Saccadic Sightings

An introduction to the art project, *Saccadic Sightings*, reflections on working with a MobileEye, and on the difficulty of visualising sensory experience.

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In the movie *Being John Malkovich*[1], the protagonists gain access to John Malkovich's mind through a small portal in an office building. While 'in there', they discover that they can manipulate his body, in effect take control of him. The puppeteer, who eventually does so, plays Malkovich as he would a puppet, seeing the outside world through Malkovich's eyes. The movie is a funny example of the Homunculus-problem[2], that there is a viewer (or, if you will, a soul) inside our head looking out onto the world through our eyes. I have spoken to neurologists who scoffed at the thought of this idea still being taken seriously by anyone, primarily because it seems to require the eye to work as a camera, which, it has long since been established, it doesn't. However, it is my belief that such a, in essence, Cartesian dichotomy still permeates the way most people think of how we see the world and how our mind works[3]. It would therefore be interesting to look closer at the information such a viewer or puppeteer would receive from the eyes, to see what 'he would have to work with'; and thereby gain a closer insight into whether our everyday/philosophical/scientific etc. models of perception are aligned in a coherent view, or not.

In my latest project, *Saccadic Sightings*, I decided to record the saccadic movements of the eye to, a) try to get an impression of what input the eye receives, at least in terms of over-all position and speed, and b) see if I could use this to create a visual representation which would 'place the viewer behind the eyes of another person'; I wanted to recreate the 'raw' input received by the eye to see if it would at all be possible to make sense of such input for an external viewer, or whether experience is so innately personal, so determined by our biology, as well as layered with psychological experiences, meanings and references, that it cannot be reproduced – except through artistic analogy.

If the eye were a camera it would be a poor one; only at its very centre, the fovea, the receptor cells (cones) are capable of registering detail and colour. The fovea accounts for approx. 1,75 degrees (or 0,5 mm of the retina) of our visual field, which means that if you are looking at something at the distance of 1,5 m., your eye is only capable of registering detail and colour of approx. 4,5 cm of what you're observing. Everything outside of that 4,5 cm circle is registered in varying halftones until approx. 50-60 degrees from the centre where after it is all blurry grey scale. In the peripheral vision the receptor cells (rods) are only capable of distinguishing black/white contrast and movement (dim-light). So, to the puppeteer the outside world as seen through Malkovich's eyes, would look not unlike a dogma movie, filmed with a pinhole camera where only the very centre (the fovea) of the actual movie would be in focus and colour, and everything outside of the centre would be a blur. The lack of colour and detail would be difficult to cope with, but the constant jagged movements of the eye would probably be even more confusing.

The eye moves constantly. Several times per second it makes movements, which we do not consciously control, called saccades[4]. The saccades are easily observed in another person; the general example being a person gazing out of a train window, his eyes jumping back and forth. The saccades (presumably) help

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1 *Being John Malkovich*, 1999, Gramercy Pictures

2 *The Homunculus Problem*, http://everything2.com/e2node/The%2520homunculus%2520problem (25 September 2008).
T. Birch, *Stating the Hommunculus [sic] Problem*, http://www.gis.net/~tbirch/homunculus.htm (25 September 2008)

3 One reason for this could be that it seems to prove a very good, albeit a little disturbing, analogy to the way we gather information about the world today - from the screens in our living rooms.

4 Wikipedia, Saccade, http://en.wikipedia.org/wiki/Saccade (25 September 2008)

us to orientate ourselves by constantly scanning our surroundings. In this way they help establish a full view of our surroundings, e.g. by picking up on some movement in our peripheral vision[5] and directing the eye's focus (the fovea) to this. Interestingly, it is impossible to observe the saccadic movements in a mirror – you can't see your own eyes move![6] The different movements[7] also seem to work as a refresh signal to the eyes, without which the rods and cones in the retina would become over-saturated with light and would stop conveying information to the rest of the visual system. There are several theories on the different purposes of eye-movements, suffice to say that they form an intricate part of our visual system without which we would not be able to see, and over which we have little to no conscious control. What can be said, is that regardless of one's preferred theory of how the information, received through the pupil, is processed further in the retina etc., the information is certainly affected by the position of the eye, and to a large degree the position determines what information is gathered. Considering how stable and smooth the visual world appears to us (as it does to the puppeteer inside John Malkovich), it is obvious that a lot of the movement input, the saccades, is 'masked' or reduced[8] before we gain conscious access to the input, i.e. perceive a visual image. Think of the visual world as an ever-changing puzzle, constantly being laid out, never quite complete. The information gathered by the saccades then represents each new piece being laid, but, consciously, we feel we see the whole puzzle at all times.

Through my collaboration with The Arts & Genomics Centre in Leiden[9], I was able to lend a MobileEye from Stephen Oliver Associates, London[10], for a period of a few months. A MobileEye is a tetherless eye tracking device. It consists of 2 small cameras mounted on a pair of security glasses and a portable dv recorder (fig. 1). One camera records the eye while the other camera records the scene, in front of the eye. These two video

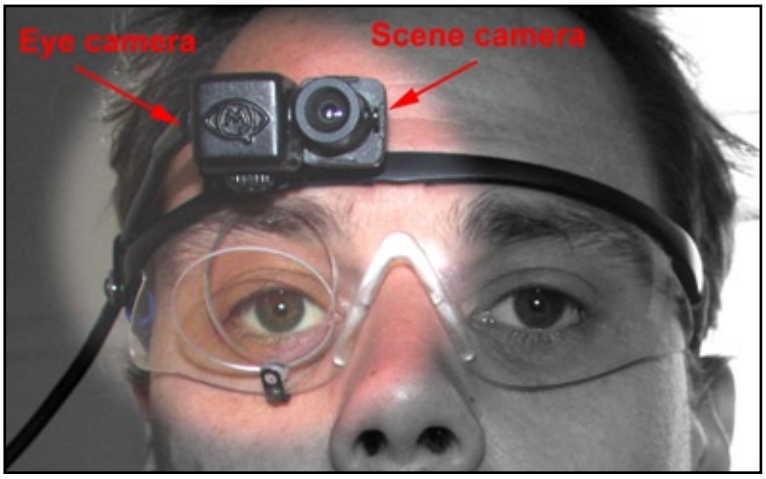

fig. 1: Close-up of MobileEye.

5 In 2007 I made an installation in The Filmhouse, The Hague, Peripheral Panorama, in which I created a large scale representation of a person's peripheral vision, www.runepeitersen.com/panorama.htm . The studies of the eye and vision then were what lead me to proceed with this project.

6 "It is a common but false belief that during the saccade, no information is passed through the optic nerve to the brain. Whereas low spatial frequencies (the 'fuzzier' parts) are attenuated, higher spatial frequencies (an image's fine details) which would otherwise be blurred out by the eye movement remain unaffected. This phenomenon, known as saccadic masking or saccadic suppression, is known to occur in the time preceding a saccadic eye movement, implying neurological reasons for the effect, rather than simply the image's motion blur.
A person may observe the saccadic masking effect by standing in front of a mirror and looking from one eye to the next (and vice versa). The subject will not experience any movement of the eyes nor any evidence that the optic nerve has momentarily ceased transmitting. Due to saccadic masking, the eye/brain system not only hides the eye movements from the individual but also hides the evidence that anything has been hidden. Of course, a second observer watching the experiment will see the subject's eyes moving back and forth. The function's main purpose is to prevent smearing of the image."
Wikipedia, Saccadic Masking, http://en.wikipedia.org/wiki/Saccade#Saccadic_masking (25 September 2008)

7 Along with the saccadic movements, there are micro saccades, flicks and drifts, which all add to the constant movement of the eyes.
Wikipedia, Fixational Eye Movement, http://en.wikipedia.org/wiki/Fixational_eye_movement (25 September 2008)

8 *see 6*

9 The Arts & Genomics Centre, Leiden Institute of Chemistry, Gorlaeus Laboratories, P.O.Box 9502, 2300 RA Leiden, The Netherlands, http://www.artsgenomics.org/

10 S. Oliver Associates Northumberland House, Popes Lane, Ealing, London W5 4NG, United Kingdom, http://www.s-oliver-associates.com/

streams are recorded onto a dv-tape as interlaced footage[11]. Using EyeVision software (fig. 2) the point of gaze can be calculated and projected back onto the scene footage as a small crosshairs, which enables you to see how the eye moved when observing the scene. This produces fascinating movies which allow you to see how your gaze moves around in a scene. The use of eye tracking offers a lot of information about the viewed and which visual cues are picked up by the eye. As such it doesn't reveal a lot about the experience of seeing, partly because the video reinforces the visual image of 'seeing the puzzle at all times'. I meant to change that.

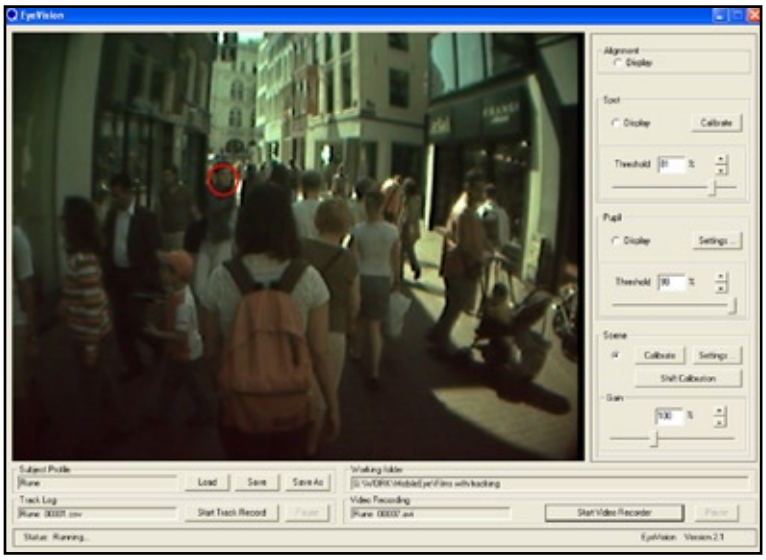

fig. 2: Processing MobileEye footage.

Prior to receiving the MobileEye I had several different recording setups in mind, which would allow me to 'illustrate' the gap between what the eye registers and the visual world we perceive. My basic idea was to use the tracking information, but instead of showing the crosshairs, I would invert the tracking data of the scene and apply it to the scene-video. This video I would then overlay with a filter, emulating the layout of the rods and cones in the retina, thus blocking out information not registered by the eye (fig. 3). Instead of the crosshairs jumping all over the screen, you would have a steady centre (the fovea) with elements of the scene appearing in focus in the centre, but blurred outside the centre (peripheral vision). This way, it would be relatively easy to point out the difference between the registered and the perceived, and it would also – hopefully – make a compelling video in which processes within the eye would largely determine the outcome. One setup would involve recording a person's eye-movement while that person was watching a movie. Imagine how watching a movie in a cinema would look if the above technique was applied to the footage. You could show the MobileEye-movie next to the original movie to give an impression of the difference, and thereby, by implication, show the amount of extrapolation done by or taking place in the mind before the imagery reaches our consciousness. Another option would be recording two different persons watching the same movie – would their eyes register the same movie?

fig. 3: Visualisation of eye input.

11 "Interlaced scan refers to one of two common methods for "painting" a video image on an electronic display screen (the second is progressive scan) by scanning or displaying each line or row of pixels. This technique uses two fields to create a frame. One field contains all the odd lines in the image, the other contains all the even lines of the image. A PAL based television display, for example, scans 50 fields every second (25 odd and 25 even). The two sets of 25 fields work together to create a full frame every 1/25th of a second, resulting in a display of 25 frames per second."
Wikipedia, Interlace, http://en.wikipedia.org/wiki/Interlace (25 September 2008)

There are certain situations, which seem to induce ‘tricks of the eye’, situations in which it can be difficult determining what we see because the input is too vague or too overwhelming. Additional setups I wanted to try out included walking through a forest in twilight, staring at the sea on an overcast day, recording eye-movements during the sexual act etc. How would the eye react, in response to the mind trying to deal with ambiguous or minimal information, would there be any noticeable difference? And how about walking down a crowded pedestrian street or inner city park on one of the first really hot spring days – what, I wondered, would catch my eye (fig. 4)?

fig. 4: MobileEye recording with point-of-gaze indication.

The MobileEye is an incredibly straightforward to use and versatile device. It is extremely easy to put on, and doesn’t restrict your movements anymore than any other pair of glasses and a small backpack would. It is not invisible, though, and people do take notice, and probably realize they are being recorded.
Unfortunately, during the first recordings, it became clear to me that due to the scene-cam’s limitations, some of my original ideas wouldn’t be successful. In order to be mounted on the glasses, the scene-cam obviously has to be very small. This means that the camera has trouble adjusting to light or dark environments and that the image is grainy and occasionally out of focus. This didn’t come as a complete surprise to me, but once I started recording I began to realize how the image quality might have an adverse effect on my plans.

My very first recording took place in my studio building. I geared up and basically just went for a walk around the building, trying very hard to look at everything. At a certain point I went into the studio of a colleague of mine. She was somewhat surprised to see me dressed up like that, but I had already told her of my project, so we talked a bit back and forth about the MobileEye and I invited her to come and see the footage once I was done recording. One of the things I was curious about, concerning eye movements was how we register a person in front of us; what features do we look at to identify another person? While talking to my – female – colleague, it dawned on me that showing her how my eyes registered her during our conversation, might be a bit awkward. I realized, that unconsciously, I had been ‘scanning’ her, looking quite directly, briefly, but directly at her breasts and crotch, and although it didn’t imply anything sexual and it didn’t invoke sexual thoughts in me, it could be misconstrued once she saw it on screen. In order to avoid such embarrassment (and to test my control over my eye movements), I tried to keep my gaze away from her body and focus instead on her face. I was actively trying to censor my eyes’ natural movements because of what might in the recording be perceived as a faux pas. The censoring, I noticed, impeded me; I felt I was missing something in my visual field. Eventually, we went to my studio and watched the footage with the crosshairs together. Most of the time my gaze, the crosshairs, was directed at her eyes, mouth or something in the room, but on a couple of occasions it darted directly to her bosom. In the end it just gave us a few laughs, but it began to dawn on me, that the way our eyes, consciously or unconsciously, scan our surroundings is a very intimate process and by recording it, I was tearing away a veil between myself and my surroundings. I have always en-

joyed observing other people from a distance, but now my observations were being observed and I felt spied upon.
Later I came to realize, that the standard eye-movement 'greeting' of another person involves a very quick head-breast-crotch movement – even if you're standing in front of a mirror.

Next step was to take the MobileEye outside. In line with the above example, I wanted to test it in a busy park to see what would catch my eye – how would I orientate myself? Biking through a busy park on a beautiful spring day, I became very aware of myself looking. I noticed how my gaze jumped from one object or person to another, and I made mental notes, so I would be able to compare my memory of the seen with the recording. I especially noticed that sometimes my gaze lingered a bit longer at some particularly interesting observation, and occasionally this even caused me to turn my head in order to follow up on an observation. This had to do with another issue I was interested in looking at, namely attention, and how varying degrees of attention help determine our focus, as well as our experience of an observation's emotional impact. Later, when I inspected the footage, I realized how much I had 'zoomed' in my observations, and how impossible it was for that aspect of my observations to be seen in the footage. I easily recognized most of the observations which had had the biggest impact. I recognized plenty of smaller observations, certain signs, light posts etc., but the details of these observations, the subtleties, the emotional responses they had evoked, were nowhere to be seen. Furthermore, many of the observations were too far away for the camera to record in even poor detail. I thought of mending this by zooming digitally, but there was no way that would come even close to my recollection of the observations. The footage did reveal something very interesting though. I had been acutely aware of what I expected to see; I had specifically chosen a day and a setting to go along with my notion that we're all beasts beneath our clothes, and that this reveals itself in how our eyes scan the surroundings. The footage completely bore that notion out. Not only did my gaze jump specifically from woman to woman, but, and this surprised me, my gaze barely landed on a single man! It simply went straight from one woman to the next, easily ignoring several men in its path. When I pondered this, I realized, that I obviously remembered that there had been men in the park, but I was completely unable to recall a single one, except the old Italian guy in the ice cream stand. I was, on the other hand, able to recall at least a dozen different women in some detail.
My biggest surprise, however, came when I looked at the footage again and noticed how my gaze jumped between the women. It didn't sweep the surroundings looking for the next 'target', no, it jumped – sometimes to the other end of the screen – as if it knew where the next target would be before it had seen it. And in most cases the footage showed that it couldn't have seen it first. In a sense, this just corroborated what I expected, but I had expected to see much more random jumps, this seemed eerily purposeful, almost omniscient.

By now every time I put on the MobileEye, I noticed a shift in the way I was seeing. The MobileEye had difficulties registering eye movements which went 'off the screen'. For most tasks this didn't present a problem, but simply being aware of this limitation made me adjust my head movements according to my gaze. Similarly, the limitations concerning detail, focus, depth and lighting, made me conscious of the act of seeing in a way I had never been before. I made sure I didn't focus on small objects far away; I was very aware of light sources and tried to always position myself to get good light. Via a strange feedback process I had adjusted my sight to that of the MobileEye's – I started seeing in low resolution.

At the same time I was looking into what to do with the footage, how to present it. It had become clear that my original plans weren't going to work. I could use the tracking data as I had planned, invert the data to make the scene footage jump around the centre, but it didn't provide the imagery I'd hoped. Partially this had to do with the quality of the video – it was difficult to zoom in on attention points without getting a big blur. I had tried the cinema setup, using a beamer in my studio, but realized that the final image simply wouldn't be clear enough to make any sense. On the other hand, the footage produced by the MobileEye was exquisite in its crudeness, and provided a very direct visual representation of look-

ing through someone else's eye[12]. I started thinking more in terms of cinema, and looked at how simple actions performed by the person wearing the MobileEye would engage the viewer. I tried to introduce pseudo narratives and associations brought on by objects in a scene. The actions and events in the scene became the focus of the recordings. This meant I had to exercise even more control over my eye movements. My eye and my gaze became the camera – I was now literally filming with my gaze.

In this way all the things I couldn't capture became very present in their absence. Because I had become so focused on my vision, I had begun to notice the stream of associations often generated by an object. Often I would notice my gaze moving 'inward' and not paying much attention to the objects in front of me. This, of course, was absent in the footage, making the otherwise intimate footage strangely distant. I started considering whether it could be added in the post processing. With this in mind I began making mental notes and often spoke out loud (the MobileEye is equipped with a microphone) about the associations I got from a given scene or object, letting lose a 'stream of thought' which I could then later elaborate upon in the post processing.
As mentioned, I began performing small actions, gestures, so that the viewer would become even more involved in the scenes. I asked friends and colleagues to perform actions for me wearing the MobileEye.
A painter made a drawing, a bio artist performed a series of lab tests and I even had a friend act out the last 10 minutes of Ophelia's life – including the suggestion of drowning (fig. 5).

fig. 5: 'Ophelia' recording her last minutes with the MobileEye.

Since I only had the MobileEye for a limited period of time and I knew the editing was going to be a very lengthy process, I simply tried to gather as much footage as possible, so I had a lot of material for the final editing. As it turned out, this was a very good approach.
One of the inherent dangers for an artist, when working with scientific equipment, or otherwise collaborating with scientists, is that the artist starts to think of himself as a scientist and of his work as scientific. It is so tempting to borrow the methodology and language of science, invent a few experiments and try to claim some sort of scientific relevance or credibility. In one of the first meetings I had with professors from The Netherlands Institute for Neuroscience, I realized that my idea of recreating the eye's input was something a lot of people had already been working on for a long time. I was shown complicated computer models displaying the input for the different types of receptor cells and impressive images of how this might look. However, the idea, I had of sharing or reproducing experience baffled them – it seemed pointless to them. Their interest was primarily in discovering how the eye works, whereas I was looking for the experience of seeing.
In order to get the best possible quality footage, I had not only captured the processed footage with the crosshairs, but also all the original footage directly from the dv tapes. This footage contained the video streams from both cameras, eyecam and scenecam, interlaced. It was my intention to deinterlace the footage, to get rid of the eyecam stream and use the scenecam stream as a base for the application of the tracking data. However, having spent some time during the summer away from the project, I looked at the footage from a fresh perspective, no longer bound by misguided notions of having to produce scientific defendable work. What struck me was that the interlaced footage contained a lot of the ideas

12 This may seem to contradict my whole argument, but there are several established visual representations for how we think this should look, e.g. 1st person video games, hand held camera/steadicam etc.

I wanted to convey. In a single image you have the scene and an eye watching the scene, recorded simultaneously. You don't see exactly what the eye is seeing, because there's no crosshairs, but you know you're observing it, observing the same scene, you're observing on the screen. And at the same time, the eye also seems to be observing you from the screen – a Chinese box of observing and being observed (fig. 6).

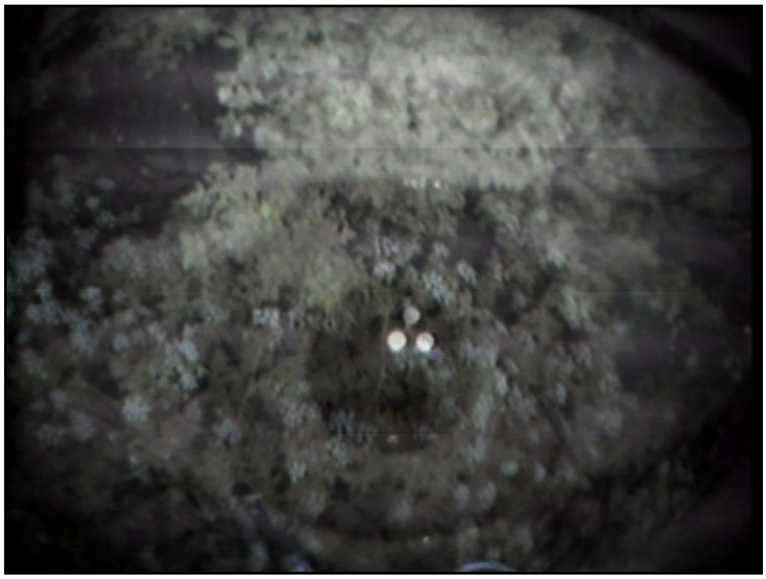

fig. 6: Observing the observing. Eyecam and scenecam footage interlaced.

My focus was shifting from the original ideas of tracking the saccades to using the raw recordings to capture an experience as a whole. This would require splitting up different aspects of seeing and giving them their own separate movie. It would also have to involve introducing association-laden objects, actions and narratives – making sure though, to leave 'holes' in the suggested narrative for the viewer to 'fill in'. For instance, the first movie, *Encounters*, is about associations and mental imagery – a fast paced movie, drawing inspiration from music video, dogma movies, video games etc.; another will concern itself with the saccades as originally planned, but executed slightly differently; yet, another will allow the viewer to see different actions unfolding in front of him, or objects suggesting, but not revealing, a subjective narrative. In total I expect there will be 5-7 movies, which will mainly consist of different footage, although some overlapping will and should take place.

Working with the MobileEye has enabled me to create a series of works, which will confront the viewer with questions of what it means to see and be seen. Rather than recreating an experience of seeing based on a physical model of how the eye works, it captures the psychology of seeing, by forcing the viewer into the position behind someone else's eye, inside someone else's mind, but without the puppeteer's control over where to look and when to look away.

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For further information about Saccadic Sightings or other works by Rune Peitersen please visit www.runepeitersen.com/saccadic or www.runepeitersen.com