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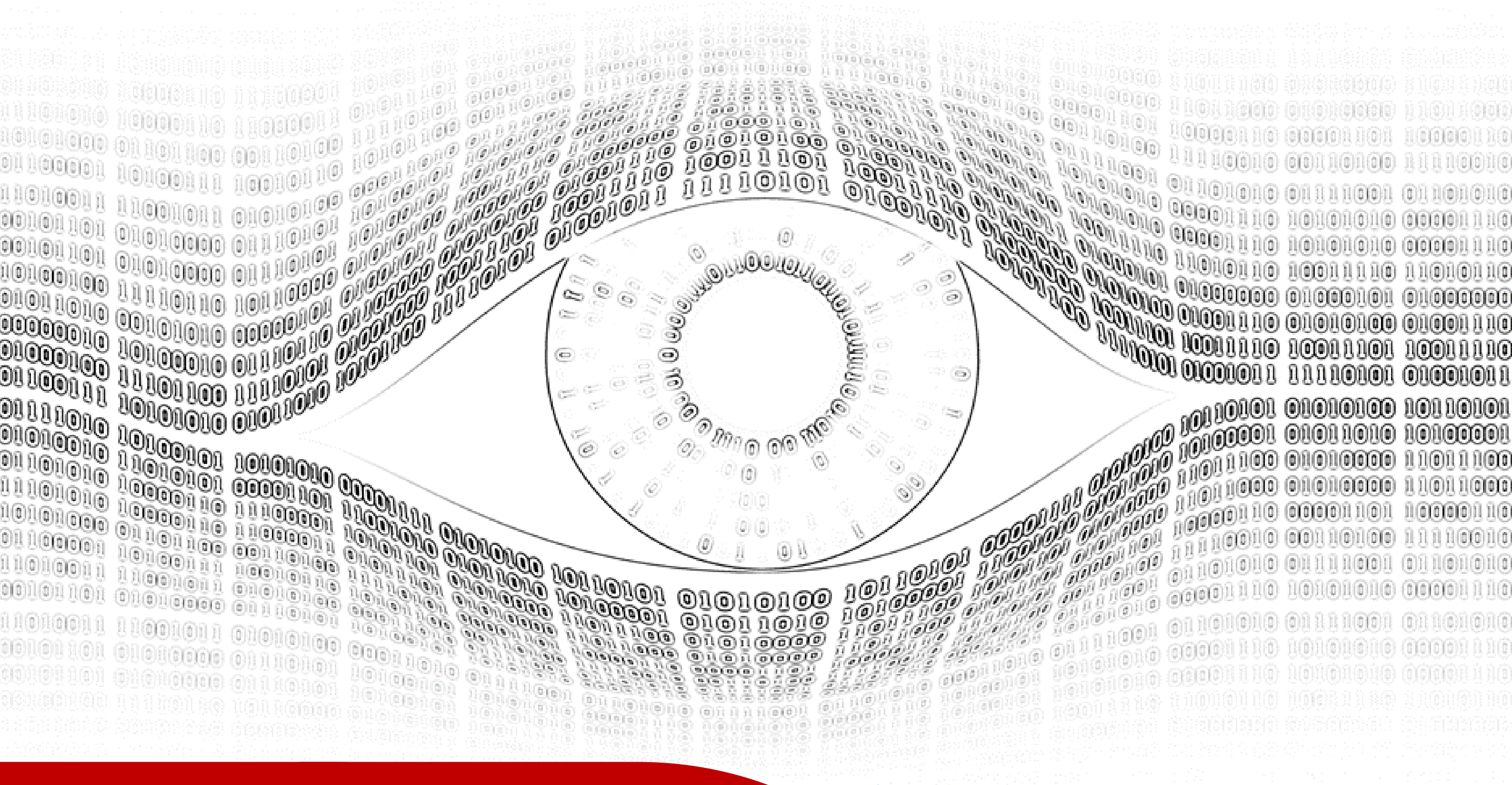

# Eye Tracking

*Eyes on the Prize: Eye tracking for business value*


**Dr. Frouke Hermens**

Assistant Professor
Department of Computer Science, OU
frouke.hermens@ou.nl

**Dr. Deniz Iren, PMP**

Assistant Professor
Center for Actionable Research (CAROU)
Department of Information Science, OU
deniz.iren@ou.nl



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## Eyes on the prize: eye tracking  for business value

It may not be instantly obvious to many, however, only a very small section of the human visual field is perceived in detail. To experience this, try reading this sentence while focusing on the title on top of this page. You will realize that this task is not possible. When eyes focus on an object of interest, only that object is seen in detail; all the rest around it is blurred. For this reason, the eyes must change direction approximately five times per second to gain a more comprehensive picture of the scene. It is the brain that combines the detailed and blurred views, creating the illusion of a well-visible world. Such rapid movements of the eye provide rich information about the points of attention, intentions, and even decision-making process of an individual. Utilizing specialized equipment and analysis techniques, eye tracking technology enables the measurement of eye movements, and yields actionable insights in many business cases.

### Business value of eye tracking

Eye tracking is used for many purposes such as scientific research, marketing, design improvement, usability studies, and medical applications. Insights that are revealed by eye tracking guide designers and developers to improve their products and services. The gaze patterns of users may help identify non-intuitive and suboptimal designs of products, navigation difficulties of websites, and thus, clearly highlight the improvement opportunities in terms of user experience. In scientific research, eye tracking is used to reveal how human brain processes visual information, and how people make decisions based on what they see. In healthcare, eye tracking is used to diagnose medical conditions and monitor the effectiveness of the treatment for such conditions.

The insights gained from eye tracking are directly applicable to business decisions that yield value. For instance, by understanding the attention mechanisms of a target customer base, a company can create more effective marketing campaigns to enhance business and revenue. Moreover, better design leads to more intuitive interaction with technological products and services, provides enhanced user experience, and improves customer satisfaction.

**Figure 1**: Heatmap visualization highlights where customers focus on an advertisement brochure.

### How does it work?

There are various devices and software tools on the market specially designed for eye tracking. Although the solutions for eye tracking have been around for many years, with more advanced cameras, computer vision algorithms, and analytical techniques the use of eye tracking is becoming more mainstream. The traditional eye trackers that are large infra-red camera setups that are mostly used on desktop settings have evolved into more portable and mobile solutions that are suitable to use in the field.

For example, new generation automobiles come with the technology that monitors if the driver pays attention to the road. Eye tracking devices also come in the form of wearables, such as a pair of glasses. There are also attempts to track users' eyes with webcams, however this tends to be less accurate than with custom-built eye trackers.

Despite the evolution of the technology, the principles underlying eye tracking have remained constant. Most precise eye trackers use infra-red cameras because it makes recording the pupil easier under various lighting conditions (see Figure 2). The camera captures an image of the human eye and head, and it records the point of focus. To improve the precision, the setup needs to be calibrated by asking the user to focus their gaze on certain points that are known in advance.

There is a wide variety of commercially available eye tracking devices in terms of cost and quality. While entry-level eye trackers can be as inexpensive as a few hundred Euros, the professional-grade ones cost up to tens of thousands. It is possible to get started with just a high-resolution webcam, however, it does not yield results as accurate as special eye tracking devices.

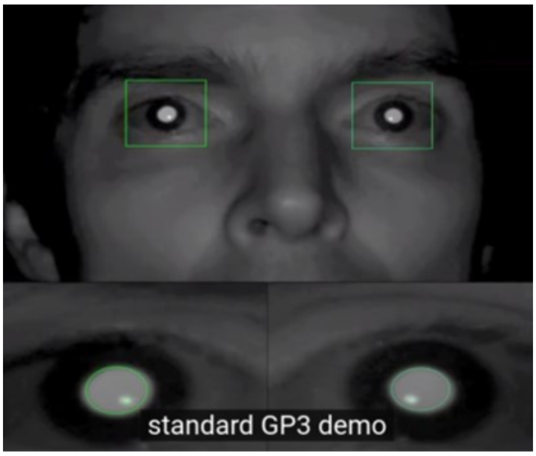


**Figure 2:** Eye trackers use infrared cameras to record the pupil under varying light conditions

## Eye tracking challenges

There are two major challenges of eye tracking that are often overlooked. First, eye tracking generates large quantities of data to be analyzed. An eye tracker typically records the position where the observer is looking 60 to 1000 times per second. This means that methods are needed to reduce the amount of data while preserving the important aspects captured.

Second, eye tracking data need to be analysed and presented in such a way that it offers actionable insights. A common first step is parsing of the data into fixations and saccades. In between these eye movements (saccades), the eye stays relatively still (fixations). Saccades are fast changes of position, and this information is used to separate them from fixations. Only during fixations, detailed processing is thought to take place, and data can therefore be reduced to one sample per fixation. Converting the raw eye tracking data into fixations and saccades has the added advantage of reducing the amount of data because it is no longer necessary to separately store the individual samples that comprise a fixation.

There are different ways to explore the resulting fixation data. A common method is the scan-path which visualizes the common patterns of eye movements across many observers and the most focused regions. Another method of visualising the eye tracking data is the heatmap. The heatmap pools information across observers and thereby highlights the areas where most people look at (see Figure 1). These methods have complementary strengths as one depicts the order of the scanning movements and the other highlights the aggregated gaze information of many observers. Both methods are easy to interpret by humans. However, automated analysis is more complicated. For this, objects being looked at, such as the price tag of a lamp, need to be detected. Such automatic detection of regions is particularly important yet challenging especially when using a mobile eye tracker in the field.

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## Use cases

Due to the unique type of insights eye tracking provides on how users focus their attentions on products, it is very commonly used in usability studies. In a typical usability study, potential users are asked to use or interact with a product or service. The way users look for information, and explore the product reveals important points of improvement in the design. Usability studies address a large variety of products or services ranging from websites and advertisements to physical store layouts.

Many questions can be tackled in a usability study: What are the visible factors that affect the buying decision of a customer? Which parts of a website are intuitively explored or ignored by users? Do blinking adverts or adverts with bright colours attract attention more strongly? Are there differences between young and old observers or between males and females? Putting in the effort to answer such questions potentially leads to the the creation of business value.

The application of eye tracking is not limited to design improvements and advertisement campaigns. This technology has been increasingly used in human-computer interaction. For instance, high-end car brands come with eye tracking-based assistive capabilities to detect distracted and tired drivers to avoid accidents.

## Enter artificial intelligence

The recent advancements in artificial intelligence have drastically transformed digital technologies. Eye tracking is no exception. Artificial intelligence methods enhance eye tracking broadly in three ways. First, they enable faster and better techniques for analyzing eye tracking data. Such analytical applications of artificial intelligence help the analysts to take extra steps into extracting useful information from eye tracking data. For instance, they can be used to predict future actions of a customer, such as making the decision to purchase a product, based on how they look at the image of a product and the alternatives.

Second, artificial intelligence makes eye tracking smarter by allowing the automated detection of the scenes and objects of interest. This is especially handy in mobile eye tracking applications in the field. For instance, in an assisted-driving scenario, the car can detect obstacles in close vicinity and alerts the driver if they are distracted and not looking toward the road ahead.

Third, artificial intelligence may improve the tracking of attention in observers by providing tools to detect facial expressions and body landmarks that can be linked to visual attention. This means that future technology may detect attention not only from the eyes but also from facial expressions and body language.

## How to adopt eye tracking?

Regardless of being an established corporation or an ambitious start-up, the path to successfully adopting eye tracking consists of the same essential steps.

The journey starts with setting clear goals: Identify a relevant business problem or opportunity such as improving the design of an app or creating a more effective advertisement campaign.

Knowing what is out there enables good decisions: Evaluate the existing eye tracking solutions on the market that address the specific needs of the business. At this point a careful consideration of costs and benefits is essential as professional-grade eye tracking equipment and software come with a steep price tag.

Take a bold step and try it: Gain experience with eye tracking technology in an actual pilot use case to familiarize the business with the capabilities and challenges of eye tracking. Before making a significant investment, consider collaborating with external eye tracking experts either from consultancy organizations or research institutions.

When the goals are aligned, commit: If a strategic decision is made to strongly embed eye tracking into the operational business processes, then set up a team of employees responsible for eye tracking. If necessary, consider acquiring training as it may prove more efficient than self-exploration.

Institutionalize: Finally, make the necessary resources available for eye tracking within the organization, define roles and responsibilities, and introduce a process that effectively connects the eye tracking insights into business decisions.

## Contact

Questions or comments? Get in touch:

Dr. Frouke Hermens | frouke.hermens@ou.nl

Dr. Deniz Iren | deniz.iren@ou.nl

## Conclusions

Eye tracking can serve many purposes ranging from marketing and usability studies to human-computer interaction and medical applications. It yields actionable insights that guide businesses to improve their products and services. Eye tracking uses specialized hardware and software that may differ significantly in terms of cost and performance. The effective use of eye tracking is not without challenges. It yields a large amount of data that have unique characteristics, and certain knowledge and skills are required to transform these insights into business decisions. The power of eye tracking is multiplied when combined with the capabilities of artificial intelligence.