Tobii Pro X3–120 Eye Tracker Product Description



Product Description Tobii Pro X3-120 Eye Tracker

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1 Introduction

1.1 Overview

This document describes the features and functionality of the Tobii Pro X3–120 Eye Tracker. The Tobii Pro X3–120 is a stand alone eye tracker that can be used in various setups by attaching it to monitors, laptops or for performing eye tracking on physical objects. The eye tracker requires some assembly before first time use and after transport.

The Tobii Pro X3–120 Eye Tracker is an unobtrusive eye tracker for detailed research of natural behavior. Its large head movement box allows the subject to move during recording while maintaining accuracy and precision. The Tobii Pro X3–120 Eye Tracker offer maximum flexibility with numerous software and stimuli set-up options. The Tobii Pro X3-120 has a sampling rate of 120 Hz.

The Tobii Pro X3–120 is a compact and light weight eye tracker measuring only 324 mm (12.7") in length and only 118 grams (4.2 Oz) in weight. It enables your portable eye tracking lab and studies that require an eye tracker to track even large objects at close distances. Use the eye trackers to conduct studies on:

- Laptops
- PC monitors up to appr. 25" (16:9)
- Mobile devices
- Real-world interfaces
- Projections, simulators
- TV screens

1.2 Applications Areas

The modular system can be used both in screen and real-world test scenarios, making way for a very broad spectrum of studies. You can mount the eye tracker on a laptop, a PC monitor, an all-in-one PC, or even a tablet. Present your stimuli using a projection or TV. You can study real-world interfaces like a control panel, an ATM or a store shelf. The supplied mounting solutions support a variety of study designs. Tobii Pro X3–120 Eye Tracker — is designed for studies aimed at determining precisely where the participants are looking and for studying and measuring eye fixations and other eye tracking metrics based on these.

1.3 Basic Operating Principles

During tracking, Tobii Pro Eye Trackers use infrared diodes 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 the image sensor. Sophisticated image processing algorithms identify relevant features, including the eyes and the corneal reflection patterns. Complex mathematics is used to calculate the 3D position of each eyeball, and finally the gaze point on the screen; in other words, where the subject is looking.



Tobii Eye Trackers are designed for use in indoor office environments with adult participants.

2 Technical Specifications

The characteristics of an eye tracker can be described in terms of gaze accuracy and gaze precision. Accuracy describes the angular average distance from the actual gaze point to the one measured by the eye tracker. Gaze precision describes the spatial variation between successive samples collected when the subject fixates at a specific point on a stimuli. More information regarding the accuracy and precision measurements can be found in *Appendix B Accuracy and Precision Measurements*, page 9 in tests reports available on the Tobii Pro web site. A glossary can be found at *Appendix A Glossary*, page 8.

2.1 Tobii Pro X3-120 Eye Tracker Specifications

Table 2.1 Gaze Accuracy (preliminary)

| Gaze accuracy ¹ | Tobii Pro X3-120 Eye Tracker (firmware version — 1.7.1) | | |
|----------------------------|---|-----------|--|
| Gaze accuracy. | Binocular | Monocular | |
| At ideal conditions | 0.4 | 0.5 | |
| At 25° gaze angle | 0.6 | 0.7 | |
| At 30° gaze angle | 0.6 | 0.8 | |
| At 1 lux | 1.0 | 1.6 | |
| At 300 lux | 0.4 | 0.5 | |
| At 600 lux | 0.5 | 0.6 | |
| At 1000 lux | 0.5 | 0.7 | |
| White stimuli background | 0.7 | 0.9 | |

Accuracy under ideal conditions is measured in the center of the head movement box. Data is collected immediately after calibration in a controlled laboratory environment with constant illumination with stimuli points at gaze angles of ≤20°.

Table 2.2 Gaze Precision (preliminary)

| Gaze precision at ideal conditions | Tobii Pro X3-120 ¹ | |
|------------------------------------|-------------------------------|-----------|
| Gaze precision at ideal conditions | Binocular | Monocular |
| Human Eye | 0.24 | 0.34 |

[.] Dynamic illumination pattern compensation is applied in the Tobii Pro X3-120 Eye Tracker.

Table 2.3 Eye Tracking Specifications (preliminary)

| Eye Tr | acking Specifications | Tobii Pro X3-120 Eye Tracker |
|--|--|---|
| Sampling rate | | 120 Hz |
| Eye tracking technique | • | Corneal reflection, dark and bright pupil combination |
| Binocular tracking | | Yes |
| Pupil measurement | | Yes (40 Hz, bright pupil mode only) |
| Total system latency Time to tracking recovery | | <11 ms. |
| | | For blinks: immediate |
| | | After lost tracking: <100 ms. |
| Head movement ¹ | Freedom of head movement at 80 cm (width x height) | 50 cm x 40 cm (19.7" x 15.7") |
| | Operating distance (eye tracker to participant) | 50 - 90 cm (19.6" - 35.4") |

| Eye Tracking Specifications | Tobii Pro X3-120 Eye Tracker |
|-----------------------------|--|
| Recommended screen size | Up to 25" (16:9) |
| Data sample output | Timestamp, eye position, gaze point, pupil diameter, validity code |

^{1.} Freedom of head movement describes the volume in front of the tracker in which the user must have at least one of the eyes. The numbers are specified parallel/orthogonal to screen surface, assuming the eye tracker is at a 20 degree angle to the screen.

Table 2.4 Eye Tracking Unit

| Eye Tracking Unit | Tobii Pro X3-120 Eye Tracker |
|------------------------|--|
| Eye tracker processing | On Windows PC or External Processing Unit (accessory) |
| Connectors | USB 3.0 (with BC 1.2), LAN with External Processing Unit (accessory) |
| Weight | 118 g (4.2 oz.) |
| Size | 324 x 20 x 17 mm (12.7 x 0.8 x 0.7") |
| Mounting solutions | Adhesive Mounting brackets for monitors, laptops and tablets. |

Table 2.5 Tobii Pro X3-120 Eye Tracker External Processing Unit (accessory)

| Connectors | USB 3.0, LAN and power connector |
|------------|----------------------------------|
| Size | 115 x 111 x 32.7 mm (W * D * H) |
| Weight | 0.5 kg. |

Table 2.6 Hardware package content

| Tobii Pro X3-120 Eye Tracker |
|--|
| 4 x Adhesive mounting brackets for permanent installation. |
| Safety Instructions and Installation Guide |
| USB cable |
| Travel Case |
| Cleaning Wipe |
| Tobii Pro X3-120 Eye Tracker USB memory stick containing the Tobii Pro X3-120 installer, documentation and training video. |
| Tobii Pro X3-120 Eye Tracker user manual (PDF) |

Table 2.7 Accessories

| Tobii Pro X3-120 External Processing Unit |
|---|
| Mobile Device Stand |
| Additional Mounting Bracket |
| Tripod Stand |

Table 2.8 Compliance

| Ingress protection | IP class 20 |
|---------------------|-------------|
| CE – European Union | Yes |
| FCC - USA | Yes |

| IC – Canada | Yes |
|------------------------------------|-----|
| RCM – Australia | Yes |
| Eye Safety IEC/EN 62471:2008 | Yes |
| Electrical safety IEC 60950-1:2005 | Yes |
| RoHS 2 | Yes |
| WEEE - European Union | Yes |

Table 2.9 Compatible software

| Tobii Pro Lab |
|---|
| Tobii Pro Studio 3.3.4 or later. |
| Tobii Pro SDK |
| Tobii Analytics SDK 3.1.0 or later. |
| Applications built on Tobii Pro SDK or Analytics SDK 3.1.0 and later. |

Table 2.10 Minimum system requirements

| Operating system | Windows 7, Windows 8.1 (64-bit), Windows 10 (64-bit) |
|------------------|--|
| CPU | Intel Core i7 (4 cores), 2.0 GHz |
| RAM | 8 GB |
| Connectors | 1 x USB 3.0 with the latest driver and with BC 1.2 or 1 x Gigabit LAN port for External Processing Unit (accessory). |



When using X3–120 without the EPU together with Tobii Pro Lab, the host computer must comply with the recommended system requirements for Pro Lab.

Data Output

Different applications can be connected as clients to the eye tracker to, e.g., gather eye gaze data in real-time and perform calibrations. Applications that can be used together with the eye tracker include the Tobii Pro Studio software, third party software products, or your own custom software based on the Tobii Software Development Kit. For more information about the supported software products please refer to the product descriptions and documentation for the respective products.

Below is a summary of the data that the eye tracker outputs. Please note that the parameter names, definitions and coordinate systems may differ depending on the software used, please refer to the software documentation for additional information.

Timestamp in microseconds from the eye tracker's internal clock. Additional timestamps are available in Tobii Studio. Gaze Point Left X, Y Horizontal (X) and vertical (Y) coordinates of the gaze point for the left eye. Available in different coordinate systems in Tobii Studio and the Tobii Analytics Software Development Kit. Eye Position Left X, Y, Z The 3D position of the left eye in relation to the eye tracker. Available in different coordinate systems in Tobii Studio and the Tobii Analytics Software Development Kit. **Pupil Diameter Left** Estimated diameter of the left eye pupil in millimeters. Validity Code Left Indicates whether or not left eye has been correctly identified by the eye tracker. Gaze Point Right X, Y Horizontal (X) and vertical (Y) coordinates of the gaze point for the right eye. Available in different coordinate systems in Tobii Studio and the Tobii Analytics Software Development Kit. **Pupil Diameter Right** Estimated diameter of the right eye pupil in millimeters.

Eye Position Right X, Y, Z The 3D position of the right eye in relation to the eye tracker. Available in different coordi-

nate systems in Tobii Studio and the Tobii Analytics Software Development Kit.

Validity Code Right Indicates whether or not the right eye has been correctly identified by the eye tracker.



Timestamp

The validity code can have two values for X3-120:

- 0: The eye was identified.
- 4: The eye was not identified.

Eye Tracking Setups 4

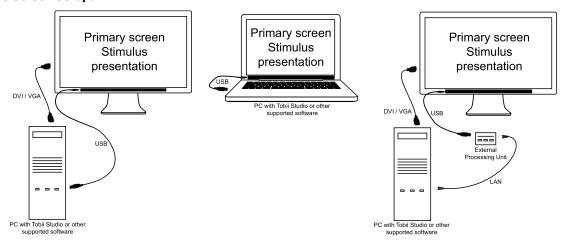
This chapter describes typical setup configurations that can be used with the Tobii Pro X3-120 Eye Tracker. For specific information about custom configurations or system requirements and recommendation, please contact your Tobii Pro sales representative or Tobii Pro technical support. The System Requirements and Recommendations document can be downloaded at www.tobiipro.com.

Your particular needs might differ from these typical configurations. More detailed information is available in the Eye Tracker User Manual provided with the product.

Typical Tobii Pro X3-120 Eye Tracker Screen Setups 4.1

These basic setups are the simplest setups when using on screen stimuli, such as images, movies or web. To record the participant's reactions, the conversation between the test leader and test participant, you need to connect an external user camera and microphone to the computer running Tobii Pro Studio. The setups below do not include the user camera and user sound.

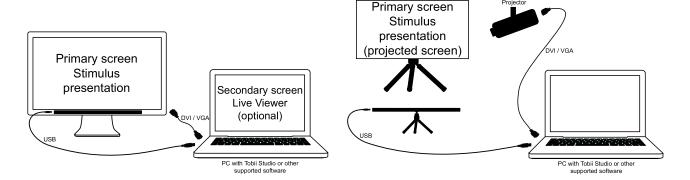
Single Screen Setups



4.1.1 Local Live Viewer

The setup below is used when the test is to be supervised from a separate screen where the test leader can see the eye movements of the subject in real time during testing.

Local Live Viewer Setups

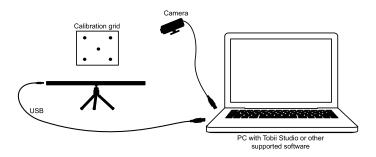


4.2 Typical Tobii Pro X3-120 Eye Tracker Physical Object Setup

When studying a stimuli that doesn't have a screen or when studying an external device such as a mobile phone, a physical object setup needs to be used where a video or web camera captures the image of the stimuli.

To record the participant's reactions, the conversation between the test leader and test participant, you need to connect an additional camera and microphone to the computer running Tobii Pro Studio. The setups below do not include the user camera and user sound.

Physical Object Setup



4.2.1 External video stimulus recording

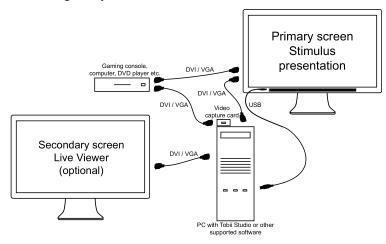
This setup is suitable when using a Tobii Eye Tracking system for eye tracking data analysis when the stimulus is presented from a separate computer or other RGB or VGA sources. This could include a computer game, a DVD player, or when stimulus is presented on a computer running a different operating system. The computer running Tobii Pro Studio must be equipped with an additional video capture card.



Note that if the external application runs on the Windows operating system, and it does not use 3D graphics acceleration or it does not have a high processor load and high memory usage, it may be more suitable and less complex to instead run this on the same computer as Tobii Pro Studio and use the Screen Recording option in Tobii Pro Studio.

For this setup, the image from the Tobii Pro Studio computer has to be displayed on the screen during calibration (to display the calibration points). The external stimulus computer, however, should be shown on the screen during the actual test. Both devices must therefore be connected to the same screen. To switch between the inputs, use a switch or a screen that allows for multiple input sources. The image shown on the screen must be sent to Tobii Pro Studio to record the video stream and synchronize it with the gaze data. If the stimulus is presented from an analogue video source, e.g., a VCR or an analogue video camera, a similar setup with slightly modified components can be used.

External Video Stimulus Recording Setup



Appendix A Glossary

Monocular/ binocular Monocular data shown is based on data from the participant's dominant eye only. Binocular data is

the average of the two eyes.

Gaze precision Describes t

Describes the spatial angular variation between a set of consecutive gaze samples. Gaze precision

can be measured under various conditions.

Gaze accuracy Describes the angular average distance from the actual gaze point to the one measured by the eye

tracker. Gaze accuracy can be measured under various conditions.

Sampling rate

Number of eye tracking data samples per second.

Total system latency The duration from mid-point of the eye image exposure, to when a sample is available via the API on the client computer. This includes half of the image exposure time plus image read-out and transfer

time, processing time and time to transfer the data sample to a client computer.

Time to tracking recovery for blinks When a participant 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, the system will regain tracking immediately when the pupil becomes visible again, but only if the participant 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 eyelid movement itself or when the eye is closed.

Time to tracking recovery after lost tracking An eye tracker working in a natural user environment may occasionally lose track of the participant's eyes, e.g., when the participant 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. If the eye tracker is unable to detect the eyes of the participant even after about one minute, the system will enter a "slow search" mode, leading to larger recovery times.

Freedom of head movement

Describes an area (width x height in cm) where at least one eye is within the eye tracker's field of

Operating distance

Describes the range of distances (minimum and maximum) between the participant's eyes and the surface covering the eye tracker sensors at which eye tracking can be done while maintaining tracking.

Eye tracking processing unit

Gaze data calculations are performed by firmware embedded in the eye tracker or in a separate processing unit.

Appendix B Accuracy and Precision Measurements

Gaze accuracy and precision are typically measured in degrees of visual angle. One degree accuracy corresponds to an average error of 12 mm (0.47") on a screen at a distance of 65 cm (27"). Data is presented as monocular or binocular. Monocular data is based on data from the subject's dominant eye only. Binocular data is the average of both eyes. Please refer to the test report *Tobii Pro X3-120 Eye Tracker Accuracy and Precision Test Report.pdf* for more details about the accuracy and precision performance of the Tobii Pro X3–120 and the test methodology used.

Appendix C Safety and Compliance

Safety

C1.1 Mounting Warning



The Tobii Pro X3-120 should be mounted according to the instructions of the approved mounts used. Tobii AB or its agents are not liable for damage or injuries to a person or its property due to a Tobii Pro X3-120 falling from a mounted configuration. The mounting of a Tobii Pro X3-120 is done entirely at the user's own risk.

The double sided tape supplied with the adhesive Magnetic Mounting Plates (if applicable) is designed to permanently attach the bracket to the monitor/laptop. Attempting to remove the bracket after attaching it using the supplied tape can result in damage both to the monitor/laptop and the bracket.

Do not lick the adhesive tape or place any part of the tape or Magnetic Mounting Plate in one's mouth or on one's

Do not mount the Tobii Pro X3-120 on monitors positioned above the head or face of a user unless using a dedicated "fixed mounting" solution.

C1.2 **Emergency Warning**



The Tobii Pro X3-120 system is to be used for research purposes only. Be aware that due to the low, but possible risk of failure or distraction, the Tobii Pro X3-120 should not be relied upon or used in dangerous or otherwise critical situations.

C1.3Infrared Warning



When activated, the Tobii Pro X3-120 emits pulsed infrared (IR) light. Certain medical devices are susceptible to disturbance by IR light and/or radiation. Do not use the Tobii Pro X3-120 when in the vicinity of such susceptible medical devices as their accuracy or proper functionality could be inhibited.

C_{1.4} **Epilepsy Warning**



Some people with Photosensitive Epilepsy are susceptible to epileptic seizures or loss of consciousness when exposed to certain flashing lights or light patterns in everyday life. This may happen even if the person has no medical history of epilepsy or has never had any epileptic seizures.

A person with Photosensitive Epilepsy would also be likely to have problems with TV screens, some arcade games, and flickering fluorescent bulbs. Such people may have a seizure while watching certain images or patterns on a monitor, or even when exposed to the light sources of an eye tracker. It is estimated that about 3-5% of people with epilepsy have this type of Photosensitive Epilepsy. Many people with Photosensitive Epilepsy experience an "aura" or feel odd sensations before the seizure occurs. If you feel odd during use, move your eyes away from the eye tracker.

C1.5Magnetic Field Warning



The Tobii Pro X3-120 Magnetic Mounting Plates contains magnets. Magnetic fields may interfere with the function of cardiac pacemakers and implantable cardioverter-defibrillators. As a general rule, maintain a minimum distance of 6 inches (15 centimeters) between any item with magnets and your heart device.

The magnets can also shut off the monitor on a laptop if the laptop is equipped with a magnetic sensor to switch off the monitor when closing the laptop. If this happens, shut of the sensor on the laptop.

C1.6 Child Safety



The Tobii Pro X3-120 is an advanced computer system and electronic device. As such it is composed of numerous separate, assembled parts. In the hands of a child certain of these parts have the possibility of being separated from the device, possibly constituting a choking hazard or another danger to the child.

Young children should not have access to, or use, the device without parental or guardian supervision.

Do not open Tobii Pro X3-120 C1.7



Non-compliance will result in loss of Warranty! There are no user serviceable components inside. Contact Tobii Pro Support if your Tobii Pro X3-120 is not working properly.

C1.8 **Environment**



The Tobii Pro X3-120 system is designed for use in dry indoor environments. Avoid any exposure to direct sunlight as this will affect eye tracking quality and longer exposure can overheat the equipment. Avoid exposure to any liquids, gels, moist, rain, sweat or other damp materials or environments. Do not use the eye tracker near water — the device is not water resistant.

The device complies with IP Class 20 and has no protection against objects smaller than 5 mm. Keep the eye tracker in a clean and dust free environment. When using the equipment take adequate precautions against dust and dirt.

Do not place or use the equipment in places subject to extreme temperatures and humidity, such as on top of and or near a heating element, in a hot or damp room, or in a hot automobile in the sun.

Compliance Information



All Tobii Pro X3-120 are CE-marked, indicating compliance with the essential health and safety requirements set out in European Directives.

この装置は、現在設置されている場所で妨害波の測定がされた情報技術装置です。この場所以外で使用 する場合は、その場所で、再び妨害波の測定が必要となります。

C2.1**FCC Statement**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.



Modifications not expressly approved by Tobii AB could void the user's authority to operate the equipment under FCC rules.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into a wall outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or experienced radio/TV technician for assistance.

C2.2 Industry Canada Statement

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

C2.3 **CE Statement**

The Tobii Pro X3-120 complies with the following Directives:

- 2011/65/EU (RoHS 2) Restriction of Hazardous Substances Directive
- 2004/108/EC (EMC) Electromagnetic Compatibility Directive

C2.4 Standards

The Tobii Pro X3-120 complies with the following standards:

- FCC part 15, Class B
- ICES-003 Issue 6:2016 Class B
- EN 55032: 2012+AC: 2013 Class B
- EN 55024:2010+A1:2015
- EN 61000-3-2: 2014
- EN 61000-3-3: 2013
- **AS/NZS CISPR 32:2013**

C_{2.5} Disposing of the Tobii Pro X3-120

Do not dispose of the Tobii Pro X3-120 in general household or office waste. Follow your local regulations for the disposal of electrical and electronic equipment.

Other limitations and considerations

C3.1 Intended use



The Tobii Pro X3-120 is intended to be used in research activities about human behavior including eye movements, involving adult participants in a dry and dust free indoor environment. The product should only be used as described in the User's Manual. Please read the User's Manual and other supplied documentation thoroughly before using the product.

C3.2 Light conditions



We recommend that eye tracking studies be performed in a controlled and well-lit environment. Sunlight should be avoided since it contains high levels of infrared light which will interfere with the eye tracker system. Sunlight affects eye tracking performance severely and longer exposure can overheat the eye tracker. The eye tracker is not designed for exposure to (direct) sunlight. Eye tracking generally does not work in strong direct sunlight. Shielding the eye tracker adequately from the sun may prevent sunlight from interfering with eye tracking. For better performance, use the supplied tinted lenses if the product is used in an environment with strong sunlight..

C3.3 Eyelashes



Long eyelashes can be obstructive when the participant's eyes are less open, especially if the participant is wearing mascara. In rare cases, eyelashes may completely block the view of the participant's pupils, making eye tracking impossible.

C3.4 Droopy eyelids



Droopy eyelids or otherwise obstructive eyelids can block the view of the participant's pupils. In rare cases, such eyelids may completely block the view of the participant's pupils, making eye tracking impossible.

Keeping Tobii Pro X3-120 firmware up to date C3.5



From time to time Tobii Pro will release updates for the eye tracker firmware that will improve performance and/or introduce new functionality. The latest firmware can be downloaded from the Tobii Pro Support website http://www.tobii.com/analysissupport. Make sure to regularly check for and update to the latest version of the software and firmware.



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