Tobii Pro Spectrum
Product Description

tobii pro

1 Introduction

This document describes the features and functionality of the Tobii Pro Spectrum eye tracker.

1.1 Overview

The Pro Spectrum is an advanced, high-frequency eye tracking platform, intended for extensive studies into human behavior and the mechanics of eye movements. The design allows the subject to move naturally during recording while still maintaining high accuracy and precision. This means that eye movements such as saccades and short fixations can be studied without using a chinrest. Pro Spectrum delivers superior eye tracking through high-quality hardware components as well as fine-tuned algorithms that work in a variety of conditions (dark or bright environments, during head movements) resulting in excellent eye tracking quality over the entire screen. This eye tracker can be used in various setups, either with an attached monitor or in standalone form to perform eye tracking with physical objects.

1.2 Product Versions

The Pro Spectrum is available in four different product versions, the only difference between these is the maximum data output frequency; 150, 300, 600 or 1200 Hz. The 150, 300 and 600 Hz versions can be upgraded to a faster version, but that requires the unit to be returned to the production team at Tobii Pro for an upgrade. Pro Spectrum is delivered with a pre-mounted monitor and includes all required connection and power cables in a robust travel case.

1.3 Application Areas

The Pro Spectrum is suitable for use in areas such as:

- Neuroscience studies - for example those combining eye tracking and EEG data;
- Ophthalmology studies - for example those where a large freedom of head movement is needed;
- Reading studies - for example those where large freedom of movement is important;
- Psychology research - for instance in developmental psychology and psycho-linguistics;
- Tests requiring a latency of less than 5 ms - for instance in gaze-contingency studies.

1.4 Basic Operating Principles

Eye trackers from Tobii Pro use infrared illuminators to generate reflection patterns on the corneas of the subject's eyes. These reflection patterns, together with other visual data about the subject, are collected by image sensors. Sophisticated image-processing algorithms identify relevant features, including the eyes and the corneal reflection patterns. Complex mathematics is used to calculate the 3–D position of each eyeball and the gaze point on the screen (or when you don't use a screen, it calculates the gaze point on the object); in other words, the data shows your where the subject is looking.

2 Technical Specifications

2.1 Eye Tracking Specifications

Eye tracking technique	Binocular bright and dark pupil tracking Two cameras capture stereo images of both eyes for the accurate measurement of eye gaze and eye position in 3D space, as well as pupil diameter
Sampling frequency	60, 120, 150, 300, 600 or 1200 Hz (max. frequency depends on product version)
Accuracy*	0.3° at optimal conditions (down to 0.16°)
Precision*	0.06° RMS at optimal conditions (down to 0.04°)
Precision filtered*	0.01° RMS at optimal conditions
Max. gaze angle	30°
Freedom of head movement	Width x height: 34 cm x 26 cm (13.5'' x 10'') at 65 cm (at least one eye tracked).
Operating distance	55 to 75 cm (22'' and 30'') from the eye tracker reference point
Total system latency	Less than 3 frames (eg. <2.5 ms at 1200 Hz)
Blink recovery time	1 frame (immediate)
Gaze recovery time	Less than 150 ms
Recommended monitor	Supplied 23.8" monitor (see note below)
Data output (for each eye)	Timestamp Gaze origin Gaze point Pupil diameter
Eye image data stream	Eye image stream frequency is approximately 2x5 Hz Zoomed-in eye images are available in tracking mode Full-frame camera images available in gaze recovery mode
TTL input stream	8–bit timestamped data (256 event codes) Event driven detection with a timestamp accuracy of 50 µs
User calibration options	Standard calibration, 1-14 calibration points Additional options to calibrate only one eye (left/right), or one eye at the time.
Tracker and client time synchronization	Integrated synchronization between the eye tracker time domain and the client computer time domain, with an accuracy of 100 µs.

*Tobii Pro uses an extensive test method to measure and report performance and quality of data. Please download the data quality test report for more detailed information: https://www.tobiipro.com/tobii-pro-spectrum/.

For certain markets no monitor is included in the delivery due to import restrictions.

2.2 Hardware Specifications

The Pro Spectrum is supplied with a 23.8'' attached monitor. This monitor can easily be removed by the user to transform the unit into a standalone eye tracker.

Eye tracker

Dimensions	55 cm x 18 cm x 6 cm (22" x 7" x 2'') The eye tracker is mounted on a stand which raises it from the surface by 9 cm (approximately 4")
Weight	5.1 kg (11.4 lbs.) With the power supply unit, the weight is 5.7 kg (12.9 lbs.)
Eye tracker processing	Integrated
User camera mount	Standard 1/4" thread
Connectors	TTL input: 8-bit (DB-9 connector) Communication: Ethernet (RJ-45 connector) Power supply: 24 VDC (5.5 mm connector)
Power	Max. rated power consumption: 96 W Typical power consumption: 60 W
External power supply	Input: 100-240 VAC 50/60 Hz Max. rated power consumption: 120 W No load power consumption: <0.15 W Energy efficiency level: VI Complies with EISA 2007/DoE,NRCan, AU/NZ MEPS,EU ErP and CoC Version 5

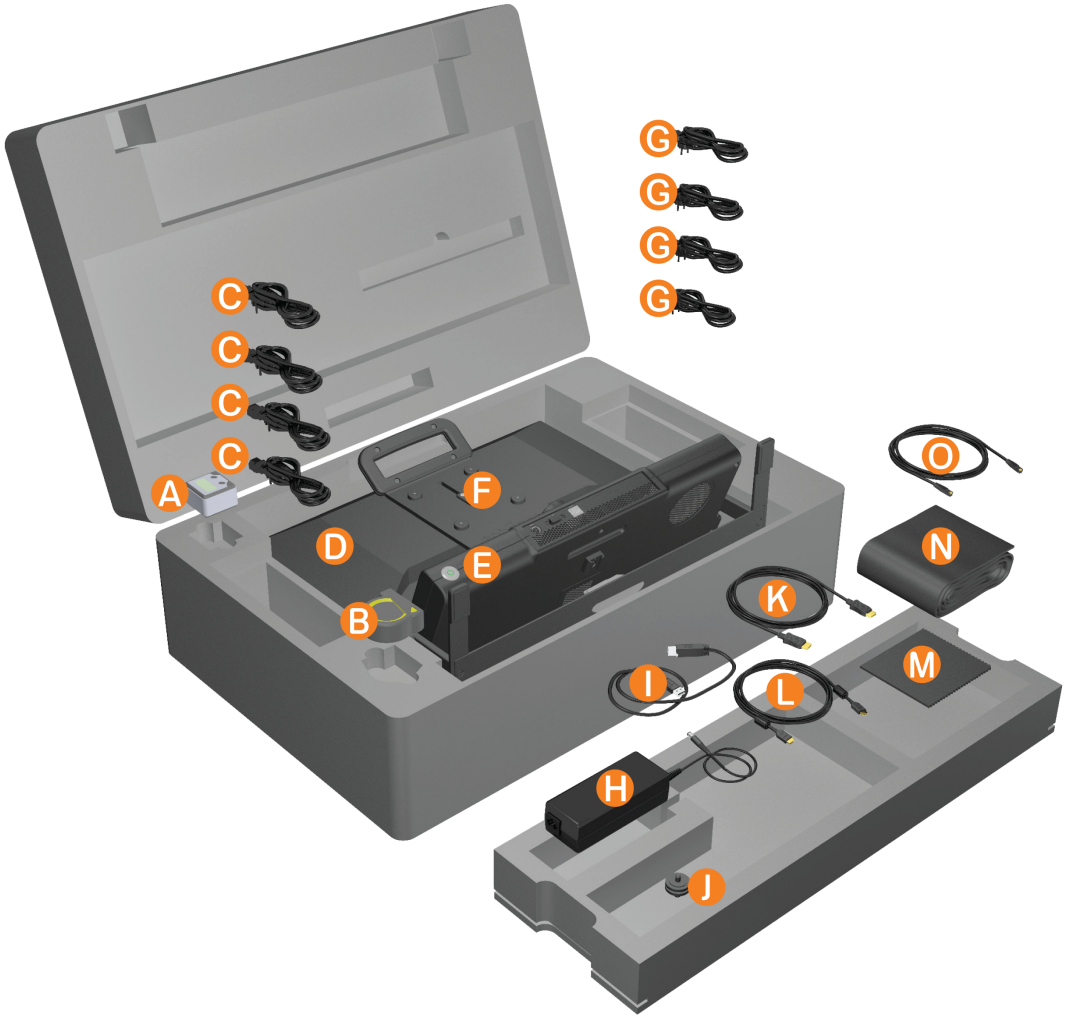
Monitor

Monitor model name	EIZO FlexScan EV2451
Panel type	IPS, LED backlight
Screen size (diagonal)	23.8”
Weight	3.8 kg (8.4 lbs.) (including mounting materials)
Aspect ratio	16:9
Resolution	1920 x 1080 pixels
Response time	5 ms (Gray-to-gray)
Connectors	DVI VGA HDMI Display port 1 port for monitor control (USB 3.0) 2–port USB hub (USB 3.0) C13 power connector Audio input connector: 3.5 mm Headphone jack: 3.5 mm
Built in speakers	1.0 W + 1.0 W
Power supply	100-240 VAC 50/60 Hz
Power	Max. rated power consumption: 42 W Typical power consumption: 13 W Power Save Mode: 0.5 W Power Management: Power Save (VESA DPM, DisplayPort Rev 1.1a, and DVI DMPM)

2.3 Setup Options

1. As delivered with monitor mounted on the eye tracker
2. Standalone without monitor
3. Eye tracker and monitor together on a VESA 100x100 mount
4. Standalone with monitor

2.4 Package content and carrying case



A. Angle meter	I. USB cable for connection between the PC and the monitor's integrated USB hub
B. Measuring tape	J. Cold shoe for mounting of a user camera
C. 4 power cables for monitor (UK, US, EU and Aus/China)	K. DisplayPort cable
D. Monitor	L. HDMI cable
E. Eye tracker	M. Cleaning cloth
F. Monitor mounting bracket	N. Fabric cord sleeve for collecting the cables
G. 4 power cables for eye tracker (UK, US, EU and Aus/China)	O. Ethernet cable
H. Power adaptor for eye tracker	

2.5 Software Options

Software applications can be connected over TCP/IP (Ethernet connector) as clients to the eye tracker (e.g. perform user calibrations and gather eye gaze data in real-time).

Tobii Pro Lab	Tobii Pro Lab is a comprehensive research software platform for eye tracking designed to meet the highest demands on different research scenarios with exact timing accuracy. This software offers an efficient workflow, making it easy to design experiments, record data, analyze and visualize eye-tracking data, and to sync this data with other biometric data streams.
Tobii Pro SDK	Tobii Pro SDK offers a broad set of tools that makes it simple to develop a variety of niche applications or scripts across multiple platforms, using a wide range of programming languages. This SDK gives the researcher access to the full set of relevant gaze data streams, such as 3D eye coordinates, raw data, pupil data, etc.
Tobii Pro Eye Tracker Manager	Tobii Pro Eye Tracker Manager is a tool used to perform firmware upgrades, configure eye tracker settings and more.
Third-party software and framework compatibility	Compatible with any application supporting the Tobii Pro SDK, such as: ▪ E-Prime 3 ▪ PyGaze ▪ PshycToolbox ▪ Octave ▪ and others

Tobii Pro Spectrum is not compatible with the Tobii Pro Analytics SDK version 3.0 or older or with Tobii Pro Studio.

3 Certifications

3.1 Compliance and Certification

The certification and compliance statements in this section are only valid for the eye tracker unit. For compliance and certification of the monitor and external power supply, please see the separate compliance documentation of those.

Safety

Safety standards	IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013 EN 60950-1:2006/A11:2009/A1:2010/A12:2011/A2:2013 UL 60950-1 Edition 2 +A1 +A2 CSA 60950-1 Edition 2 + A1 + A2 J60950-1(H29) National differences Australia to IEC 60950-1, 2nd Edition IEC 62471:2006 (First Edition)
Certification and declaration of conformance	ETL Listed (US & Canada) CB Certificate CE

EMC

EMC standards	EN 55032: 2015, Class B EN 55024: 2010 + A1 EN 61000-6-1: 2007 EN 61000-6-3: 2007 + A1 FCC 47 CFR Part 15 (2015): Class B ICES-003 Issue 6: Class B CISPR 32: 2015, Class B CISPR 35: 2016 KN 32:2015, class A KN 35:2015 KN 61000-4-2:2013 KN 61000-4-3:2011 KN 61000-4-4:2011 KN 61000-4-5:2008 KN 61000-4-6:2013 KN 61000-4-11:2008
Certification and declaration of conformance	FCC, CAN ICES-3 (B)/NMB-3(B), ACMA (RCM), CE, KC*. *Test coverage for KC certification doesn't include use of the TTL Inut port.

See ETL and CB certificates for details.

Sustainability

Directives:	RoHS Directive 2011/65/EU REACH Directive EC 1907/2006

This product is exempt from CCC.

Appendix A Glossary

Binocular eye tracking	Tracks and reports data for both left and right eye.
Blink recovery time (time to tracking recovery for blinks)	When a subject blinks, the eye tracker loses the ability to track eye gaze because the eye is covered by the eyelid. If the pupil is occluded for only a short period (a few hundred milliseconds), the system will regain tracking immediately when the pupil becomes visible again, but only if the subject has maintained approximately the same head position during the blink. Data during blinks are only lost when the pupil is occluded, i.e. during the eye lid movement itself or when the eye is closed.
Eye-tracking technique	Tobii Pro Eye Trackers use two different techniques to determine eye position: 1. Bright pupil eye tracking, where an illuminator is placed close to the optical axis of the imaging device, causing the pupil to appear lit up (the same phenomenon that causes red eyes in photos). 2. Dark pupil eye tracking where the illuminator is placed away from the optical axis, causing the pupil to appear black.
Freedom of head movement	Describes the region in space where the participant may move his/her head and still have at least one eye within the eye tracker's field of view.
Gaze accuracy	Describes the angular average distance from the actual gaze point to the one measured by the eye tracker.
Gaze data output frequency	The number of data samples per second output for each eye.
Gaze precision	Describes the spatial angular variation between individual and consecutive gaze samples (Root Mean Square), calculated on raw data.
Gaze precision filtered	Describes the spatial angular variation between individual and consecutive gaze samples (Root Mean Square), calculate after a smoothing filter has been applied to the raw data - Savitzky A. and Golay, J.E., 1964. Smoothing and Differentiation of Data by Simplified Least Squares Procedure Savitzky-Golay. Anal. Chem., vol.36, pp. 1627-1639. Filter settings: Polynomial order 2, with a 20 millisecond sampling window.
Gaze recovery time (time to tracking recovery after lost tracking)	An eye tracker working in a natural user environment may occasionally lose track of the subject's eyes, e.g., when the subject completely turns away from the tracker. If a period of a few hundred milliseconds elapses during which the eye tracker is unable to detect the eyes in close proximity to where they were last detected, the eye tracker will start searching for the eyes within the entire head movement box. The stated measurement is the typical time to tracking recovery in such a situation.
Max gaze angles	The maximum gaze angle for which the eye tracker can perform robust and accurate tracking on both eyes. The gaze angle is the angle ABC with A = center of the eye tracker (midpoint between the two eye tracking sensors), B = eye position (midpoint between the left and the right eye) and C = stimuli point.
Max head movement speed	Describes the maximum head movement speed allowed while maintaining robust tracking. The specified number is for sideways head movement.
Optimal conditions	Please download the data quality test report: https://www.tobiipro.com/tobii-pro-spectrum/

Operating distance	Describes the minimum and maximum distances between the subject's eyes and the surface covering the eye tracker sensors at which eye tracking can be done while maintaining robust tracking.
Processing Latency	Describes the time required by the eye tracker processor to perform image processing and eye gaze computations.
Sampling rate	Number of data samples per second. The Tobii Spectrum eye trackers have a stable data-rate of 60, 120, 150, 300, 600 or 1200 Hz; that is 60, 120, 150, 300, 600 or 1200 data samples per second are collected for each eye.
Total system latency	The duration from the mid-point of the eye image exposure, to when a sample is available via the API on the client computer (assuming there is a dedicated Gigabit Ethernet connection). This includes half of the image exposure time, image read-out and transfer time, processing time and time to transfer the data sample to a client computer.

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