Revealing the Secrets of Eye Tracking

*What is important when choosing an eye tracker? What do you need to know?*
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Eye tracking is getting more and more common. What was recently considered science fiction is now a real option when choosing an assistive device. It is not always easy for users or prescribers to recognize what is important when choosing an eye tracker. This document aims to provide information about the facts of eye tracking.

Eye tracking

When talking about eye-trackers it is important to look at complete solutions; one has to consider all components – hardware, software, peripherals, service and support – and how well they work together. “The chain is only as strong as its weakest link” applies to eye tracking solutions too.

Mechanical construction

To achieve reliable and accurate eye tracking, the tracking components and the monitor have to be attached to each other in a stable way. If the tracker is out of position for some reason, the accuracy of tracking is affected. Furthermore, the tracker can be mounted on a wheelchair or moved from one environment to another, so it is important that it is a stable and robust unit.

Make sure the tracker and screen are securely fixed together, without external components or protruding wires that are more vulnerable to damage. This is especially important for active and mobile users. Secure and flexible mounting is also very important.

Tracking techniques

There are two general methods of eye tracking: “dark pupil” or “bright pupil” tracking.

Generally “dark pupil tracking” works better with users with dark eyes. Dark pupil tracking also generally works better in bright environments and outside.

“Bright pupil tracking” generally works better with children and blue-eyed people. Bright pupil tracking also works better in darker rooms.

One can’t say that dark pupil tracking is better than bright pupil tracking or vice versa – both have advantages and disadvantages. What is important is the accuracy and reliability experienced by each unique user.

Tracking components

Good eye tracking requires good quality components.

The main components are the light sources and the cameras/sensors. Light sources are LEDs with a frequency in the near IR (infrared) or IR field. The LEDs are put together in different formations to get certain
reflections in the eye. Eye trackers can have one, two or more light sources. To read the reflections and track eye movements, a digital camera or sensor is also required. These cameras are typically of various resolutions from one tracker to the next. For the camera to accurately “see” the eye, optics are added to the camera to help adjust for the distance of the eyes from the screen.

All components can be of various qualities and price ranges and although these can affect the quality of the tracking.

Image processing and algorithms
How does the device interpret the fixation point from data provided by the cameras/sensors?

This is the biggest challenge faced by eye tracker manufacturers, and is what the user can see and feel when using the tracker. Extensive knowledge, experience, and complex mathematical calculations are necessary to understand where the user is actually looking on a monitor. Tracking has to work in a stable and accurate way for the whole monitor area, without delay, flickering or jumping. Once the right algorithms are in place, you can use additional software features to “filter” the results for individual users – making it more accurate. Tracking can be done with one or two eyes. If the user only has/uses one eye, or if one eye is less accurate than another, it can affect the accuracy of the tracking.

The reliability and accuracy experienced by the user is more important than how the images are processed and algorithms are designed. It is a good idea to try the tracker and see whether it remains tolerant of head movements, eye glasses, contacts, and if it is accurate in all areas of the monitor and how smoothly it follows your eye movements.

User friendliness

Track box
How much can you move in front of the screen and still use the eye tracking?

Different trackers have different sized “track boxes”; the size of the imaginary ‘box’ within which you can move your head. The user’s condition affects how important this feature is. If a user remains totally still while using the tracker, it is mainly the calibration that is important. If a user moves (voluntarily or not) they will require a larger track box – the size of which depends on the individual and how large their movements are. It is for these users that the size of the track box and the combination of accurate calibration is most important.

The importance of the track box size depends on the user’s movement size, the tolerance of the tracker and the calibration procedure.

Calibration
All trackers need to be calibrated for each user.
Calibrating is the procedure that helps to make an eye tracker accurate. Most systems use a 3, 5, 9 or 16 point calibration, where the user needs to dwell on each point for a certain amount of time. Some systems need to be recalibrated if the user moves out of the tracking field, changes position or restarts the unit.

A good calibration is very important. For some users, needing to recalibrate regularly can be time consuming and fatiguing, so choosing an eye tracker that provides an efficient calibration method is important.

Interaction
How do you interact with and control the tracker?

Most trackers operate as a mouse alternative (“mouse control”), and provide slightly less accurate control than an ordinary mouse. Because eyes are sensory organs which are constantly moving and are instantly attracted to moving objects, other trackers use a different method, where the mouse cursor is replaced by feedback of another type (“direct control”), on the icons or objects the user is controlling. With this method, special software which “filters” the eye movements is required to control the mouse using eye tracking. At a normal working distance from the monitor, eye tracking accuracy should be within 1 cm or ½ an inch.

Whether to use mouse control or “direct control” depends on the user, what they intend to control and which software they use. Using “direct control” usually reduces the cognitive load and is beneficial for those with less accurate eye control.

Flexible input methods and settings
All users have different needs and wishes, and may have very different abilities. Can the eye tracker accommodate all these individual needs?

When interacting with a tracker there are several different selection techniques, the most common being dwelling, using switches or blinking. Most trackers support all input methods, either one at the time or in combination. Most settings can be adjusted by the user or the assistant.

Flexibility is important both when choosing a tracker for an individual or choosing one which may be used by several people, such as in a classroom or assessment centre. One user may even require different input method settings depending on which application they are using, or depending on the time of day and their fatigue levels. It is important that these settings are easily adjustable for the user. Also, for multi-user environments, it should be possible to support the different needs of each user.

Software
How is the eye tracker intended to be used?

Which functions does the product offer? How is it intended to be used? Is the user in fact able to operate the device? In some cases it is possible to control Windows applications by using the mouse control, but those “icons and menus” are typically smaller and can be difficult for some users to access. If using the eye tracker for communication, special software which produces synthesized speech is necessary. There are several
different types of communication software, and these usually offer either text or symbol-based communication. Most also offer additional functions like controlling standard Windows applications, web surfing, e-mailing, text messaging, environmental control etc. Some also offer pre-made interfaces which help to optimize the communication method for the individual.

When choosing an eye tracker, make sure to also get appropriate software that will support the user’s abilities and interests. They may interact with this software all day and since it is often their method of communication – it is essential that it works!

Also make sure that it is easy to adjust the content of the communication interfaces, so that the user can get the most out of the system and also have the opportunity to grow with the system. It is crucial to take time to set up and adjust the software for the user – making it appropriate for immediate use, and flexible enough for possible expansion in the future.

**Summary**

*What is important when choosing an eye tracker? What do you need to know?*

In short: Functions and flexibility!

Try the system with the user, in a relaxed and supportive environment. Ensure that the system is reliable and accurate, and that the communication software fulfills the user’s needs - short-term and long-term! This is often the user’s only method of communication and it is essential to make sure that it is well chosen, well set up, and well supported!

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