Computer Science

**Johan Häger**

# Your Title

Bachelor's Project

2015:xx

# Your Title

**Johan Häger**

This report is submitted in partial fulfillment of the requirements for the Bachelor's degree in Computer Science. All material in this report which is not my own work has been identified and no material is included for which a degree has previously been conferred.

Johan Häger

Approved, Date of defense

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Examiner: NN

# Abstract

Put the text of your abstract here

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# 1 Introduction

o Project goal and motivation o Project summary and overview - the ”red thread” o Project results (brief summary) o Dissertation Layout

# 2 Background

On April 4th, 2012, Google announced “Project Glass”.[3] Google Glass, as the device is now known, was under development for several years at Google’s research and development department, Google X. As part of the announcement Google stated: “We think technology should work for you—to be there when you need it and get out of your way when you dont.”.[5] Serge Brin, one of the founders of Google, gave a Ted Talk in February 2013[8] where he talked about why Google decided to produce the device. His argument was that users stayed on their smartphones for too long. Brin also argued that when users were using their smartphones they were looking down on a screen and were not aware of their surroundings. Instead Google wanted to create a device that [TODO could play off the users surroundings and would also] would give the user notifications that could quickly be dealt and done with.

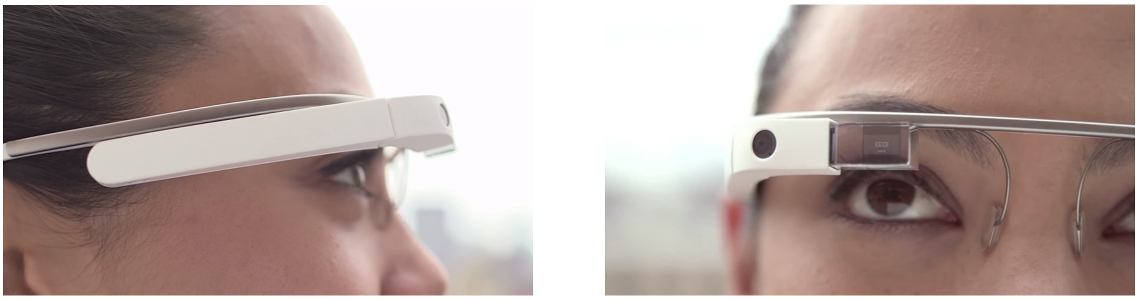
Thad Starner, technical lead/manager on Google Glass, claimed that Google Glass is supposed to be an extension of the self.[28] He compared Google Glass to a watch. Not in terms of where the user keeps his or her focus (with a watch you must look down, similar to a smartphone), but rather in terms of how a watch is easy to access and that the access is instant. Starner said that with Google Glass, Google wanted to minimise the time between intention and action.

## 2.1 What is Google Glass?

Google Glass, or simply “Glass” as the device is known within Google, is a head mounted display (HMD) that can be seen as an augmented reality device[1] designed to bring notifications to the user more easily than a smartphone does. Google Glass can be seen in Figure 2.1. According to Google “Glass is designed to be there when the user needs it and

[1] See section 2.1.4

to stay out of the way when the user does not".[16] Google Glass is meant to give the user relevant information at relevant times.



(a) The user can control Google Glass with the touchpad.

(b) The display sits slightly above the users line of sight, on the right hand side.

Figure 2.1: Google Glass is a small head mounted display equipped with a touchpad, a camera and a microphone.[7]

Google Glass is partially controlled with a touchpad, but can also be controlled with voice command. The touchpad sits on the right hand side of the user's glass frame and runs from the temple to the ear (see in Figure 2.1 (a)). When the user touches anywhere on the touchpad Google Glass "wakes up" from stand by and displays the start screen (which consists of a clock). The display is mounted above the user's line of sight, on the right hand side (see Figure 2.1 (b)). The display can be slightly adjusted so that the user can see all that is currently being displayed.

### 2.1.1 Head-Mounted Display (HMD)

A head-mounted display (HMD)[25] is a device that is worn on the head and that places a small display in front of one or both of the users eyes. The device can either be a stand alone device or a part of a helmet. Google Glass has a see-thorugh and such devices are sometimes called an optical head-mounted display (OHMD)[27].

### 2.1.2 Heads-Up Display (HUD)

A heads-up display (HUD)[26] is defined as any transparent display that, when presenting information, does not require users to look away from their usual viewpoints. In other words, a HUD may be a HMD (or an OHMD) and a HMD may be a HUD. While a HMD is always worn on the head a HUD can be a stand-alone display. In contrast a HUD must be a transparent display. A requirement a HMD does not have.

### 2.1.3 Virtual Reality

Virtual reality[22] is defined as a computer generated simulation that enables users to interact with a three-dimensional environment. Virtual realities are common in interactive mediums such as video games. Virtual realities can also be combined with a HMD in order to completely engulf the user in the virtual reality. One such example is the Oculus Rift, seen in Figure 2.2, that completely covers the user's eyes, allowing the user to get emerged in the virtual reality.

Google Glass is able to display a virtual reality but does not work as a virtual reality device. Google Glass only covers a small part of the user's sight and as such does not have the capability of simulating a three-dimensional, interactive, environment in contrast to the Oculus Rift. Oculus Rift, unlike Google Glass, is able to replace the user's reality with a completely virtual reality since Oculus Rift completely covers the user's eyes.

### 2.1.4 Augmented Reality

Augmented reality[11] is defined as the combination of reallty (or what is within current context being perceived as reality[2]) with useful, computer generated data. Augmented reality, unlike virtual reality, is not meant to replace reality, but rather to enhance interaction with the current reality.

[2] Augmented reality is for instance common in video games to give the player environmental and health information


Figure 2.2: The virtual reality device "Oculus Rift" is a HMD that completely covers the user's eyes.[20]

A HUD may create an augmented reality. The reason a HUD does not always create an augmented reality is due to the fact that the information being presented might not be useful within the current context. An augmented reality is, as stated above, meant to enhance reality, while a HUD does not have that requirement.

Google Glass is a HUD that have the potential (and intent) to create an augmented reality. Google Glass is meant to bring useful information to the user while not distracting from reality. One example of useful information that could enhance the users interaction with reality would be a shopping list while shopping, as seen in Figure 2.3.


Figure 2.3: One way of bringing useful information to the user is by displaying a shopping list while the user is out shopping.[16]

## 2.2 Similar Products

Today there are several products either already on the market or under development that are more or less similar to Google Glass. Following is a brief list describing some of the competition Google Glass faces.

- **Microsoft Hololens**[18]

  Microsofts offer in the augmented reality device space is a HUD that displays information over both of the user's eyes. The intention, according to Microsoft, is not to be an immediate competitor to Google Glass. Microsofts aim is not to make the same device asGoogle Glass. Google Glass are meant to be worn all the time, at all times. Microsoft Hololens is rather a device users only puts on when they intends to use it.

  But the mot striking difference between Microsoft Hololens and Google Glass lies in the interaction with the real world. Google Glass is a two dimensional display that sits slightly above the users line of sight (see 2.1). Microsoft Hololens on the other hand is meant to interact with the world even further.

Microsoft intends to give the user tools to work in a 3D space. Microsofts concept video[19] of Microsft Hololens shows examples of 3D modelling with the use of kinetic handmovement detection, meaning that users will be able to see what they are working on from different angles simply by walking around it, just as if the object in question was real and had a physical mass.

- **Recon Jet** (HUD for sports)

  [TODO]

- **GlassUp**[12] (Sued by Google)

  GlassUp is an Italian company that received most of its founding through the crowd-funding site Indiegogo.[13] GlassUp have been sued by Google for being to similar to Google Glass [TODO REFERENCE]. GlassUp does however make distinctions between the two products. On GlassUp's Indiegogo page the company made the comparison that looking at Google Glass was like looking in the back view mirror in while GlassUp was like looking out the windscreen.

  GlassUp displays information close to the center of the user's vision where as Google Glass keeps the information on the user's upper right. GlassUp claim that this decision was made so that there would be less strain on the user's eye.

- **C Wear Interactive Glasses**[21]

  C Wear Interactive Glasses is an industry focues device developed by Penny in Västerås, Sweden. It does not feature the same slick design many of the other virtual reality devices have (although many of them look terrible as well). One of the examples of this is that one key user interface is where the user can bite on a stick that is connected to the glasses. Probably because of the loud envornment that surronds most workers.

The GUI of Penny have the look of a normal PC application which comes from the fact that Penny keeps connected to a computer. However this might not be the most optimal interface since nagivation comes from head movements.

## 2.3 User Interface

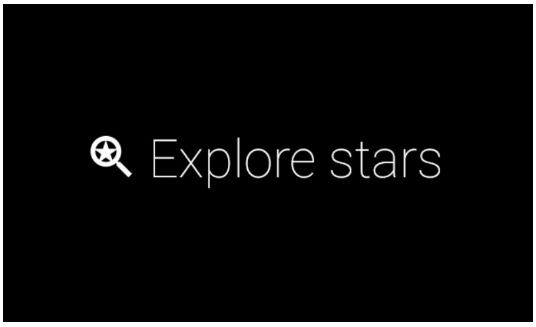
Google Glass' graphical user interface (GUI) is called a timeline (see Figure 2.4).[7] The timeline consists of a row of cards. Cards are basic applications such as a clock (see Figure 2.5 (a)) or information about the weather. Cards can also represent more in-depth applications, on Google Glass called “Immersions” (see Figure 2.5 (b) and (c)). Immersions handles activities such as browsing an image gallery or playing a game.


Figure 2.4: A visual representation of the Google Glass GUI as the GUI is perceived by the user. In reality only one card can be displayed at a time.[7]

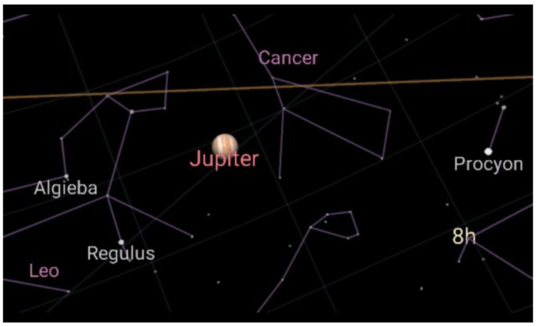
The first screen the user sees when starting up Google Glass is the home screen. The home screen displays a clock and also shows the text ”ok glass”, as seen in Figure 2.5 (a).

The home screen is a part of the timeline and acts as the center point. Cards to the left of the home screen are upcoming activities such as an event in the user's calendar or an upcoming flight. Cards to the right of the home screen are from the past. Cards from the past will for instance show text messages or photos.


(a) The Google Glass home screen is a card that displays a clock.




(b) The card "Explore stars" represents an immersion.




(c) The immersion "Explore stars" allows the user to look around at stars using the built-in head motion tracker.

Figure 2.5: Cards can either display basic applications, such as a clock, or represent more in-depth applications (immersions), such as an application that lets the user look at a map of stars.

In order to move left on the timeline (forward in time) the user must swipe a finger backwards on the touchpad. In order to move right on the timeline (backward in time) the user must swipe a finger forward on the touchpad. The fact that the user must swipe backwards when stepping forward in time might not seem especially intuitive. In western culture a timeline is normally represented as going from left to right. One example of that are books. However, one might think of this action as swiping cards behind the back. Swiping forward when stepping backwards in time would then in turn mean bringing cards placed behind the back into focus. Cards in the past are behind the user while cards in the future are in front of the user.

When the user wants to turn off Google Glass the user swipes down on the touchpad. Swiping down on the touchpad will put Google Glass in stand by. If the user wants to turn off Google Glass entirely, in other words power down the device, there is a power button on the opposite side of the touchpad. Holding down the power button for a few seconds will turn off Google Glass. For a better visual understanding of how Google Glass works see Figure 2.4 as well as the video referenced in the caption.

Google Glass uses a Bone Conduction Transducer (BCT) to transfer sound to the user.[17] The BCT transfers sound to the inner ear by conducting sound through the bones of the skull.[23] The advantage of this technique is that the sound maintains clarity, even in noisy environments. Also, since the user does not plug any earphone into the ears, outside sound is not blocked out.

Google Glass also features a 5 megapixels camera. The camera is placed between the touchpad and the display, as seen in Figure 2.1 (b), and is capable of capturing video at a 720p resolution. The camera can be used for video conferencing, as Google showed in 2012[2], but the camera can for instance also be used when the user wants to scan a QR Code[3].

[TODO write about voice control]

[3] See section 2.6

## 2.4 Compared to Smartphones

Despite being two very different devices, the mobile phone and Glass, Google's design recommendations are not all that different for the two. Google ask developers who are designing for smartphones to think of simplicity and clarity. Google put much emphasis on making applications easy to use.

There are some differences however. For smartphones Google also recommend that developers keep track of what the users have done in the past. Google ask developers to remember the user's input history and customisation, all to make it easier for the user when they (hopefully) come back to the application.[14]

Google differ in how they want developers to design applications for smartphones and Google Glass respectively. Google are much more open to developers using their own ideas when designing for smartphones. Google encourage freedom and give more subtle hints of how to design. For instance Google want developers to make applications fun and easy to use. They recommend consistency and a rewarding application.

Designing for Google Glass comes with a few more restrictions.

[TODO expand and elaborate with more examples]

## 2.5 Limitations with Google Glass

An early concern with Google Glass came from people who wore regular glasses every day as Google Glass seemed to require their own separate frames. Isabelle Olsson at Google responded on the issue on April 12th 2012 with the following: "We ideally want Project Glass to work for everyone, and we're experimenting with designs that are meant to be extendable to different types of frames.".[4]

Today many eyecare providers have been trained for Google Glass and Glass frames. These trained eyecare providers are however mostly located in the United States,[9] but Google points out that many eyecare providers should be able to help replace the lenses on Google Glass' frame[10].

A more alarming concern has been the health of the eyes. [6]
Concerns regarded eye pain and misalignment of the eyes as Google Glass placed a screen above one eye and not both. Google also saw these potential issues and approached Eli Peli, professor of ophthalmology, as the development och Google Glass started.

Peli claims that Google Glass has been designed with more saftey and comfort in mind than previous, similar products. Peli pointed out that Google Glass is see-through and only covers a small part of the user's eyes. As such Google Glass does not require a potentially poorly adjusted camera to capture the environment and display the environment to the user, which could cause eye pain.

Peli also pointed out that Google Glass is meant only to be used in short bursts. The user should not be starring at the display for long periods of time, which would have potential to cause a misalignemtn of the eyes.

Even though there might not be any health risks involved, there is still a question of how much help Google Glass may be to users. A study performed in 2002[30], regarding the effects of HMDs, showed that HMDs may only be of help to users under controlled forms. Whenever the surrounding gets too distracting, for instance within a moving crowd, performance goes down. The study however noted that pilots had been able to successfully turn HMD into something they could use to their advantage. Since the study was not done over a long period of time the participants was potentially not given enough time to get used to wearing and using their HMDs.

## 2.6 QR Code

The Quick Responce (QR) Code was announced in 1994. Having been under development for several years at Denso Wave, barcode developer, the goal was to create a new form of barcode that could carry more information and be easily read.[?]

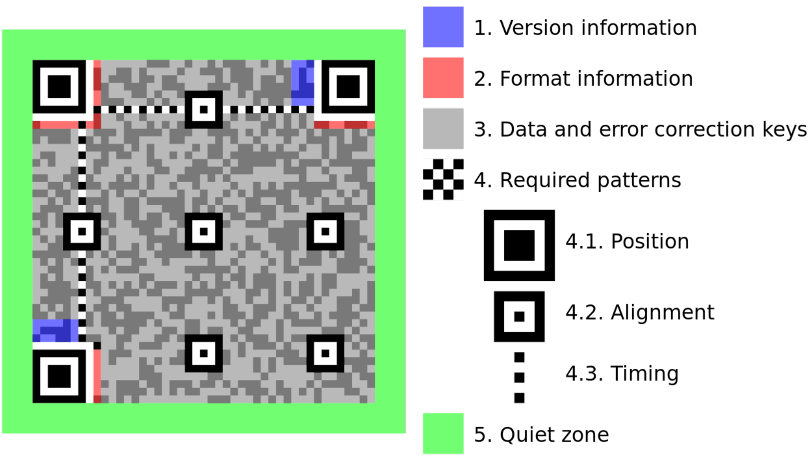



Figure 2.6: The standardised fields in a QR Code.[?]

[TODO WRITE ABOUT THE STANDARDISED FIELDS OF QR CODE]

## 2.7 Information (and Ways of Presenting Information)

In 1985 Sture Allén, professor of computational linguistics, and Einar Selander, honorary doctor at Umeå University, in their book—Information on Information—defined information after having gone through "a large number of examples from texts of different kinds". Allén and Selander defined information as "a certain amount of facts or ideas".[29] Presenting information can be done in a number of different ways.

### 2.7.1 Text

Text is one of the oldest forms of presenting information, with written text dating back to 4000 years B.C..[24] Text is also a simple presenting form to use that does not require much high end hardware. Other forms of presenting information require more memory, more computational power and more graphical power. Text also has the advantage that the user can read through text at their own speed. Text does not have any perception of time.

Text does however have the disadvantage of requiring attention. The person reading the text must keep the attention on the text throughout and can not look away in order to receive all the information being presented. Text is also restricted to the language the text has been written in. In order to globalise an information presentation several texts must be written so that users from different nations can read the text. For instance, English was in 2010 only the third most spoken language, behind Mandarin and Spanish.[1]

### 2.7.2 Images

The advantage of using images as the form of presenting information is that one can show the viewer the information rather than telling the viewer the information. Showing the viewer could potentially mean that more information could be presented within a smaller space than text could achieve. Images also gives the same advantage as text in terms of at what speed the viewer can perceive the information—at any speed. Images, similar to text, does not have a perception of time.

Similar to text though, images require the viewers attention in order to present the information. The viewer can not look away from an image and still receive the information. Another disadvantage with images is the fact that images can be interpreted in different ways. The saying “a picture is worth a thousand words” goes both ways. On one hand images may present much information with one single images. On the other hand the information may not be crystal clear and not as clear cut as a describing text may be.

Photos and graphics

### 2.7.3 Audio

Images and text both have the disadvantage of requiring full attention in order for the information to be perceived. Audio solves this problem. With audio os information presentation form the listener can look away and yet still receive the information that is being presented. In other words audio is well suited for multitasking as long as the other task the listener is performing does not involve audio as well.

Audio does however have the disadvantage of not being insusceptible to time. The listener does not possess the same amount of control as he or she does with either text or images. Audio may be paused and rewinded but the fact that audio is still tied to a timeline is a disadvantage. Another disadvantage with audio is that, similar to text, audio is dependent on the language. If a information presentation were to be spread globally several audio files would be required (given that the audio contained spoken words).

### 2.7.4 Video

Since video consist of many images bundled together video gives the same advantages as images in terms of showing the viewer the information instead of telling. Video presents the viewer with images at such speed that the images gives the impression of movement. Video may also include audio. The inclusion of audio gives video all the same advantages as audio. In other words video could potentially give the advantages of two other forms of information presentation.

Similar to audio, video is constantly moving. The viewer are bound to the playback speed of the video. Even though a video may be paused or even rewind the viewer is not in the same amount of full control as with images or text. With text and images the reader (or reader) can deceide the speed at which the information should be perceived for themselves. If the video does not include audio video, similar to images or text requires full attention in order for the information to be perceived.

## 2.8 Summary

o Introduce problem area / give relevant background info

o Introduction - Explain WHY you are doing this study

o Information - Background / your study in the wider context

o Similar work (projects, systems etc.)

o Summary - for this chapter

# 3 Design

## 3.1 Presenting Information on Google Glass

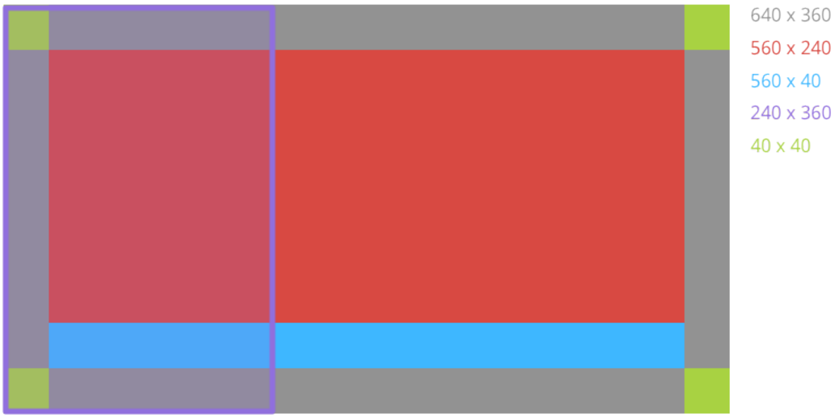



Figure 3.1: Google provide developers with strict guidelines as to how they should use the limited space that Google Glass can present information on.[15]

## 3.2 Summary

o Design - Present your project design in general o Information - Give details here (possibly several sub-sections)

# 4 Implementation

## 4.1 Summary

o Implementation - Present your project implemetion in general o Information - Give details here (possibly several sub-sections) o Summary - for this chapter

# 5 Result / Evaluation

o Introduction - Summarise your main results o Give details of the results o Best presentation? (text, tables, diagrams?) o Implementation Evaluation - your results against your expectations o Summary - for this chapter

# 6 Conclusion

o Conclusion o Project Evaluation o Problems - How would you do this the next time? o Future work

## 6.1 Future Work

# 7 Abbrevations

**BCT** Bone Conduction Transducer

**GUI** Graphical User Interface

**HMD** Head-Mounted Display

**HUD** Heads-Up Display

**OHMD** Optical Head-Mounted Display

**QR Code** Quick Response Code

# References


[1] Nationalencyklopedin (2010). *Världens 100 största språk 2010.* http://www.ne.se/uppslagsverk/figur/tabell/v%C3%A4rldens-100-st%C3%B6rsta-spr%C3%A5k-2010 [2015-02-23] (In Swedish).

[2] Google (2012). *Project Glass: Live Demo At Google I/O* [Online video]. http://youtu.be/D7TB8b2t3QE [2015-02-24].

[3] Google (2012). *Project Glass: One day...* [Online video]. http://youtu.be/9c6W4CCU9M4 [2015-02-16].

[4] Olsson, Isabelle (2012). *Google Glass Frames.* https://plus.google.com/110625673290805573805/posts/Nmc8LuwFw5M [2015-02-16].

[5] Parviz, Babak. Lee, Steve. Thrun, Sebastian. (2012). *Google Glass.* https://plus.google.com/u/0/wm/4/+GoogleGlass/posts/aKymsANgWBD [2015-02-16].

[6] Denso Wave (2013). *History of QR Code.* http://www.qrcode.com/en/history/ [2015-02-24].

[7] Elise Ackerman (2013). *Could Google Glass Hurt Your Eyes? A Harvard Vision Scientist And Project Glass Advisor Responds.* http://www.forbes.com/sites/eliseackerman/2013/03/04/could-google-glass-hurt-your-eyes-a-harvard-vision-scientist-and-project-glass-advisor-responds/ [2015-02-23].

[8] Google (2013). *Google Glass How-to: Getting Started* [Online video]. http://youtu.be/4EvNxWhskf8 [2015-02-07].

[9] Sergey Brin (2013). *Why Google Glass?* Long Beach, United States of America. http://www.ted.com/talks/sergey_brin_why_google_glass [2015-02-02].

[10] Google (2014). *Find a Preferred Provider.* http://www.google.com/glass/help/frames/providers/ [2015-02-02].

[11] Google (2014). *Frames.* http://www.google.com/glass/help/frames/ [2015-02-02].

[12] Augmented Reality (2015). *Encyclopædia Britannica Online.* academic.eb.com/EBchecked/topic/1196641/augmented-reality [2015-02-19].

[13] GlassUp (2015). *GlassUp.* http://www.glassup.net [2015-02-23].

[14] GlassUp (2015). *GlassUp: Augmented Reality glasses that display messages from your smartphone.* https://www.indiegogo.com/projects/glassup-augmented-reality-glasses-that-display-messages-from-your-smartphone [2015-02-23].

[15] Google (2015). *Android Design Principles.* https://developer.android.com/design/get-started/principles.html [2015-02-16].

[16] Google (2015). *Card Regions.* https://developers.google.com/glass/design/style [2015-02-16].

[17] Google (2015). *Principles.* https://developers.google.com/glass/design/principles [2015-02-02].

[18] Google (2015). *Tech spechs.* https://support.google.com/glass/answer/3064128?hl=en [2015-02-24].

[19] Microsoft (2015). *Microsoft HoloLens.* http://www.microsoft.com/microsoft-hololens/en-us [2015-02-23].

[20] Microsoft (2015). *Microsoft Hololens Concept Video* [Online video]. http://compass.surface.com/assets/b2/15/b215c2a2-1c5b-4707-9a92-fffca6fb82fe.mp4?n=Microsoft_HoloLens_TransformYourWorld_816p23.mp4 [2015-02-23].

[21] Oculus (2015). *Low Latency 360° Head Tracking.* https://www.oculus.com/rift/ [2015-02-09].

[22] Penny (2015). *Penny.* http://www.penny.se/ [2015-02-23].

[23] Virtual Reality (VR) (2015). *Encyclopædia Britannica Online.* http://academic.eb.com/EBchecked/topic/630181/virtual-reality-VR/ [2015-02-19].

[24] Wikipedia (2015). *Bone conduction.* http://en.wikipedia.org/wiki/Bone_conduction [2015-02-24].

[25] Wikipedia (2015). *Cuneiform.* http://en.wikipedia.org/wiki/Cuneiform [2015-02-23].

[26] Wikipedia (2015). *Head-Mounted Display.* http://en.wikipedia.org/wiki/Head-mounted_display [2015-02-23].

[27] Wikipedia (2015). *Head-Up Display.* http://en.wikipedia.org/wiki/Head-up_display [2015-02-23].

[28] Wikipedia (2015). *Optical Head-Mounted Display.* http://en.wikipedia.org/wiki/Optical_head-mounted_display [2015-02-23].

[29] Wikipedia (2015). *QR Code.* http://en.wikipedia.org/wiki/QR_code [2015-02-24].

[30] Thad Starner. Project glass: An extension of the self. *Pervasive Computing, IEEE*, 12(2):14–16, 2013.

[31] Einar Selander Sture Allén. *[Information on Information]*. Studentlitteratur, Lund, 1985 (In Swedish).

[32] Laramee, Robert S. Ware, Colin. Rivalry and interference with a head-mounted display. *ACM Trans. Comput.-Hum. Interact.*, 9(3):238–251, sep 2002.