On the Importance of Visual (Digital) Wellbeing for HMDs

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ABSTRACT

Most digital devices are screen-based devices and as such our eyes are very much in demand when consuming digital content. This is especially important for augmented and virtual reality (AR/VR) head-mounted displays (HMDs) that are entering the consumer market bringing digital displays even closer to the eyes. The influence of looking at digital screens for the majority of our waking time manifests itself already in an increased occurrence of the computer vision syndrome (CVS). In this position paper we therefore propose to design content for HMDs explicitly around the unique properties and abilities of the human eye and the visual system to avoid visual discomfort or even possible impairments. Hereby we focus on concepts of how eye health features can implicitly be integrated as visual digital wellbeing features into content design for HMDs.

CHI '19, May 04, 2019, Glasgow, UK

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

CCS CONCEPTS

• **Human-centered computing** → *User interface design*; Virtual reality; Mixed / augmented reality.

KEYWORDS

eye health, visual wellbeing, computer vision syndrome, head-mounted displays

ACM Reference Format:
Teresa Hirzle, Jan Gugenheimer, Enrico Rukzio, and Andreas Bulling. 2019. On the Importance of Visual (Digital) Wellbeing for HMDs. In *Proceedings of CHI 2019 workshop on Designing Digital Wellbeing: A Research and Practice Agenda (CHI '19).* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

INTRODUCTION

Digital wellbeing is closely related to *wellbeing* in general, Dodge. et al. [6] propose a definition of wellbeing that relates an individual's resources to the challenges they are facing. Their definition is based on the three components: *psychological*, *social* and *physical*, the interplay of which crucially influences a person's wellbeing. In this position paper we propose the application of this definition to the digital context, as we see research concerning digital wellbeing focusing on the three proposed parts as well.

Most digital devices people are interacting with in everyday life are screen-based devices and as such the "main organ", with which we consume content are the eyes. We already note an increased occurrence of eye strain, headache and blurred vision, which are symptoms summarised under the computer vision syndrome (CVS) [12]. Further, it is probable that these symptoms increase in the population in near future due to AR and VR devices entering peoples' homes. In addition, with those devices the screen is moving even closer to the eyes, largely (AR) or entirely (VR) occupying our field of view. As such, our eyes will be strained more than ever in everyday life, which is calling for concepts and strategies of giving them an opportunity to deal with digital content without being injured.

ON THE DESIGN OF IMPLICIT EYE HEALTH FEATURES

As pointed out before, when talking about digital wellbeing we are relying on our eyes' health a lot. There is already a large body of research that investigates how the amount of screen time influences our vision and eye health [12], and how symptoms of the computer vision syndrome (CVS), such as eye strain, dry eyes and blurred vision, can be prevented [5, 10]. Also preventive actions (i.e. "exercises for the eyes") have been proposed, such as the 20/20/20 rule that is meant to reduce eye strain and headaches [1] (i.e. to look for 20 seconds on something 20 feet away every 20 minutes of looking at a digital screen). In the following we propose two concepts of how preventative actions or eye exercises could be applied as visual digital wellbeing features.

- *Quantifying Eye Behaviour*: One of the most recently presented applications for digital wellbeing are the *Google Digital Wellbeing Features* [7] that among others measure and quantify how often people use certain applications on their digital devices. The quantification of certain behavioural aspects in the form of data helps users to increase awareness of their behaviour [9] and to change it positively [11]. Therefore, we propose the quantification of viewing behaviours and occurrence of CVS symptoms when consuming digital content as a measure of visual digital wellbeing. For example one could generate individual daily depth maps to increase awareness for the amount of time spent in front of digital screens during the day. Further, users could be presented with information on how often they switch their eye focus during certain tasks or how their blinking rate changes during the day.
- *Implicitly Integrating Eye Exercises*: Symptoms of CVS are caused by a change in eye movements and viewing behaviour when consuming digital content compared to "real-world" content. Increased screen time for example often leads to a decreased blinking rate, resulting in dry eyes or a lack of accommodation and vergence leading to blurred vision and headaches [12]. There are already several (hardware and software-based) approaches on how to address these problems that, for example, include systems to actuate blinks [2, 4] or remind the user to follow the 20/20/20 rule [8]. Whereas most of these proposed systems interrupt the user in their current task to explicitly remind them of doing the exercises, we propose an implicitly integrated solution, where eye exercises are an inherent part of the user interface. User interface elements could for example appear at different focus depths (e.g. using light field displays) to get the eye into a relaxed state more often (i.e. focusing on a large distance relaxes the eye lens and muscles around the eye that are in charge of con-/divergent eye movements [3]). As such, notifications could for example be positioned at different depths in the visual field of view to nudge the user towards refocusing more often and as such implicitly obeying the 20/20/20 rule. Another exercise that could be integrated is displaying content in the peripheral visual field to "force" the eye moving on the edges of our visual field. The development of features that automatically recognise eye behaviour that leads to CVS symptoms and integrating corresponding interface reactions is one of the main areas researchers should focus on when developing applications for visual digital wellbeing.

AN ENTIRELY DIGITAL LIFE? - PUSHING VISUAL DIGITAL WELLBEING TO ITS LIMITS

Digital Wellbeing has drawn our attention only recently, however its implications will be wide spread in future. We have only just started to develop digital wellbeing features and to integrate them in our daily usage devices. A life without digital devices is hardly imaginable anymore. When pushing a "digital device-based vision" to its extreme, we could even imagine an entirely digital life (e.g. "living in VR"). As such, the development of digital wellbeing features now will not only influence the definition

of digital wellbeing itself, but most probably fundamentally shape our way of interacting with future digital devices. Similarly as we design touch and gesture-based interfaces that are ergonomically optimized towards our hands and body aiming to avoid "gorilla arm effects", near-eye displays have to be optimized towards the eye to avoid a similar "gorilla eye effect". As such, researchers should increasingly focus on the eyes and visual system when developing for digital wellbeing in future, as the consumption of digital screen-based content crucially relies on an intact visual system. Instead of developing digital wellbeing features retroactively (as it is now with smartphone usage), we should implicitly integrate visual digital wellbeing features and make them an integral part of user interfaces in upcoming consumer head-mounted displays.

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