

Products Used: LabVIEW™ • NI DAQ™ • NI PCI-1408 • NI PCI-6024E-Vision

Synchronising Image Analysis Data Collection and Target Control for Human Factors Research

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The Challenge: Simultaneously measuring the pupil, vergence, and accommodation, all of which are interlinked oculomotor parameters, to monitor the visual effects of high-stress conditions, such as air combat.

The Solution: Using National Instruments PCI-1408 image acquisition card with LabVIEW and DAQ to analyse the output of the Autorefactor while simultaneously monitoring or controlling the position of the task image.

One Instrument Measuring Three Parameters

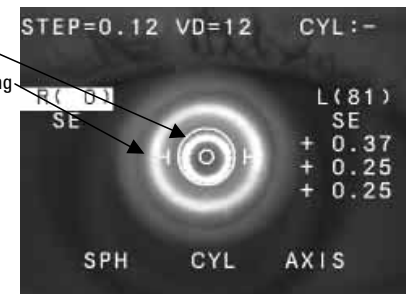
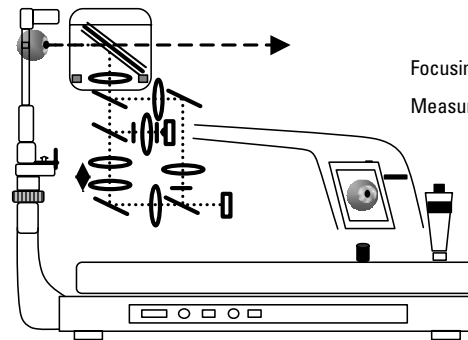
In the area of optometry and vision sciences at the Neurosciences Research Institute, School of Life and Health Sciences, Aston University, one of our research areas involves investigating the interaction between human

National Instruments LabVIEW software easily adapts and does not require advanced computer language skills.

factor tasks, such as driving and military aviation and the oculomotor system. The oculomotor system consists of:

- 1) The pupil – Controls the amount of light entering the eye. Acts as a good indicator of mental workload because of innervation by the parasympathetic and sympathetic pathways of the body
- 2) Vergence – Relative alignment of the two eyes. Controls and prevents double vision by turning the eyes to be more convergent. An object of interest, closer than the far distance, falls on corresponding points at the back of both eyes
- 3) Accommodation – Distance at which the eyes focus, by muscles altering and manipulating the shape of the crystalline lens within the eye

Until now, few instruments could measure all three interlinked oculomotor parameters



SRW-5000 output image with measurement ring switched permanently on

Diagrammatic representation of the Shin-Nippon SRW-5000 and its monitor output

simultaneously. Those instruments that attempted this required intensive calibration and produced data of variable quality.

Shin-Nippon, a Japanese company, introduced a new autorefactor, the SRW-5000. The subject has an unobstructed view

of the outside world and a semi-reflective mirror images the eye. The SRW-5000 projects a ring of infrared light into the eye and provides a measure

of refractive error or accommodation by measuring the size of the reflected ring in multiple meridians, using static image analysis. This measure proves accurate and repeatable compared to standard methods of refraction.

Thresholding and Blob Image Analysis with LabVIEW and Vision

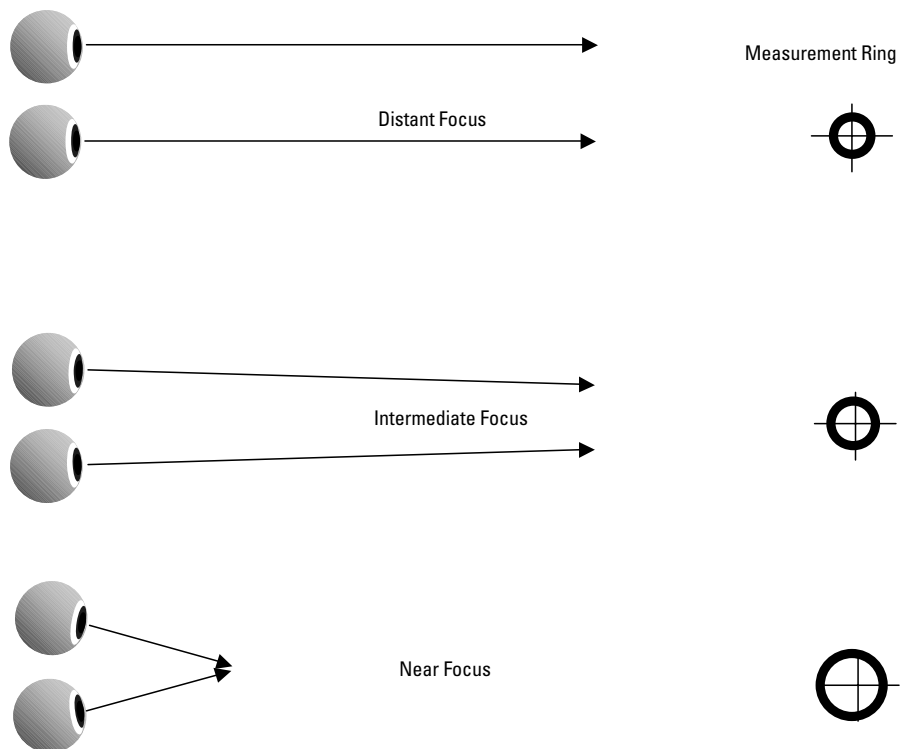
For research purposes, we can learn even more information about the oculomotor system if we confirm the data. To do this, we tapped into the SRW-5000's video source, which we use to image the measurement ring and to align the instrument with the visual axis of the eye. We fed this image into a National Instruments PCI-1408 image acquisition card in a Pentium III 700MHz PC. Using the menu system of the SRW-5000, we permanently activate the measurement ring,

making it visible for continuous analysis when aligned with the instrument on the visual axis of an eye.

Thresholding and blob image analysis with National Instruments LabVIEW programming and Vision software allowed us to locate the measurement ring. Therefore, we quantify the horizontal width online at up to 60 Hz. Although the National Television Systems Committee (NTSC) signal completely refreshes at a frequency of 30 Hz, by analysing the noninterlaced signal, we can achieve a frequency of 60 Hz on a half-height image. The centre position of the image allows us to measure small changes in eye alignment. The measurement ring obscures the pupil size in the SRW-5000's video image. Therefore, a second video camera with infrared illumination focuses on the eye and feeds into the second channel of the PCI-1408 image Capture Board. We quantify the pupil size online at 60 Hz simultaneously, again using thresholding and blob LabVIEW image analysis.

Conventional image analysis for edge detection limits a resolution of one pixel for a given intensity threshold criterion. However, in a real image, a pixel staircase of changing intensity contains an edge. We fit the staircase with a quadratic profile using an edge detection VI. Therefore, a given intensity threshold criterion detects the edge of the measurement ring. We then extrapolate a give

Customer Solutions



Measurement Ring Changes with Eye Focus

LabVIEW is an ideal platform for any researchers involved in electronic data acquisition or image analysis.

threshold to sub-pixel accuracy, improving measurement resolution.

To measure latency and response times, we synchronized the data collection and target changes. We achieved this by fitting a PCI-6024E low-cost Multifunctional I/O board into a PC and attaching it to a BNC-2090

analogue adapter. With LabVIEW, we simultaneously monitored the oculomotor response and the movement of an X-Y plotter, which is controlled by a waveform generator. Alternatively, LabVIEW could generate a voltage to control the X-Y plotter directly.

In conclusion, National Instruments LabVIEW software easily adapts and does not require advanced computer language skills. As such, it is an ideal platform for any researchers involved in electronic data acquisition or image analysis. ■

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