Computer Science

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Bachelor's Project

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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.

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Approved, Date of defense

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Examiner: NN

Abstract

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2 Background

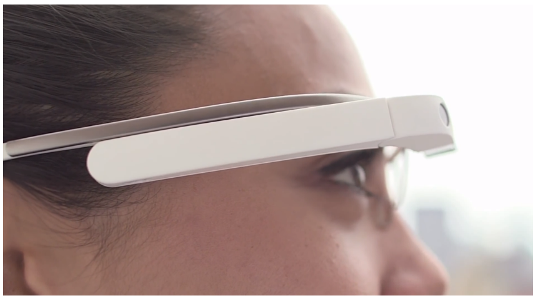
On April 4th, 2012, Google announced “Project Glass” [7]. Google Glass, as the device is now known, was under development for several years at Google’s research and development department, Google X. As part of the announcement Google stated: “We think technology should work for you—to be there when you need it and get out of your way when you don’t.” [9].

Sergey Brin, one of the founders of Google, gave a Ted Talk in February 2013 [23] 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 at a screen and were not aware of their surroundings. Instead Google wanted to create a device that would give the user notifications that could quickly be dealt and done with. Google also wanted to make the device hands-free and put the display where the user did not have to look down. Brin stated that the development team at Google X added the camera later on in the development process but in fact the camera had been a great addition to the device and enabled Google Glass to capture the user’s surroundings, for instance by taking photographs.

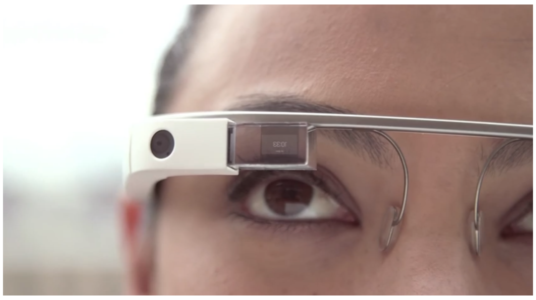
Thad Starner, technical lead/manager (responsible for both the technical direction as well as people management [22]) on Google Glass, claimed that Google Glass was intended to be an extension of the self [74]. He compared Google Glass to a watch. Not in terms of where the user keeps his or her focus (with a watch you must look down, similar to a smartphone), but rather in terms of how a watch is easy to access and how 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 (see Section 2.1.1 and Section 2.1.4 respectively) designed to bring notifications to the user more easily than a smartphone does. Google Glass is shown in Figure 2.1. According to Google “Glass is designed to be there when the user needs it and to stay out of the way when the user does not” [43]. 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 user’s line of sight, on the right hand side.

Figure 2.1: Google Glass is equipped with a touchpad and a camera [19].

Google Glass is partially controlled with a touchpad, but can also be controlled through voice commands. 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)) and can be slightly adjusted so that the user can see all that is currently being displayed.

The display is a projection that goes through an optic lense in the glass piece, seen in Figure (b), which creates a virtual image. A virtual image is an image that, projected through optic lenses, appears to be located at a point where the actual projection is not [70]. In the case of Google Glass the display appears to be located further away from the user than the display actually is. The display is said to be equivalent of a 25 inch high definition screen seen from a distance of approximately 2.5 meters [45].

2.1.1 Head-Mounted Display (HMD)

A head-mounted display (HMD) [63] is a device that is worn on the head and that places a small display in front of one or both of the user's eyes. The device can either be a stand alone device or a part of a helmet. A branch of HMDs are optical head-mounted displays (OHMDs) [66]. A OHMD is a HMD with a see-through display, for instance Google Glass.

2.1.2 Heads-Up Display (HUD)

A heads-up display (HUD) [64] is defined as any transparent display that, when presenting information, does not require userss to look away from their usual viewpoints. In other words, a HUD may be a HMD 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. A OHMD, however, is always a HUD since a OHMD has a transparent display.

2.1.3 Virtual Reality

Virtual reality [59] 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 experience 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 field of vision and as such does not have the capability of simulating a three-dimensional, interactive, environment in

Figure 2.2: The HMD “Oculus Rift” is a virtual reality device [52].

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 [32] is defined as the combination of reality (or what is within current context being perceived as reality [1]) 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.

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

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

enhance reality, while a HUD does not have that requirement.

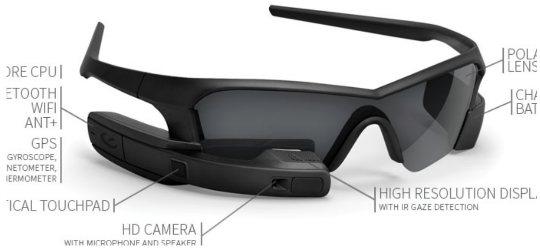
Google Glass is a HUD that has the potential (and intent) to create an augmented reality. Google Glass is intended to present useful information to users while not distracting them from reality. One example of useful information that could enhance users interaction with reality would be a shopping list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

Figure 2.3: A shopping list while the user is out shopping is useful information [43].

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 short list (a more extensive list of devices can be found on wikipedia [66]) describing some of the competition Google Glass faces, with each product shown in Figure 2.4.

(a) Microsoft Hololens [50]



(b) Recon Jet [57]

(c) GlassUp [36]

(d) C Wear Interactive Glasses [56]

Figure 2.4: There are many OHMD devices similar to Google Glass [66].

2.2.1 Microsoft Hololens [50]

Microsoft's offer in the augmented reality device space is a HUD that displays information in front of both of the user's eyes, called Microsoft Hololens, seen in Figure 2.4 (a). However, while Google Glass is meant to be worn at all times, Microsoft Hololens is rather a device users only wear when they intend to use Microsoft Hololens. Google Glass is, as Thad Starner stated [74], meant to be an extension of the self and is meant to be worn even though the user might not be actively using Google Glass at the time in order to bring helpful notifications and information to the user. Microsoft Hololens is rather a tool to be used actively for a certain purpose, such as modelling [49], and then put away. Google Glass may be used the same way if the user wants to, but that is not the intent.

The mot striking difference between Microsoft Hololens and Google Glass lies in the interaction with the real world. Google Glass is a two dimensional (2D) display that sits slightly above the users line of sight (see Section 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 three dimensional (3D) space. Microsoft's concept video [51] of Microsoft Hololens shows examples of 3D modelling with the use of kinetic hand-movement detection. Microsoft Hololens will enable users to see what they are working on from different angles simply by walking around the object, just as if the object in question was real and had a physical mass.

2.2.2 Recon Jet [57]

Recon Jet, seen in Figure 2.4 (b) is an HMD developed by Recon Instruments. Recon Jet is suited for athletes. [57] Because of the target audience Recon Jet has been fitted with a display that has high contrast in order to give good readability in high ambient lighting. The display's virtual image appears as a 30 inch wide screen at approximately 2 meters distance [58], to be compared with Google Glass' virtual image which appears as a 25 inch high definition screen seen from a distance of 2.5 meters [45].

Unlike Google Glass, Recon Jet's display is located below the user's line of sight, as seen in Figure 2.4. Recon Jet's target audience, athletes, are used to having their information below line of sight. For instance a bike may have dashboard mounted to the handlebar, or an athlete might be using a watch to check the time. Google Glass is meant to be worn at all times while the location and the brightness of the display indicates that Recon Jet, however, is meant to only be used while the athlete is working out and not more regularly.

2.2.3 GlassUp [34]

GlassUp is an Italian company that received most of its founding for the HMD device, GlassUp (seen in Figure 2.4 (c)), through the crowd-funding site Indiegogo [35]. GlassUp has been accused of being to similar to Google Glass, partially because of the name of the device [13]. GlassUp does however make distinctions between the two products. On GlassUp's Indiegogo page the company made the comparison that looking at Google Glass' display was similar to looking in the back view mirror while GlassUp was similar to looking out the windscreen. The comparison referenced the fact that Google Glass' display is located above the user's line of sight, similar to a rear view mirror.

GlassUp instead displays information close to the center of the user's line of sight. GlassUp claimed, on the company's Indiegogo page, that the display was placed closer to the center of the users line of sight so that there would be less strain on the user's eyes. However, the biggest difference from Google Glass is that GlassUp is meant only to act as a second screen. GlassUp is a "receive only" device which displays information from the device currently connected through bluetooth, for instance a smartphone. GlassUp does not do any calculations on its own and must stay connected to a bluetooth device in order to display information [35].

2.2.4 C Wear Interactive Glasses [55]

C Wear Interactive Glasses, seen in Figure 2.4 (d), is an industry focused device developed by Penny in Västerås, Sweden [10]. C Wear Interactive Glasses projects an image onto the actual glass in front of the user's right eye and as such covers a larger area than similar devices such as Google Glass, Recon Jet and GlassUp [54]. The display is said to be perceived as a 75 inch display at a distance of 2.1 meters [56]. The projection is transparent which enables users to still see what is happening in front of them. 2 Being industry focused C Wear Interactive Glasses is also equipped with a hands-free user interface that does not require voice command. C Wear Interactive Glasses uses a jaw sensor which lies against the user's jawbone muscle. The sensor detects tension in the muscle, which registers as a click, to be compared with a toucn on the Google Glass touchpad [56].

C Wear Interactive Glasses, similar to GlassUp, is designed to be connected to an external device [56]. However, where GlassUp is connected through bluetooth C Wear Interactive Glasses is connected through an adapter which can send data and visual information via USB and HDMI. The external device can be a smartphone, a tablet, a PC or even a TV.

2.3 User Interface

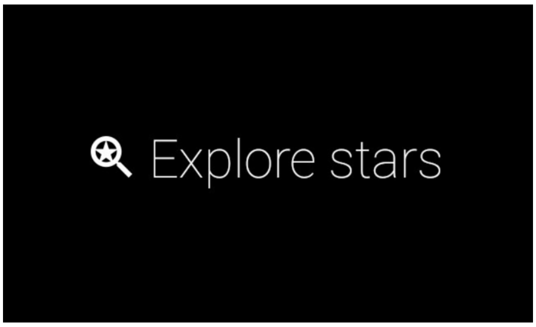
The Google Glass graphical user interface (GUI) is called a timeline [19] (see Figure 2.5). The timeline consists of a row of cards. Cards are basic applications such as a clock (see Figure 2.6 (a)) or information about the weather. Cards can also represent more in-depth applications, on Google Glass called "Immersions" (see Figure 2.6 (b) and (c)). Immersions handle activities such as browsing an image gallery or playing a game.

Figure 2.5: A visualisation of the timeline as the timeline is perceived by the user [19].

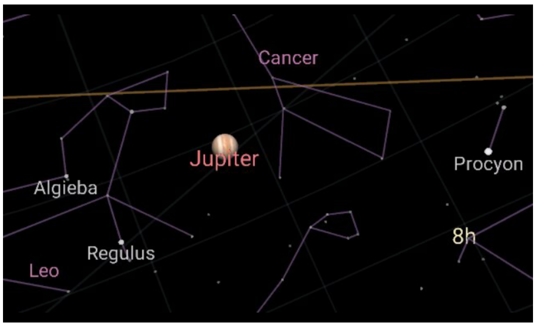
The first screen the user sees when starting up Google Glass is the home screen. The home screen displays a clock and also shows the text "ok glass", as seen in Figure 2.6 (a). The home screen is a part of the timeline and acts as the center point. Cards to the left of the home screen are upcoming activities 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.

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

(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 2.6: Cards can either display basic applications or represent immersions.

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 is books, where the reader not only reads each line from left to right, but also turn pages from the right (the future) to the left (the past). However, on Google Glass, the swiping action could be thought of 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 mode. 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 2.5 as well as the video referenced in the caption.

Google Glass uses a Bone Conduction Transducer (BCT) to transfer sound to the user [45]. The BCT transfers sound to the inner ear by conducting sound through the bones of the skull [60]. 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 their ears, external sound is not blocked out.

Google Glass also features a 5 megapixels camera [45]. The camera sits 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 [6], but the camera can for instance also be used when the user wants to scan a QR Code (see Section 2.6).

The user can also interact with Google Glass using voice commands. As seen in Figure 2.6 the home screen consists not only of a clock but also of the words “ok glass”, in quotes. “ok glass” indicates to the user that voice commands are available. The voice command menu is accessed as soon as the user says the words “ok glass”. Doing so brings up a list of voice commands available, as seen in Figure 2.7.

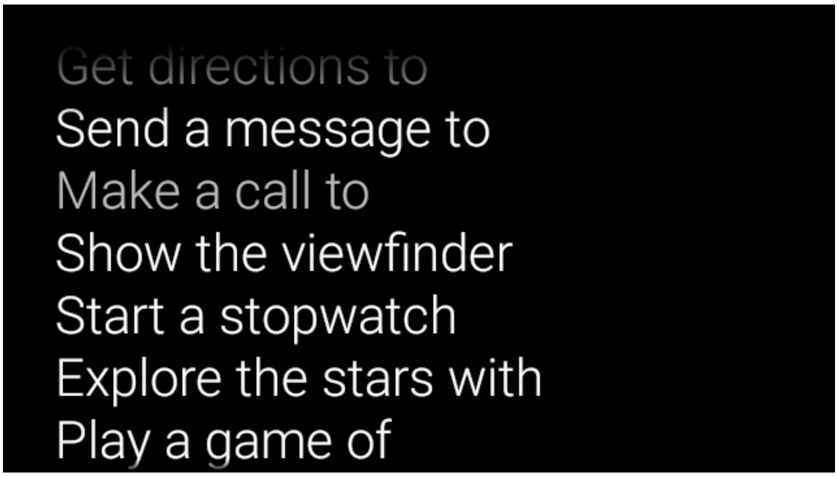


Figure 2.7: Saying "ok glass" will bring up the voice command menu [47].

In order to progress further the user must say one of the options being displayed out loud. Doing so will either make Google Glass perform the task spoken or give the user the option to add an input option to the task chosen. For instance, if the user where to say "ok glass, Start a stopwatch", Google Glass would start a stopwatch.

Google Glass also supports head motions as a form of input from the user. Head motions are not enabled in the timeline as a way of input but tilting the head may wake up Google Glass from stand by mode, if the user has enabled the head wake up feature [42]. The head motion interface may also be used in certain immersions, such as "Explore stars" seen in Figure 2.6 (c).

2.4 A Comparison with Smartphones

Compared to smartphones one of the biggest advantages of Google Glass is the fact that Google Glass is a HMD. With a smartphone the user needs to either hold the smartphone in either one or both hands, or alternatively put the smartphone on a table. In other words can Google Glass offer a hands-free experience that smartphones cannot.

Another advantage of Google Glass compared to smartphones also comes from the fact that Google Glass is an HMD. The user does not need to look away in order to see what is currently being displayed. Google Glass does not distract from what the user is currently doing as much as a smartphone where the user needs to either look away or hold up the smartphone in from of their eyes.

However, smartphones does give the user a bit more control. The control comes from the fact that smartphones supports multi-touch, which Google Glass does not. On a smartphone users may also touch directly on the screen, in contrast to Google Glass where the touchpad sits on the right hand side of the user. Smartphones also have a larger touch area than Google Glass.

The smartphone screen size has been increasing ever since the iPhone first launched in 2007 [65], as seen in Figure 2.8. Looking at currently available smartphones, in Figure 2.9, the increase in screen size does is set to continue as the average screen size is approaching five inches. In terms of comparison with Google Glass the increase in screen size entails that more information could be displayed on a smartphone than on Google Glass.

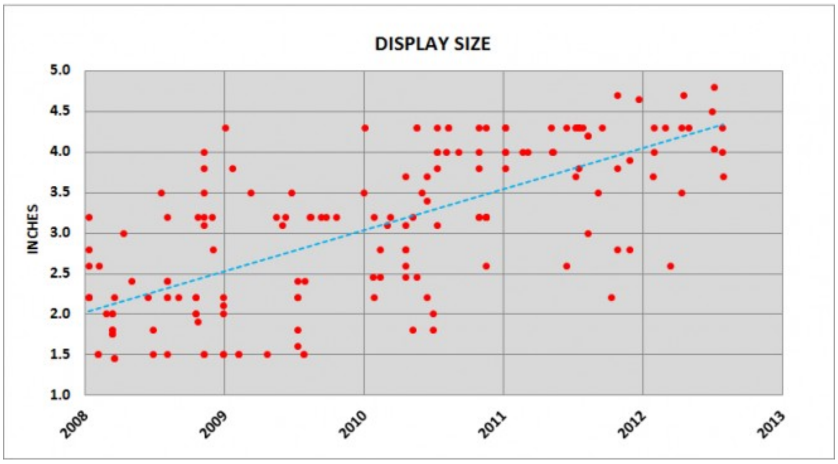


Figure 2.8: Smartphone screens have been increasing in size for several years [12].

However, one of the biggest differences between smartphones and Google Glass is the plural, smartphone**s**. There are several smartphone brands competing on the market, each offering several models. Google Glass is simply Google Glass, one product. As seen in Section 2.2 Google Glass does face competitors that have approached HMDs differently,

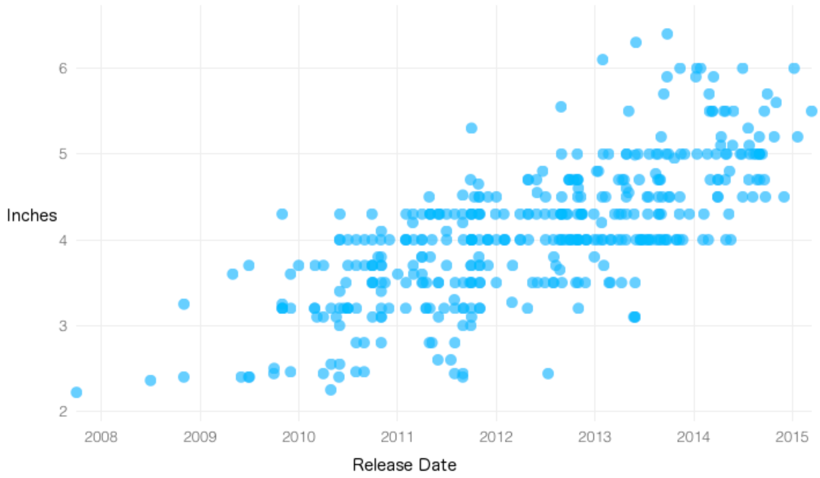


Figure 2.9: Screen sizes of the most popular, currently available smartphones [26].

and as HMDs increase in popularity there is potential for an even wider offering of models and screen sizes.

2.5 Limitations of Google Glass

One early concern with Google Glass came from people who wore regular glasses every day, as Google Glass seemed to require 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." [8].

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 [28], but Google points out that many eyecare providers should be able to help replace the lenses on Google Glass' frames [29].

As described in an article posted on forbes in 2013 [18], a more alarming concern has been the health of the user's eyes. Concerns were raised regarding eye strain and misalignment of the user's 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 who had been studying HMDs for two decades, as the development och Google Glass started.

Peli claimed that Google Glass has been designed with more safety 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 field of vision. 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 strain.

Peli also pointed out that Google Glass is meant only to be used for short periods. Google Glass is meant to give the user notifications that can be quickly dealt and done with. The user should not be looking at the display for long periods of time, which would have the potential to lead to eye strain. While Peli stated that the risks are zero, he still claimed that the likelihood of Google Glass causing any damage is minimal.

Even though, according to Google's expert, 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 [76], regarding the effects of OHMDs, showed that OHMDs may only be of help to users under controlled forms. Whenever the surrounding evnironment becomes too distracting, for instance within a moving crowd, performance decreases. The study however noted that pilots had been able to successfully turn HMD into a tool they could use to their advantage. Since the study was not carried out over a long period of time the participants were potentially not given enough time to get used to wearing and using their HMDs, explaining the poor performance when using a distracting background.

2.6 QR Code

As mentioned in Section 2.3 Google Glass is equipped with a camera that could be used to take photos from the user's perspective. One potential use of the camera would be to scan Quick Response (QR) codes. The QR Code was announced in 1994. Having been under development for several years at Denso Wave [15] the goal was to create a new form of barcode that could carry more information than a linear barcode and be easily read.

A conventional barcode is capable of storing approximately 20 digits while a QR code can store several thousand digits [16]. Information is encoded using standardised encoding modes and displayed as a 2D barcode. A QR code has several standardised fields, as seen in Figure 2.10. Using position fields a QR code can be read from any direction, compared to a conventional barcode which can only be read horizontally [17].

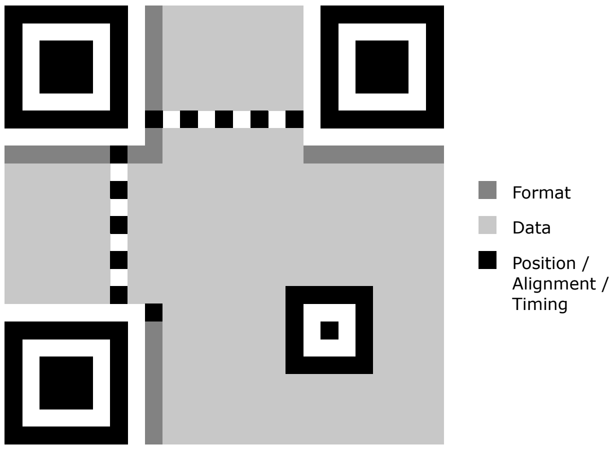


Figure 2.10: The standardised fields of a QR code [67].

A QR code can be used to encode information, originally written with alphabetic characters, japanese symbols (Kanji) or numeric characters [14]. With the help of a QR code information which would otherwise have taken up a large space can now be easily fitted in smaller areas.

2.6.1 Decoding

Decoding a QR code is a fairly straight forward process which, although time consuming, can be done by hand, as described in several guides around the Internet [11, 24, 72]. A QR code may be divided in to three standardised fields, which help QR code scanners to identify and decode QR codes. The three fields can be seen in Figue 2.10. The position, alignment and timing fields are used to identify and position the QR code correctly as a QR code may be scanned from any direction. In order to decode a QR code the three main position fields residing in three of the QR code's corners must be positioned as seen in Figure 2.11.

The next step is to identify the mask used on the data field in the QR code. The mask is used to remove any large, empty or filled, areas within the data field which might make the decoding process more difficult for QR code scanners. The mask field is a part of the format field, seen in Figure 2.10. The format field holds information about error correction, as well as which mask has been used on the data field. The mask is found among the first five bits in the format field. The first two bits of the first five bits of the format field contain information regarding the amount of error correction data the QR code contains, and the other three contain information on which mask has been used.

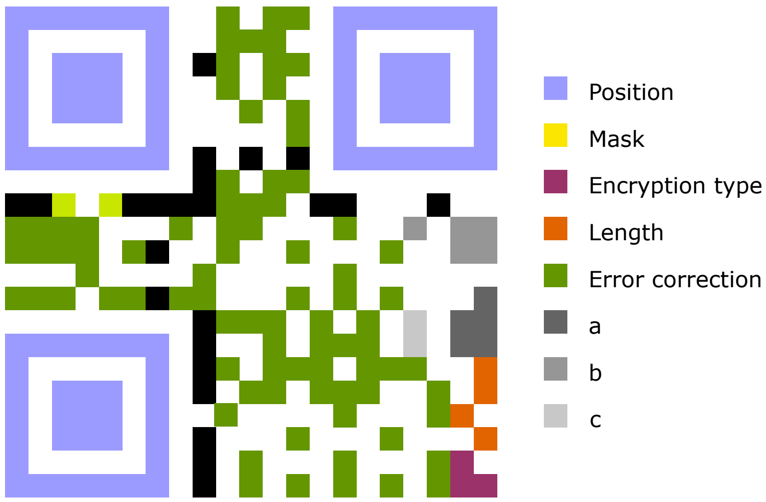


Figure 2.11: A QR code example, encoded with the string "abc".

In Figure 2.11 the mask field has the value of 101, seen more clearly in Figure 2.12. Filled blocks should be interpreted as a 1 and empty blocks should be interpreted as a 0. However, the mask field is always XOR:d with 101 prior to being printed in the QR code and must as such be XOR:d back to the original mask value. In the case of Figure 2.11 the original mask value is calculated as follows:

$$101 \text{ XOR } 101 = 000$$

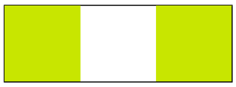


Figure 2.12: Mask pattern encoded as 101.

There are eight different mask patterns in total, each represented by a unique bit string. The mask pattern represented by 000 can be seen in Figure 2.13, while the rest of the mask patterns may be found here [5]. The mask used in Figure 2.11 means that all bits should be flipped if the following formula is true:

$$(i + j) \ mod \ 2 = 0,$$

where i and j represents the indexes of the specific block, horizontally and vertically respectively [5].

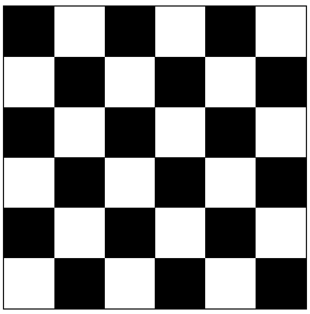


Figure 2.13: Mask pattern represented by the bit string 000 [5].

Having decoded the mask pattern the next step is to decode the data area. The data area always contains a header, containing information on the encryption type as well as data length. The blocks containing the encryption type is always the size of four blocks, and always located in the lower right corner, as seen in Figure 2.11. The number of blocks used for the data length may vary between eight and ten blocks depending on the encryption type.

As such the first step in decoding the data area is to decode the encryption type. The information in the data area is to be read from the lower right and upwards, in a zig-zag pattern, with a width of two blocks. When reaching the top the zig-zag pattern continues, although downwards. See Figure 2.14 for a better understanding of the zig-zag pattern. The start point is always in the lower right corner since the encryption type must be decoded first.

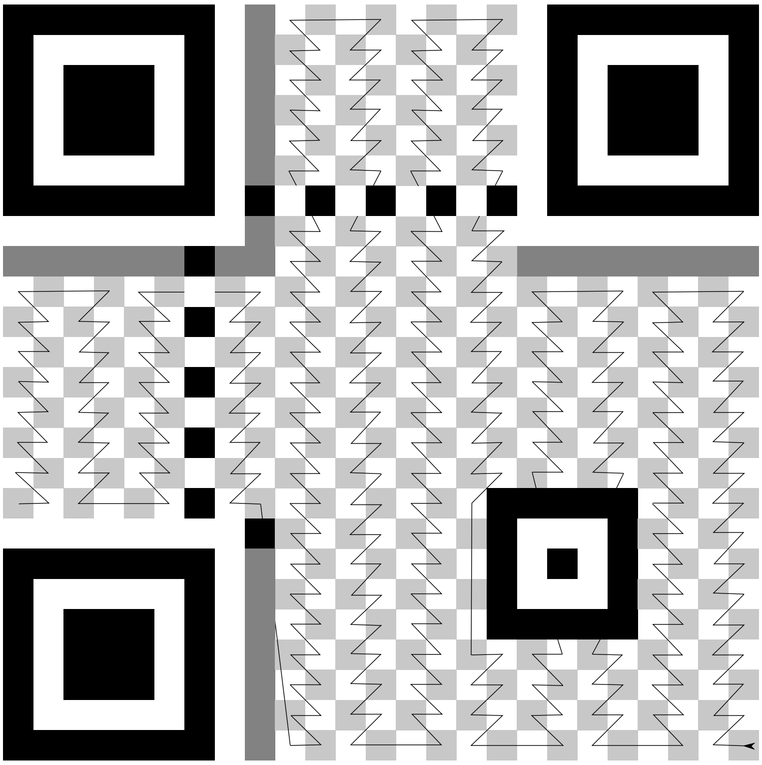


Figure 2.14: The zig-zag pattern used when decoding a QR code.

Using the zig-zag pattern the encryption type bit string in Figure 2.11 can be found to be 1101, seen more clearly in Figure 2.15. However, the encryption type is a part of the data section and as such must be unmasked. Using the mask formula gives the following results:

$$(20 + 20)\ mod\ 2 = 40\ mod\ 2 = 0$$

$$(20 + 19)\ mod\ 2 = 39\ mod\ 2 = 1$$

$$(19 + 20)\ mod\ 2 = 39\ mod\ 2 = 1$$
$$(19 + 19)\ mod\ 2 = 38\ mod\ 2 = 0$$

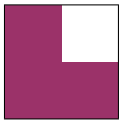


Figure 2.15: Encryption type encoded as 1101.

As such the blocks at position (i, j) = (19, 19), and (i, j) = (20, 20) must be flipped. The “flipping” process may be done by XOR:ing the massked encryption type bit string with a bi string representing the bits that must be “flipped”, putting ones at the positions where the corresponding bit in the masked encryption type bit string must be flipped, and zeroes at the position where the corresponding bit does not need to be flipped. The masked encryption type bit string, 1101, must as such be XOR:d with 1001, as follows:

$$1101\ XOR\ 1001 = 0100$$

There are several encryption types used in QR codes, however the most common ones are the following (represented by the following bit strings):

- 0001 Numeric
- 0010 Alphanumeric
- 0100 8-Bit Byte

The encryption type used in Figure 2.11 is as such of encryption type 8-bit Byte.

After having decoded the encryption type the next step is to decode the length. The encoded length is the length of the message encoded in the QR code. Since the message encoded in the QR code may not cover the entire data section of the QR code (the rest is made up of error correction information) the length of the message is necessary in order to know when the message ends. Since the encryption type used in Figure 2.11 is an 8-bit Byte the size of each field that follows is eight bits in size.

The length field in Figure 2.11, seen also in FIgure 2.16, is the following bit string: 10011010. However, the length field is a part of the data section and must as such be unmasked in order for the original length value to be obtained.

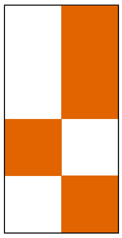


Figure 2.16: The message length encoded as 10011010.

$$(18 + 20)\ mod\ 2 = 38\ mod\ 2 = 0$$
$$(18 + 19)\ mod\ 2 = 37\ mod\ 2 = 1$$
$$(17 + 20)\ mod\ 2 = 37\ mod\ 2 = 1$$
$$(17 + 19)\ mod\ 2 = 36\ mod\ 2 = 0$$
$$(16 + 20)\ mod\ 2 = 36\ mod\ 2 = 0$$
$$(16 + 19)\ mod\ 2 = 35\ mod\ 2 = 1$$
$$(15 + 20)\ mod\ 2 = 35\ mod\ 2 = 1$$
$$(15 + 19)\ mod\ 2 = 34\ mod\ 2 = 0$$

The encryption type bit string must as such be XOR:d with 10011001, as follows:

$$10011010\ XOR\ 10011001 = 00000011 = 3$$

The message in Figure 2.11 is as such of length 3.

Finally, the data is decoded. The first 8-bit Byte, seen in Figure 2.17, gives the following bit string: 11111000. However, being a part of the data section, the bit string must be unmasked, as follows:

$$(14 + 20)\ mod\ 2 = 34\ mod\ 2 = 0$$
$$(14 + 19)\ mod\ 2 = 33\ mod\ 2 = 1$$
$$(13 + 20)\ mod\ 2 = 33\ mod\ 2 = 1$$
$$(13 + 19)\ mod\ 2 = 32\ mod\ 2 = 0$$
$$(12 + 20)\ mod\ 2 = 32\ mod\ 2 = 0$$
$$(12 + 19)\ mod\ 2 = 31\ mod\ 2 = 1$$
$$(11 + 20)\ mod\ 2 = 31\ mod\ 2 = 1$$
$$(11 + 19)\ mod\ 2 = 30\ mod\ 2 = 0$$

The first 8-bit Byte bit string must as such be XOR:d with 10011001.

$$11111000\ XOR\ 10011001 = 01100001 = 64 + 32 + 1 = 97$$

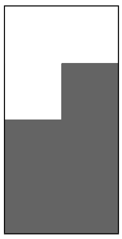


Figure 2.17: The first 8-bit Byte encoded as 11111000.

The second 8-bit Byte, seen in Figure 2.18, reaches the top of the data section and as such the last four bits must be read horizontally to the left, as described in Figure 2.14. Doing so gives the following bit string: 11110100. Again, the bit string must be unmasked.

$$(10 + 20)\ mod\ 2 = 30\ mod\ 2 = 0$$
$$(10 + 19)\ mod\ 2 = 29\ mod\ 2 = 1$$
$$(9 + 20)\ mod\ 2 = 29\ mod\ 2 = 1$$
$$(9 + 19)\ mod\ 2 = 28\ mod\ 2 = 0$$
$$(9 + 18)\ mod\ 2 = 27\ mod\ 2 = 1$$
$$(9 + 17)\ mod\ 2 = 26\ mod\ 2 = 0$$

$$(10 + 18)\ mod\ 2 = 28\ mod\ 2 = 0$$

$$(10 + 17)\ mod\ 2 = 27\ mod\ 2 = 1$$

The second 8-bit Byte bit string must as such be XOR:d with 10010110.

$$11110100\ XOR\ 10010110 = 01100010 = 64 + 32 + 2 = 98$$

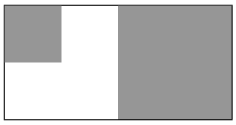


Figure 2.18: The second 8-bit Byte encoded as 11110100.

The third, and final 8-bit Byte, seen in Figure 2.19, to be decoded is read downwards as described in Figure 2.14, giving the following bit string: 00000101. The bit string must be unmasked:

$$(11 + 18)\ mod\ 2 = 29\ mod\ 2 = 1$$

$$(11 + 17)\ mod\ 2 = 28\ mod\ 2 = 0$$

$$(12 + 18)\ mod\ 2 = 30\ mod\ 2 = 0$$

$$(12 + 17)\ mod\ 2 = 29\ mod\ 2 = 1$$

$$(13 + 18)\ mod\ 2 = 31\ mod\ 2 = 1$$

$$(13 + 17)\ mod\ 2 = 30\ mod\ 2 = 0$$

$$(14 + 18)\ mod\ 2 = 32\ mod\ 2 = 0$$

$$(14 + 17)\ mod\ 2 = 31\ mod\ 2 = 1$$

The third 8-bit Byte bit string must as such be XOR:d with 01100110.

$$00000101\ XOR\ 01100110 = 01100011 = 64 + 32 + 2 + 1 = 99$$

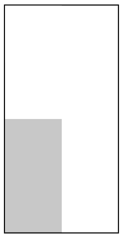


Figure 2.19: The third 8-bit Byte encoded as 00000101.

Since the message length was found to be of size 3 all parts of the message in Figure 2.11 have been found. The rest of the data section contains information regarding error correction, used in case the QR code was somehow damaged.

The message in Figure 2.11 has been decoded as 97, 98 and 99. Converting there numbers using an ASCII table gives the following result: a, b and c [2]. The encoded message in Figure 2.11 has as such been decoded to “abc”, which is correct and may be checked by scanning Figure 2.11 using a QR code scanner.

Although the decoding of a QR code may seem like an extensive process, the process may be divided in to the following five parts:

1. Aligning the position
2. Finding the mask used on the data section
3. Unmasking the encryption type
4. Unmasking the length of the encoded message
5. Unmasking the message

Although time consuming, decoding information from a QR code by hand is possible and follows the same steps as a QR code scanner.

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" [75]. Allén and Selander defined information as "a certain amount of facts or ideas". While defining the concept of information can be done, there are several ways of presenting information.

2.7.1 Text

Text is one of the oldest forms of presenting information, with written text dating back to 4000 years B.C. [61]. Text is also a simple form of presentation 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 users can read through text at their own pace. Text may be viewed independently of time in contrast to sound and video.

Text does however have the disadvantage of requiring attention. The person reading the text must focus their attention on the text throughout and cannot look away in order to receive all the information being presented. Text is also restricted to the language the text has been written in. Several texts must be written in order to make the text available to people who might not have the native language in the specified country as their first language. For instance, in 2010, 44.7% of the Spanish speaking population in the United States spoke English less than "very well" [3].

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 give the same advantage as text in terms of at what pace the viewer could perceive the information. Images, similar to text, may be viewed independently of time in contrast to sound and video.

In a similar way to text, images require the viewers attention in order to understand the information. The viewer cannot 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 image. On the other hand the information may not be crystal clear and not as clear cut as a describing text might be.

Images may also present information in two different ways. One way is with photographs. Photographs may present abstract and/or concrete information and visualise what might be difficult to describe only using words. Another way of using images is by presenting information using graphs. Graphs are usually more clear cut with regard to information they present. However, graphs may in some cases be an insufficient way of presenting information. Graphs are used to present statistical information and are usually easier than photographs to translate into words. Statistical information, and as such also graphs, can summarise a period in time where as photographs captures a moment.

2.7.3 Audio

Images and text both share the disadvantage of requiring the user’s vision in order for the information to be perceived. Audio solves this problem. While audio does require the user’s attention audio uses a different sense than text and images. With audio as the form of presenting information 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 listening to audio as well.

Audio does however have the disadvantage of having to be understood in real-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 rewound 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 information were to be used on a world-wide basis several audio files would be required (given that the audio contained spoken words) translated into different languages.

2.7.4 Video

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

However, similar to audio, video is presented in real-time. The viewer is bound to the playback speed of the video. Even though a video may be paused or even rewound the viewer does not possess the same amount of control as with images or text. With text and images the reader (or viewer) can deceide the pace 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

Google Glass was announced in 2012 along with the statement “We think technology should work for you—to be there when you need it and get out of your way when you don’t.” [9]. Google wanted to create a device where the user did not have to look down [23] as well as a device where the time between intention and action was minimised [74].

Google Glass (see Figure 2.1 (a) and (b)) is an small HMD that is partially controlled with a touchpad mounted on the right hand side of the frames. The display sits slightly above the user's line of sight, on the right hand side. Google Glass' display is a projection that goes through an optic lense, creating a virtual image which makes the perception of the display to be equivalent of a 25 inch high definition screen seen from a distance of approximately 2.5 meters [45].

Today there are many products similar to Google Glass either already on the market or in development. Microsoft Hololens is an HMD focused on letting the user work in a 3D space (with for instance 3D modelling [49]) by covering both of the user's eyes. Recon Jet, GlassUp and C Wear Interactive Glasses are three products more similar to Google Glass in the sense that they only display information in front of one eye. However, Recon Jet is aimed at athletes, to be used while athletes are working out. GlassUp and C Wear Interactive Glasses are meant to be connected to an external device, such as a smartphone or a PC. Google Glass is a stand-alone device meant to be worn at all times.

The GUI of Google Glass is called a timeline and consists of a row of cards [19]. Cards are basic activities, such as a clock, but may also represent more in-depth applications, such as a game, on Google Glass called "Immersions". The center point of the timeline is the home screen and the first screen the user sees when turning on Google Glass. Cards to the left of the home screen are upcoming events, such as a flight, and cards to the right of the home screen are from the past, such as text messages. The user moves left on the timeline by swiping a finger backwards on the touchpad and in order to move right the user must swipe a finger forwards on the touchpad.

In order to play sounds Google Glass uses a BCT which transfers sound through the bones of the skull [45]. The advantage of this technique is that external sound is not blocked out. In order to capture the environment Google Glass is also equipped with a 5 megapixles camera [45] and a microphone. Using the camera and the microphone the user may give input to Google Glass, for instance when using voice commands in order to control Google Glass hands-free.

The hands-free experience is also what sets Google Glass appart from regular smartphones. Smartphones must be held by the user or put on a table. The user must also look down at the screen of a smartphone, in contrast to Google Glass which puts the display slightly above the user's line of sight. Smartphones does however give the user a bit more control with multi-touch and touchscreen. Another advantage of smartphones is the larger screens. Smartphone screens have been increasing in size ever since the iPhone launched in 2007 [12]. However, as HMDs increase in popularity, there is potential for a wider offering of models and screen sizes.

Smartphones and Google Glass may in many cases be used for similar applications. For instance QR code scanning, since both smartphones and Google Glass are equipped with a camera. The QR code was announced in 1994 by Denso Wave [15]. The goal was to create a new form af barcode that could carry more information than a linear barcode and be easily read. While a conventional bardoce is capable of storing approximately 10 digits a QR code can store several thousand digits [16]. A QR code also uses position fields which make the QR code readable from any direction, compared to a conventional barcode which can only be read horizontally [17]. A QR code can be used to encode information, originally written with alphabetic characters, japanese symbols (Kanji) or numeric characters [14].

Information has been defined as "a large number of examples from texts of different kinds" [75] and may be presented in a number of different ways. The four main ways of presenting information are text, images, sound and video. Text and images both have the advantage of being independent of time. Readers/viewers may perceive the information at their own pace. Images may also be divided into photographs and graphs. The difference of the two lies in the fact that graphs are used to present statistical information. Text and images does however both share the disadvantage of requiring readers/viewers vision.

Audio solves the problem of requiring the user's vision since audio uses a different sense. The listener may as a result multitask in terms of listening to the information being presented through audio while performing other tasks. For instance the listener may be listening to the radio while driving a car. In contrast to text and images audio is not independent of time. Video has the same disadvantage as audio of not being independent of time. Video is, however, unique as video is the only form of presenting information which may combine images and as such show movement. Adding audio to video gives viewers the advantage of choice as they may choose to either watch or only listen.

3 Design

The application designed and implemented in parallel with this report is a proof-of-concept of an application used for assembling components. The application is intended to function as a substitute for instruction manuals, where Google Glass will allow users to scroll through the instructions hands-free. A proof-of-concept of a similar application for smartphones has been designed and implemented at the same time, in order to provide a point of reference as well as help evaluate the pros and cons of using Google Glass.

The application works as seen in Figure 3.1. First the user must use the application to scan a QR code. The QR code is then decoded. The decoded information from the QR code is an ID used to download information regarding the product connected to the QR code the user just scanned. The downloaded information contains product name, as well as necessary components and instructions needed to build the specific product. The product information is then sent to the display.

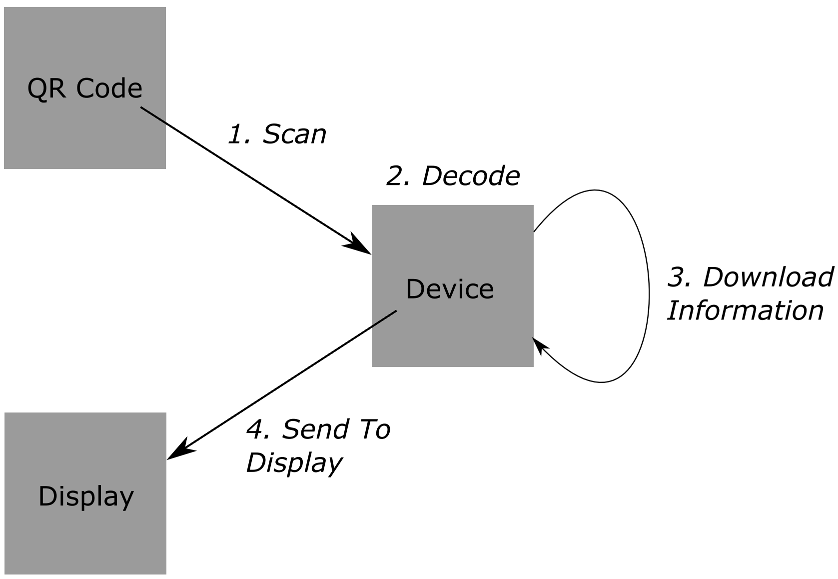


Figure 3.1: A road map to how the application is intended to work.

As seen in Figure 3.2, the application is designed as a slide view, with only one slide being displayed at a time. Instructions are to be divided into several steps, each presented on a separate slide which users may scroll through at their own pace. On Google Glass, users may scroll through the application using voice commands in order to make the application truly hands-free. By applying the slide view design users may focus on one instruction at a time.

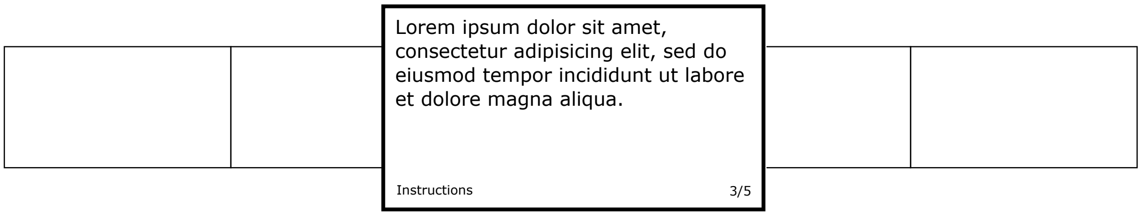


Figure 3.2: A simple sketch of the application's GUI design.

The instructions are the major focus of each slide, with each instruction using most of the slide. At the bottom of each slide additional information may be found, such as a label which, for instance, specifies that the information being presented on the current slide is an instruction (other information may also be presented, such as components required to complete the instructions). The design has been heavily inspired by Google's own guidelines [43] as to how applications for Google Glass should be designed.

3.1 Glassware Flow Designer

Google provides developers with a design tool to help them visualise applications prior to implementation. The design tool, called "Glassware Flow Designer" [41], allows developers to discover recommended design patterns and to draw out the flow of their application prior to implementation.

In Figure 3.3 the Glass Flow Design for the Google Glass application described in this report is shown. When the application launches the user should scan a QR code. After successfully doing so the product name will be displayed, in order to help the user confirm that the correct instructions have been loaded in. This is followed by the slides which show the required components. After the list of components follows the instructions. The slides can be controlled either by swiping on the Google Glass touchpad or via voice commands.

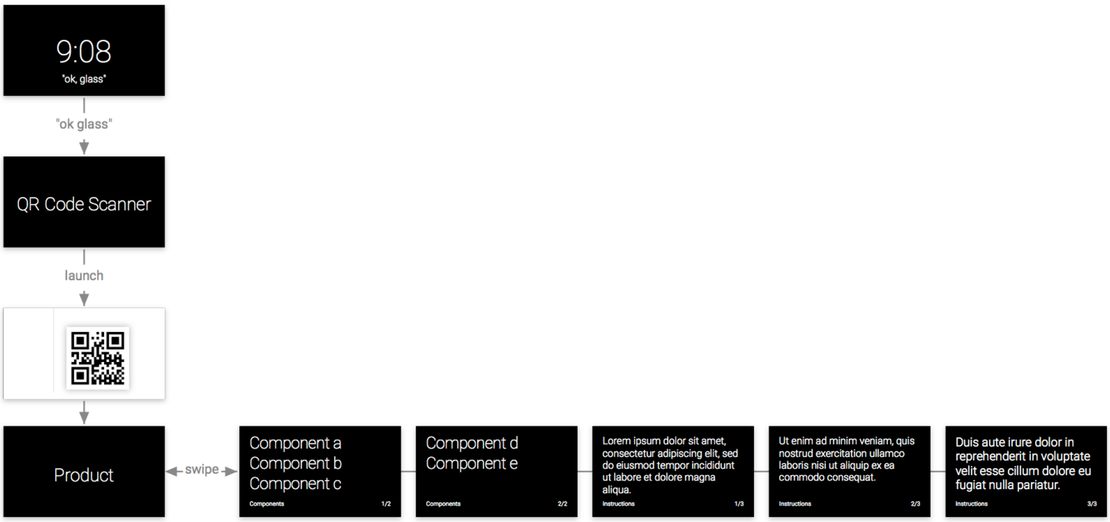


Figure 3.3: Glass Flow Design of the Google Glass application.

3.2 Presenting Information on Google Glass

As part of the design guidelines for Google Glass, Google provides developers with a card layout template, seen in Figure 3.4. The different coloured regions are intended for different types of information. The red area is the main area intended for presenting information in text form with the green squares representing the preferred margins. The thick blue stripe almost at the bottom marks the footer. The footer should hold supplementary information, such as a user name or a timestamp. The blue, slightly transparent, area to the left is mainly intended for images with associated text being presented to the right. The grey area, seemingly appearing behind all the other coloured areas, represent the entire card, with a size of 640 pixels wide and 360 pixels high [40].

Google goes even further in providing developers with guidelines for the design of cards. Google provides developers with a set of fixed card layouts. Specific card layouts set up the necessary margins and leave the developers to input the information to be displayed.

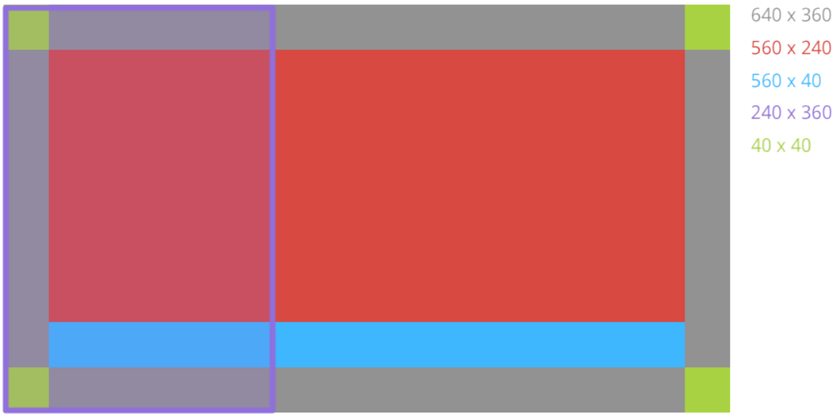
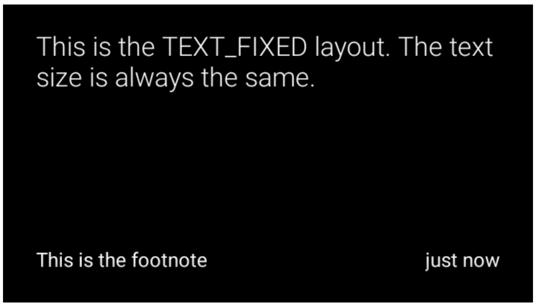


Figure 3.4: Google's design guidelines include a card layout template [40].

Four examples of fixed card layouts can be seen in Figure 3.5.

(a) Text layout.



(b) Fixed text layout.

(c) Columns layout.

(d) Title layout.

Figure 3.5: Four different standard card layouts [39].

In terms of the information displayed, Google's default typeface family is called "Roboto". Google states that Roboto's geometrical forms and open curves makes for a natural reading rhythm [44]. Roboto is the typeface family used on all of Google's standard card layouts, some of which are seen in Figure 3.5. Google uses different typfaces from the Roboto typeface family for different texts [40]. Roboto Light is most common, with Roboto Regular being used for footnote text and Roboto Thin being used for larger texts, such as titles on the title card layout seen in Figure 3.5 (d).

One of the advantages of using Google's default layout is the fact that the text is dynamically resized to fit the card. Dynamically resized text means that the text is only as small as the text needs to be. However, there is a minimum size text may be downsized to. At 32 pixels the text is as small as the text may be and any text that does not fit on the card at that point is truncated.

Due to the limitation on the amount of text that may be presented on screen at the same time Google have provided developers with guidelines on how to present written information on Google Glass [40]. The guidelines for writing are five in total and read as follows:

- **Keep it brief.** Be concise, simple and precise. Look for alternatives to long text such as reading the content aloud, showing images or video, or removing features.

- **Keep it simple.** Pretend you're speaking to someone who's smart and competent, but doesn't know technical jargon and may not speak English very well. Use short words, active verbs, and common nouns.

- **Be friendly.** Use contractions. Talk directly to the reader using second person ("you"). If your text doesn't read the way you'd say it in casual conversation, it's probably not the way you should write it.

- **Put the most important thing first.** The first two words (around 11 characters, including spaces) should include at least a taste of the most important information in the string. If they don't, start over. Describe only what's necessary, and no more. Don't try to explain subtle differences. They will be lost on most users.

- **Avoid repetition.** If a significant term gets repeated within a screen or block of text, find a way to use it just once.

Another part of Google Glass applications where Google have provided guidelines is voice commands [47]. However, voice commands might be the most restrictive area of all in terms of what Google recommend developers to do. Any voice command not officially approved by Google is not allowed in an application if the application is to be released on MyGlass. MyGlass is the official store from which users may buy their Google Glass applications. However, MyGlass is not installed on Google Glass but rather on, for instance, a smartphone [30].

Only by using the approved main voice commands [48] will applications be approved and allowed on MyGlass. These approved main voice commands does not, however, include for instance “next slide”. Unapproved voice commands may be used during development and for separate releases. Developers may also use the built-in speech recognition. However, using speech recognition would mean not being able to launch the voice recognition simply saying “ok glass”, which is the case with approved and unapproved voice commands.

In terms of getting a voice command approved, Google have set up a checklist for developers to cross off as they design their voice commands [46]. The checklist includes not designing a voice command which is similar to an already existing voice command. The voice command should also be long enough to ensure high recognition quality, yet short enough to fit on a single line on the Google Glass display.

3.3 Presenting Information on Smartphones

Despite being two different devices, the smartphone and Google Glass, Google’s design recommendations for smartphones share similarities. For instance, similar to Google’s design guidelines for Google Glass Google recommend developers to keep information brief. Google recommend developers to use short phrases with simple words [37].

However, in contrast to Google's design guidelines for Google Glass, Google does give developers freedom to make their own decisions. "Deviate with purpose", as Google states. Google recommend developers to develop applications which are easy and fun to use.

One design guideline for applications on smartphones provided by Google is to highlight what is most important in the application. For instance, in a camera application the shutter button is the most important button. As such the shutter button should be the most prominent component in the application and easy to find, similar to Figure 3.6, making the application easy to use in terms of the core feature.

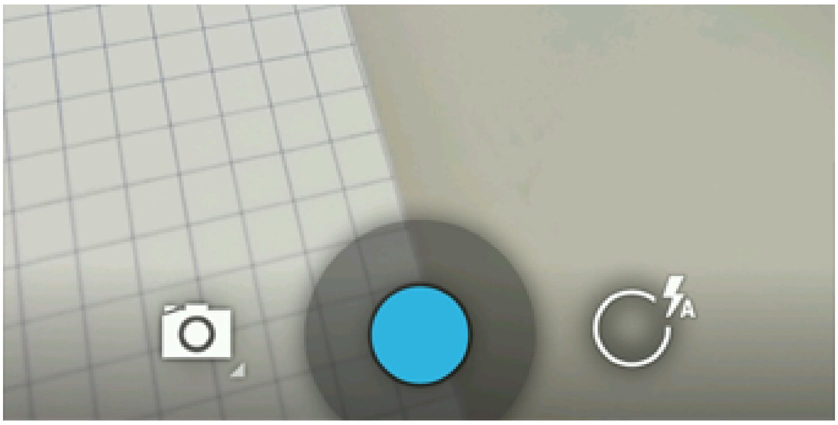


Figure 3.6: The most important component should be the most prominent [37].

In terms of clear cut differences between designing applications for smartphones compared to designing applications for Google Glass the most important one is perhaps where the user touches on the device. The Google Glass touchpad is mounted on the right hand side of the user, while the display sits in front of the user. On a smartphone the display and the touch-area is the same area. As such, buttons and other similar, intuitive, touch-objects are well suited for applications on smartphones. On Google Glass the user does not have any pointer on the screen, meaning that, for instance, menus can not be dependent on the user selecting an option by touching the option on the screen.

The use of voice command on Google Glass does help menus on Google Glass seem more similar to those on a smartphone since the users may select an option with their voice.

However, the use of buttons and icons is less practical. On the other hand, since Google Glass may be controlled by voice command, developers might also hide functionality and decide not to show buttons and icons on the screen since the user does not need a target to touch in order to interact with the application.

An example of where Google Glass might hide functionality is in a camera application. In Figure 3.6 part of a camera application for smartphones is shown, with three buttons on screen. An application for Google Glass would not need to display any buttons since the users need only to say what they want to do. If, however, the Google Glass user did not use the voice command functionality, a simple touch of the Google Glass touchpad might for instance bring up a menu, displaying possible options, similar to how saying “ok glass” would bring up the voice menu.

All the above guidelines and restrictions have been taken in to consideration when designing the application for smartphone as well as Google Glass. While the application does have the same functionality, the most noticable difference between the two applications is that the smartphone application have buttons, enabling the user to jump forward, past slides to reach, for instance, the instructions, where as in the Google Glass application such features have been limited to voice commands.

3.4 Test Cases

The following aspects of the application are to be tested in order to help determine wether Google Glass is a viable option to use as replacement for an instruction manual when assembling components. Each test will be performed 30 times, for statistical significance [53].

3.4.1 Text Length

Since the Google Glass display is small and limited in space the amount of text that may by displayed on screen is as a result also limited. As such one interesting test case is to see where the text limit lies. The test consists of trying to find the the text length limit, on both the Google Glass display as well as a smartphone display. The text used should consist of characters distributed in similar fashion to English text [1].

When the smartphone display has been filled with information, how many slides does the same amount of information require on Google Glass? If the number of slides that the Google Glass application must use in order to display all the information is significantly larger than that of the smartphone application, the use of a Google Glass application might not be preferred as the user must use the slide more often than when using a smartphone equivalent application.

3.4.2 Distance to the QR Code

Generally, the recommendation regarding at what distance the user should be positioned in relation to the QR code is the size of the QR code times ten [4]. However, different devices will have different delay time before registering the QR code in frame. As such, one test regards the time from start of the camera until Google Glass has registered the QR code. The time is to be compared with that of smartphones.

As seen in Table 4.1 three different distances will be tested. The size of the QR code will be optimised according to the formula stated above, with the scanning distance set at two decimeters. The reason for testing for other scanning distances, yet with the same QR code size is because most users might not be aware of the optimal scanning distance, as well as to determine wether Google Glass has any advantages when scanning either closer or further away from the QR code.

The size of the QR code is calculated as

$$\frac{2}{10} = 0.2 \ decimeters$$

.

Table 3.1: Average time of registering a QR code with varying distances.

Distance (dm)	**Google Glass (ms)**	**Samsung Galaxy SII (ms)**	**Samsung Galaxy SIII (ms)**
1.0			
2.0			
3.0			

3.4.3 Complexity of the QR Code

Depending on the number of characters encoded by the QR code, the density of the QR code changes. The density of the QR code increases as the number of characters encoded by the QR code increases, where the number of black and white squares increase. As such one interesting test case is where the variable is the density of the QR code, or more specific; the number of characters encoded in the QR code.

The number of characters will vary between 1, 50 and 100. The values were chosen in order to give the results big enough room so that potential difference can be determined while still keeping the number of characters to a realistic minimum. Table 4.2 shows how the results will be presented, where the results will be the average of 30 test runs.

Table 3.2: Average time of registering a QR code with varying density.

Encoded Characters	**Google Glass (ms)**	**Samsung Galaxy SII (ms)**	**Samsung Galaxy SIII (ms)**
1			
50			
100			

3.4.4 Display Time

The speed at which Google Glass registers the QR code is important to wether the device is to prefer over regular smartphones. However, another interesting aspect is how fast downloaded information may be displayed on screen, from the point that the information has been downloaded. As seen in Table 4.3 the test will evaluate three different information sizes, meant to represent three different ways of presenting information. 100 kB represent text, 1 MB represent an image and 10 MB represent video.

Table 3.3: Average display time for Google Glass with varying information size.

Information Size (Byte)	**Google Glass (ms)**	**Samsung Galaxy SII (ms)**	**Samsung Galaxy SIII (ms)**
100 k			
1 M			
10 M			

3.5 Test Units

- Google Glass
- Samsung Galaxy SII
- Samsung Galaxy SIII

The reason for using these three units was the fact that the testing required physical devices. Since the testing included scanning a QR code from a various distances physical devices were necessary. What led to the two specific smartphone models (Samsung Galaxy SII and Samsung Galaxy SIII) were partially due to availability during testing. However, another reason was the fact that both models were among the most widely distributed during the time of Google Glass' release. Samsung Galaxy SII was released in 2011 and Samsung Galaxy SIII in 2012, with Google Glass being released in 2013. Samsung Galaxy SII and Samsung Galaxy SIII have in total been sold in 100 million units to date [21, 27].

Another reason for not using more modern smartphones is due to the Google Glass version used. The Google Glass unit used was the so called Explorer Edition 1". Google

Glass Explorer Edition 1 was released in February, 2013 [33]. An updated version, "Explorer Edition 2", was released in the summer of 2014 [31].

A few updates were done to Google Glass with the new version, most noticeably a doubling of available RAM. Google Glass Explorer Edition 1 has only 1 GB RAM [20] where Google Glass Explorer Edition 2 has 2 GB RAM [31]. Samsung Galaxy SII and Samsung Galaxy SIII both have 1 GB RAM as well [68, 69]. As such using more modern smartphones in testing could be seen as unfair for Google Glass since Google Glass also exists in a more modern version.

Additional technical specifications regarding the test units can be found in Table 3.4.

Table 3.4: Technical specifications of the three test units.

Component	**Google Glass [62]**	**Samsung Galaxy SII [68]**	**Samsung Galaxy SIII [69]**
RAM	1 GB [20]	1 GB	1 GB
CPU	OMAP 4430 dual core [73]	1.2 GHz dual core ARM Cortex A9	1.4 GHz quad core Cortex A9
Screen Size	Equivalent of a 25 inch screen from 2.5 meters [45]	4.3 inches	4.8 inches
Screen Resolution	640 * 360 pixles	480*800 pixles	720*1280 pixles

3.6 Summary

o Design - Present your project design in general

o Information - Give details here (possibly several sub-sections)

4 Implementation

4.1 Android Studio

Both the smartphone application as well as the Google Glass application was developed in Android Studio [38]. Android Studio is a development environment developed by Google.

4.2 ZXing

The application was built upon the open-source barcode image processing library, Zebra Crossing (ZXing) [71].

4.2.1 BarcodeEye

The Google Glass application was built upon the Google Glass port of the ZXing library, known as BarcodeEye [25].

4.3 View Slider

4.4 AsyncTask

4.5 Text Split

4.6 Card Layout

4.7 Test Cases

4.7.1 Text Length

```
private double randfrom(double min, double max)
{
   Random rand = new Random();
```

```
    double range = (max - min);
    return min + range * rand.nextDouble();
}

private String getChar(int pos, double rand)
{
    if(rand <= doubleList.get(pos) || pos+1 <= alph.size())
        return alph.get(pos);

    return getChar(pos+1, rand);
}

public String randchar()
{
    double rand = randfrom(0, 1);
    return getChar(0, rand);
}
```

4.7.2 Distance to the QR Code

Table 4.1: Average time of registering a QR code with varying distance.

Distance (dm)	Google Glass	Samsung Galaxy SII	Samsung Galaxy SIII
1			
2			
3			

4.7.3 Complexity of the QR Code

Table 4.2: Average time of registering a QR code with varying density.

Encoded Characters	**Google Glass**	**Samsung Galaxy SII**	**Samsung Galaxy SIII**
1			
50			
100			

4.7.4 Display Time

Table 4.3: Average display time for Google Glass with varying information size.

Information Size (Byte)	**Google Glass (ms)**	**Samsung Galaxy SII (ms)**	**Samsung Galaxy SIII (ms)**
100 k			
1 M			
10 M			

4.8 Summary

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

5 Results

6 Conclusion

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

6.1 Future Work

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A Abbreviations

2D Two-Dimensional

3D Three-Dimensional

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

ZXing Zebra Crossing

B Results

Table B.1: Google Glass

	1 meter	1.5 meters	2 meters
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
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17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Table B.2: Google Glass

	1 meter	**1.5 meters**	**2 meters**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Table B.3: Google Glass

	1 Encoded Character	**10 Encoded Characters**	**100 Encoded Characters**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Table B.4: Google Glass

	1 Encoded Character	**10 Encoded Characters**	**100 Encoded Characters**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
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28			
29			
30			

C Code

D Project Specification (In Swedish)

Uppdragsbeskrivning

Google Glass

Version 1.0

Mats Persson

Distributionslista

Befattning	Bolag/enhet	Namn	Åtgärd	Info.
Student	KaU	Richard Hoorn		
Student	KaU	Johan Häger		
Konsult/handledare	Sogeti	Mats Persson		
Konsultchef	Sogeti	Åsa Maspers		
Säljare	Sogeti	Bengt Löwenhamn		

Innehållsförteckning

Ändringsförteckning

Version	Datum	Ändring
1.0	2014-10-15	Dokumentet skapats

1. Allmän beskrivning av uppdraget

1.1 Bakgrund

Sogeti Sverige AB (Sogeti) är ett IT-konsultbolag med bred verksamhet, stort fokus på kompetens och modern teknik.

Sogeti jobbar mycket med applikationer inom mobilitet och en av de nyaste teknikerna här är Google Glass.

Google Glass introducerar ett helt nytt sätt att tänka på angående hur man interagerar med applikationer och helt nya användningsområden för mobila applikationer.

2. Google Glass

Syftet med detta uppdrag är att tillverka en Proof of Concept på en applikation till Google Glass, applikationen ska kunna hämta/spara data från en web service. Applikationen ska hjälpa användare i en produktion genom att bidra med vilka delar som behövs för att kunna montera något och även en enklare instruktion över hur det ska se ut när det är klart.

Ett annat viktigt syfte med detta uppdrag är att ta reda på hur Google Glass är ur ett användarperspektiv, är det behagligt att använda en hel dag? Osv.
Även prestandamässigt är det intressant för att veta om Google Glass är nog stabila för att kunna rekommenderas till kunder på företag inom tillverkningsindustrin.
Och slutligen så är bra/dåliga sidor med denna nya teknik intressant. Finns det begräsningar? T.ex. hur länge räcker batteri m.m.

I uppdraget ingår en back-end och en front-end och nedan ser vi lite exempel på saker man kan fokusera på inom de olika delarna.

I back-end finns följande att fokusera på:

- Prestanda, hur kan man optimera en back-end som pratar med liknande appar för att skicka så lite data som möjligt så snabbt som möjligt?
- Eftersom vi jobbar med Microsofts plattform så är det intressant att veta om man ser tydliga plus/minus med att hosta tjänsten i Azure iställer för att man t.ex. hostar den själv på sitt egna nätverk.

Vi ser helst att back-end utvecklas med WebAPI eller WCF då Sogeti har stort fokus på Microsofts plattform.

I front-end som ska köras på Google glass ser vi följande man kan fokusera på:

- Användarvänlighet. Som när touchenheter kom så är detta också ett nytt unikt sätt att interagera på, hur görs detta på bästa sätt? Vad skiljer sig från applikationer till telefoner?
- Multitasking, hur mycket kan göra samtidigt och hur hanteras detta?
- Prestanda

2.1 Case

Följande case ska uppdragstagarna utgå ifrån.

Ett företag har en produktionslinje med ett antal stationer där man monterar ihop saker vid varje station. Delarna man använder för monteringen har en kod på sig som man kan scanna av. Problemet företaget har är att det är många variationer av saker som monteras på varje station och arbetarna byter ofta platser så de har svårt att hålla reda på vad som behövs för att montera och hur det ska monteras.

2.2 . Optioner

Följande är förslag på vidareutveckling av detta som uppdragstagarna själv får plocka från om tid finns.

2.2.1 Option 1 – Jämföra Google Glass med andra liknande produkter

Jämföra Google Glass med en annan liknande produkt genom att välja en mindre del av applikationen som man implementerar. Ett förslag på annan produkt är företaget Pennys motsvarighet till Google Glass.

2.2.2 Option 2 – Bildigenkänning

För att slippa att ha koder på varje produkt så skulle det vara bra om applikationen kan känna igen produkterna genom att man bara tittar på produkterna, detta dels för att se vilka möjligheter det finns för bildigenkänning på Google Glass och för att ta reda på vad som redan finns färdigt inom detta område och vad som krävs av företaget för att få bildigenkänning att fungera.

2.2.3 Option 3 – Känna av position

För att underlätta för arbetarna så skulle det vara bra om applikationen kunde känna igen vart i produktionslinjen man sitter och jobbar och då filtrera listan av produkter man har att välja mellan så det blir lättare att hitta produkter.

2.2.4 Option 4 - Röststyrning

Kunna styra applikationen med rösten och ta reda på vad det finns för begränsningar för detta. T.ex. hur tyst måste det vara runt användaren för att det ska fungera?

3. Genomförande/arbetssätt

3.1 Rutiner

Sogeti tillhandahåller arbetsplatser, datorer, hårdvara samt erforderliga utvecklingsverktyg.
Uppdragstagarna kommer att ha access till Sogetis nätverk och förväntas nyttja vår TFS-server för versionshantering.

3.2 Genomförande

Uppdragstagarna planerar själv genomförandet och Sogeti tillhandahåller stöttning både projektstyrningsmässigt och rent implementationstekniskt. Sogeti tillhandahåller all programvara och hårdvara som behövs.

Förslagsvis används SCRUM med en sprintlängd på 2-3 veckor som sätts upp där uppdragstagarna specificerar vad de tror att de hinner med i början av varje sprint och har en demo för en eller flera på Sogeti i slutet på varje sprint.

4. Stöd/kvalitetssäkring

4.1 Granskningar

Vid behov genomförs granskning som kan initieras av både handledare och uppdragstagare.

Lämpligen definieras några granskningspunkter vid planeringen av projektet.

4.2 Testarbete

Funktions-, system- och integrationstest görs av uppdragstagarna.

5. Leveranser

5.1 Dokumentation

Systemdokumentation görs av uppdragstagarna. Dokumenten lagras i projektarkiv hos Sogeti.

Lämpligen levereras en enkel användarinstruktion.

6. Konfigurationsstyrning

All programkod och tillhörande specifikationer och andra utvecklingsdokument ska versionshanteras med hjälp av Microsoft TFS.

7. Miljö

Utvecklingsverktyg väljs av uppdragstagarna tillsammans med handledare. Hårdvara som behövs för projektet tillhandahålls av Sogeti.

8. Uppföljning och Rapportering

8.1 Rapportering internt/externt

8.1.1 Statusrapportering

Rapportering av status och framskridande i utvecklingen beslutas i samråd vid projektuppstart.

8.1.2 Möten

Möten hålls vid behov. Vid uppstart läggs lämpligt antal avstämningsmöten in i projektplanen.

8.1.3 Slutrapportering

Arbetet presenteras för Sogeti i samband med lämpligt månadsmöte alternativt lunchmöte.