Automatic Calibration of ERG and VEP Stimulators

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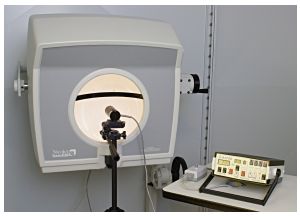
Background: Reliable ERG and VEP measurements can not be performed without periodic calibration of the Ganzfeld and video stimulators (1,2,3). Manual calibration of programmable stimulators can be very time-consuming and inaccurate. All parameters of programmable visual stimulators, e.g., stimulus strength, uniformity of the stimuli, filter attenuation and background luminance can be measured automatically. The large amount of measurements required to calibrate programmable visual stimulators can only be done using a computer-controlled measurement method.



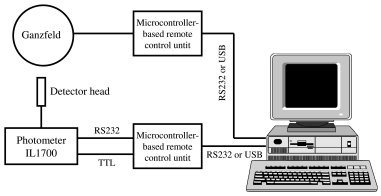


Fig. 1 *Automatic calibration of the Nicolet GS2000 Ganzfeld stimulator. Stimulus and background intensity and filter settings of the stimulator was controlled by a PC. The proprietary interface circuits and communication protocols of the Ganzfeld stimulator and the Photometer were replaced by RS232-controlled programmable microcontrollers executing high-level commands.*

Methods: A GS2000 programmable Ganzfeld stimulator (Nicolet Biomedical Systems, Madison, USA) and a VSG 2/2-based video stimulator (Cambridge Research Systems, Rochester, UK) were used for stimulus generation. Since the Nicolet GS2000 Ganzfeld uses a proprietary interface and a low-level communication protocol, it can not be controlled by standard computers. To solve communication problems the device controller integrated circuit on the main board of the stimulator was replaced by a programmable 8051-based microcontroller circuit (Fig. 2 A). Stimulus and background intensity was measured with an IL1700 radiometer/photometer (International Light, Newburyport, USA). To rationalize the communication between the computer and the photometer, a programmable 8051-based microcontroller circuit was developed (Fig. 2B). Thanks to the microcontrollers, all functions of the stimulator and the photometer could be controlled using high-level commands and standard (RS232 or USB) interfaces compatible with every operating systems (DOS, Windows, UNIX & MAC). The software for the microcontrollers was developed using an open-source C compiler (4). The calibration programs running on the PC were developed using different C and C++ compilers (Visual C, gcc, g++). Every function of the Ganzfeld stimulator and the photometer can also be controlled using a serial terminal or a terminal emulator program. Simple measurement procedures can be developed rapidly using scripts (DOS/Windows: batch files, Unix: shell scripts or PERL).

A **B**

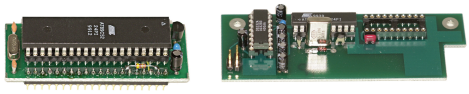
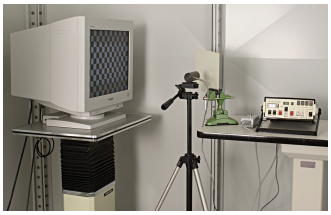


Fig. 2 *The microcontroller modul for the Nicolet GS2000 Ganzfeld stimulator can be plugged in the 40-pin IC-socket of the original controller circuit (A). Microcontroller-based remote control board of the IL1700 photometer with RS232 interface (B).*



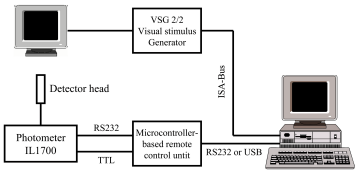


Fig. 3 *Measurement of the alteration of mean screen luminance during pattern reversal and onset/offset stimulation. The relative luminance was measured indirectly from a white surface placed in front of the monitor.*

Results: The calibration of the Ganzfeld stimulator requires 3 phases:

1. Measurement of flash luminance on all (255) programmable intensity levels.
2. Measurement of the filter attenuation of the 6 selectable filters.
3. Measurement of the background intensity (32 levels)

The results of the measurements are saved to files. These files are used to adjust flash intensity (a combination of flash intensity and filter setting) by software programs used for clinical testing. The automatic calibration of the programmable Ganzfeld stimulator can be done in about 2 hours.

The calibration of most of the parameters of the pattern stimulator (mean luminance, contrast, etc.) is simple and can be done manually. The measurement and correction of some parameters, (change of luminance during pattern reversal and pattern onset/offset) is relatively complicated and requires a computerized method (Fig 3).

Conclusions: Programmable visual stimulators can be calibrated accurately with our method. In addition to the measurement of the mean luminance of the stimulus, additional parameters, e.g., standard deviation of the flash luminance, long-time stability, etc. can be calculated. Computer-controlled calibration is more accurate, faster and provides much more information, than the conventional time consuming manual approach.

Literature:

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