

CHRONOS

2D/3D Image-based Eye Tracker

Qualified by NASA for deployment in the ISS

The Chronos 2D/3D Eye Tracker represents a new generation in image-based eye movement measurement technology. This is based on programmable CMOS image sensors, interfaced directly to digital processing circuitry. This approach has several important advantages over existent devices based on conventional video standards:

- High image sampling rates up to 200/s for 3D and up to 400 /s for 2D
- Measurement resolution $< 0.1^\circ$
- Linearity $< 2.5\% \pm 20^\circ$ H/V ($< 4\% \pm 20^\circ$ T)
- Online display of eye images
- 2D/3D measurement, monocular / binocular acquisition
- Disk storage of relevant image data for offline evaluation of acquired sequences
- Frame sync output/event trigger input (TTL level)
- Simultaneous acquisition of analogue signals
- Online analogue outputs (horizontal and vertical)
- Standard data output formats for postprocessing (ASCII)



Chronos Eye Tracker head unit.

Ergonomic Design

Drawing from our previous experience with VOG systems and consultation with experts in the fields of visual-vestibular research, optometric and neurological examination, and human factors studies, a number of innovative features have been included in the Head Unit design:

- the inertial load on the head has been kept to a minimum by selection of lightweight components and uniform distribution on the headframe.
- device slippage is reduced by the use of a vacuum-padded insert and/or a custom-formed facemask.
- field-of-view of $\pm 90^\circ$ horizontal and $+40/-60^\circ$ vertical.

Technology

The digital eye-tracking cameras, which have been designed around state-of-the-art CMOS image sensors, are interfaced to a dedicated processor board in the host PC via bi-directional high speed digital transmission links (192 Mb/s). This PCI plug-in board carries the front-end processing architecture, consisting of digital signal processors (DSP) and programmable logic devices (FPGA) for binocular, online image and signal acquisition.

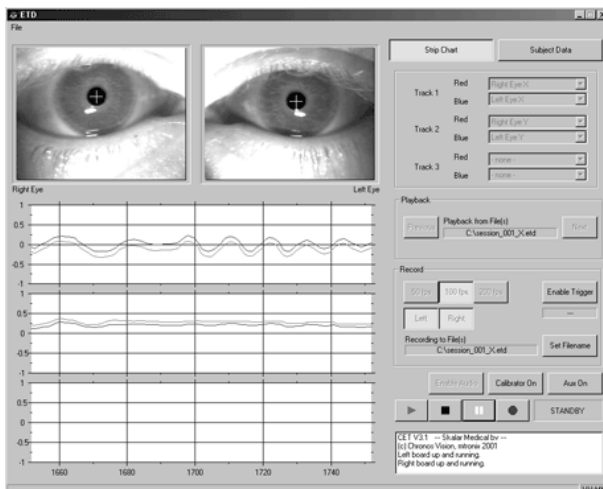
For the eye tracking task, a substantial data reduction is performed by the sensor and the front-end processing. Thus, only preselected data are transferred from the image sensor through to the host PC where the final algorithms and data storage are implemented. This eliminates the bottleneck caused by standard frame-by-frame image acquisition, and thus facilitates considerably higher image sampling rates.

The Chronos Eye Tracker is Qualified by NASA for deployment in the International Space Station. Furthermore it has been tested at a number of beta-site laboratories.

Software

Circle and ellipse fitting algorithms are included for pupil tracking, together with a new implementation of the polar correlation algorithm. An additional algorithm based on tracking artificial iris markers is also included. The program structure will include a software interface for additional user-defined image processing routines.

The software package runs under Windows 2000® with a set of front-end firmware modules implemented on the dedicated FPGA and DSP devices.

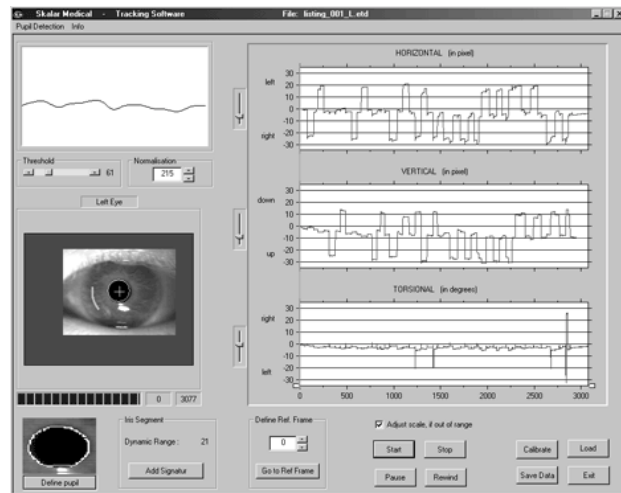


GUI showing eye image and trace of calculated eye position vs. time.

User Interface

The interactive software provides the user with a comprehensive set of options via pull-down menus or pre-stored parameter files:

- acquisition modes (sampling rate, mono / binocular tracking, 2D / 3D tracking)
- online / offline calculation of 2D / 3D eye co-ordinates.
- internal / external trigger for Record Start/Stop
- Selection of measurement algorithms
- Online storage of the resultant data set
- Archiving, selection and visualisation
- Storage of selected set-ups as parameter files.



Software program (IRIS) for off-line evaluation of relevant image data.

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