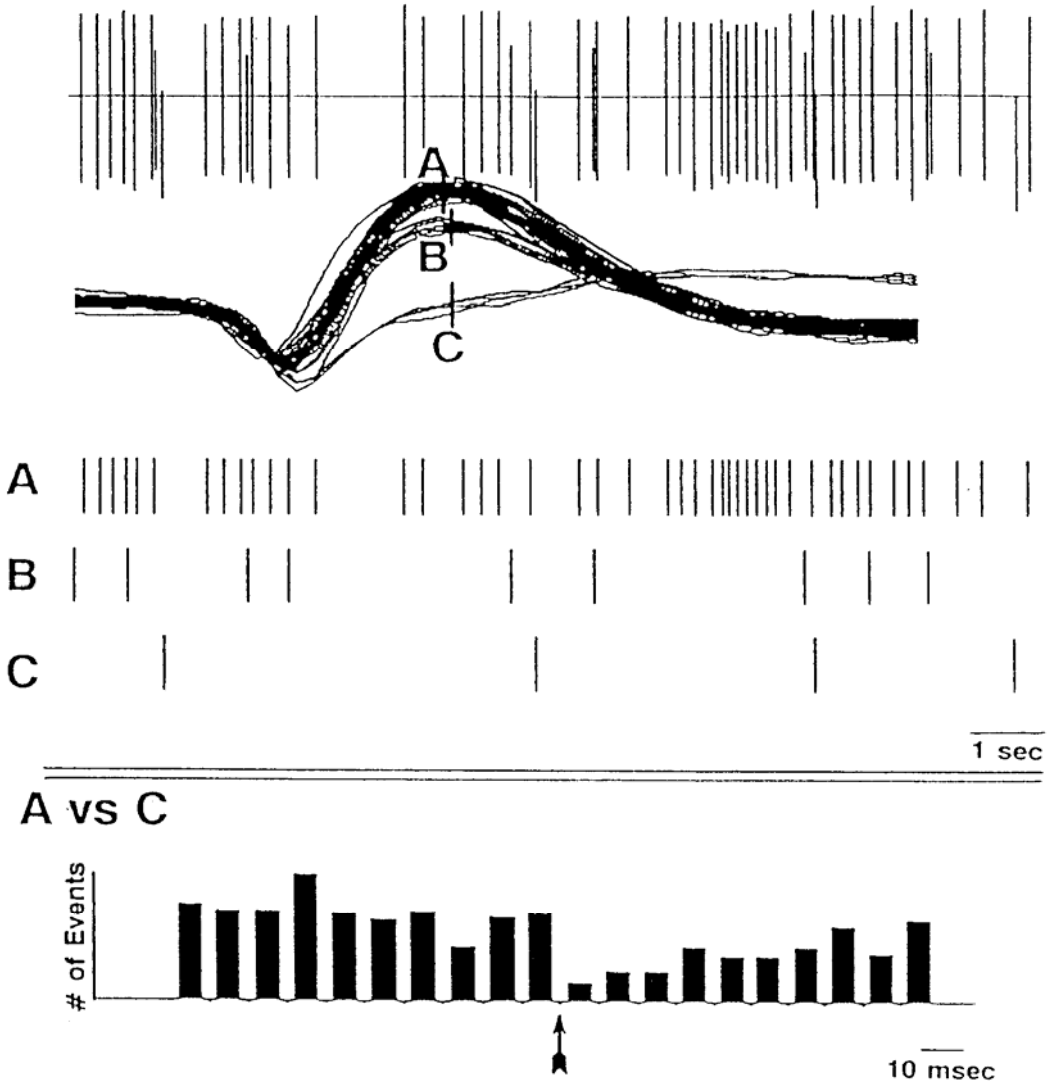

Figure 5. Inter-unit activity analysis using the "spike-tagging" algorithm. Individual spikes were superimposed and apparent groups (A,B,& C) user-tagged as indicated by lines on expanded spike forms. The composite trace above was then decomposed into three separate traces based on this categorization. Histogram at bottom resulted from "playing" the large-amplitude spike category (A) off of the small one (C). The activity of the large unit in reference to the small unit has been tallied by 10 msec bins for several data capture periods. The entire histogram profile represents the 200 msec environment immediately surrounding (100 msec before and after) the composite firings of the small unit (indicated by arrow). In this case the data indicates that the firing of the larger unit is suppressed by the firing of the smaller unit.