Mixed Reality, hype or major innovation?

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Sammandrag:

Augmented Reality (AR), även känt som Mixed Reality (MR) är nya datorplattformar som ger användaren möjligheten att frigöra sej från traditionella 2D skärmar, till 3D upplevelser av digitalt innehåll som passar användarens omgivning och position.

Till skillnad från Virtual Reality (VR) där användarens sinnen är totalt nedsänkta i en ersatt verklighet, är Augmented Reality digitala överlägg i användarens omgivning.

De instrument vilka är avgörande för 3D-datorer har testats på marknaden i.o.m huvudmonterade Virtual Reality maskiner, och kan nu produceras i stor skala. Denna avhandling behandlar Augmented Reality marknaden och förklarar hur teknologin fungerar och hur produkterna ser ut idag.

Mitt motiv är att med dessa instrument designa och utveckla ett par trendiga meta-reality glasögon som man parar ihop med en mobiltelefon. Denna apparat använder sej av ett antal sensorer för att registrera kroppspråk och handsignaler med ett syfte att lämna händerna fria att ströva runt i den riktiga världen samt manipulera de digitala överläggen.

VD:n för Apple, Tim Cook säger att Mixed Reality apparater är framtidens maskiner och möjligtvis parar ihop sej med eller ersätter I-Phone produkten inom när framtid.

Många stora teknologiföretag, Samsung, Microsoft, Sony, Facebook, Snapchat, Google har börjat utveckla sina egna flaggskepp MR-produkter som vi senare kommer att fördjupa oss i denna avhandling.

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Abstract:

Instruments for 3D computing have been market tested and manufactured at scale only recently. This thesis will cover the Augmented Reality market and explain how the technology work and looks like.

The motive is to with these instruments design and develop a fashionable set of meta-reality glasses that pairs with a mobile phone (computational device).

This device will use tracking sensors to receive gesture commands from the user to the computer, which leaves the user completely free to interact with the surrounding world.

Augmented Reality is when graphic overlays of various information is displayed into the field of view of a user. The display system is either a contact or eyewear lens which is completely transparent and does not block the vision.

The displayed content will have several sources. Some are location based and other device signals, networks or moving objects.

Virtual and real world moving objects need to correlate to the users heads position and line of sight.

My research suggests that most of big technology companies are switching focus on to development of Mixed Reality systems and instruments. Some sources say that this industry will outgrow the mobile phone market with over 300% within the next 10 years.

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Tiivistelmä:

Mixed Reality on yleistermi joka käsittää virtuaali- (VR) ja lisättyä todellisuutta (AR) teknologian kannalta. Lisätty todellisuus on kun eri graafiset peittokuvat ja tiedot jäävät näkyväksi käyttäjän näkökenttään. Näyttö on joko kontakti- tai silmälasien linssi joka ei estä käyttäjän näköpiiriä.

VR on aistien uppoutuminen kokonaiseen virtuaalitodellisuuteen jolloin käyttäjä on eristynyt oikeasta maailmasta eikä ole tietoinen mitä ympärillä tapahtuu.

Välineet jotka tarvitaan AR:än mahdollistamiseksi ovat markkinoilla testattu ja valmistettu mittakaavassa vasta äskettäin. Tämä opinnäytetyö käsittelee lisättyä todellisuutta teknologian ja markkinoiden näkökulmasta.

Motiivina on kehittää ja suunnitella muodikkaat meta-reality lasit jotka toimivat matkapuhelimen kanssa. Kyseinen laite käyttää antureita joka lukee käyttäjän liikkeitä ja tulkitsee nämä käyttöliittymäksi joka jättää käyttäjän vapaaksi olla vuorovaikutuksessa ympäröivän maailman kanssa.

Tutkimukseni osoittaa että useimmat suuret teknologiayritykset keskittyvät kehittämään omia MR-järjestelmiä ja että tämä teknologia on kehittymässä huimaa vauhtia. Applen toimitusjohtajan, Tim Cookin mukaan AR:ästä voi tulla niin iso trendi että AR-lasit saattavat jopa korvata älypuhelimen kymmenen vuoden sisäällä.

Avainsanat:	Xaas, AR/VR/MR, HCI, Teollinen internet, Yrittäjyys
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1 INTRODUCTION

In this thesis I am concerned with exploring the up and coming technologies of Augmented Reality (AR) and Virtual Reality (VR). A common term of both these two emerging technologies is Mixed Reality, in short MR.

Figure 1. Google Glass Augmented Reality from 2013. Content is controlled by touch on the glass frame. A basic demonstration of projection technology. Field of view approximately 25 degrees.

I will look at how likely these technologies are becoming mainstream consumer appliances in the next few years. I will look at the technology itself, possible uses and its current drawbacks.

I did this study to figure out whether there is only a hype around Mixed Reality or are we in front of a computer revolution, transcending from 2D screens to 3D environments overlaid with digital information?

According to the CEO of Apple, Tim Cook, Augmented Reality might outgrow today's mobile industry market in a decade, so for one aiming to become a professional within the area of digital media should not ignore this up-and-coming technology. Cook went as far as even saying traditional I-phones might become obsolete and the product might take shape of a set of glasses in 2020 and beyond.

For the unfamiliar reader with the concept of Mixed Reality, I recommend watching a 5 minute TED video by the inventor of Microsoft Hololens, Alex Kipman.

Figure 2. A TED Talk held by Microsoft Hololens creator Alex Kipman. A futuristic vision of holograms, February 2016.

Kipman demonstrates a holographic-call and various uses of Mixed Reality technology. Kipman goes on to showcase a Mixed Reality environment on stage and how to interact with these environments and objects.

He then explained the "mind of the machine" how Mixed Reality devices sense and perceive their environments. The machines need to be contextually aware in order to display various responsive digital medias in a changing real-world environment. To do so the machines need to be equipped with various sensors and access to several sources of wireless networks.

I will draw references to how the machine perceive its surrounding and how humans interact (user interface) with Mixed Reality machines in chapters 5.1 to 6.2.

1.1 Area of research

In recent years the computer industry has experienced exponential increase in processing power which gives consumers smaller yet more powerful devices. Mobile phones compete with traditional computers in efficiency and the whole industry is in a constant state of innovation.

MR devices are a new form of computer platforms, allowing users to not stare at a flat 2D surface from a device in your hand, rather wear the display and experience 3D digital imagery over the real world regardless where the user is located.

This brings up loads of service opportunities and might pave way for a temporal shift in how work and education will look like in the next few years. This constant cycle of innovation has the potential to challenge the status quo of any business according to founder and chairman of Alibaba group, Jack Ma.

At the CeBIT summit in Hannover, June 2016, Ma stated that the world is becoming more data driven, and service providers are becoming dependent on personal data directly from the users. Ma pointed out that traditional B2B and B2C business models are a thing of the past, and data driven customer to business models are the future.

Today big data can be Terabytes of information that is hard to filter and sort out which piece of data means what. All digital footprints tell something about user behaviour and this information is important while compiling your digital profile. This user behaviour data, is valuable.

Together with tracking sensors and facial recognition, which are commonplace in the field of MR, allow service providers to get very detailed information about not only the users behaviour, but also physical attributes and a whole periphery regarding who the user is, as a person and what she likes.

A lot of money has been invested into pioneering companies driving this revolution of 3D computing forward and it seems only sensible to look at how likely this technology is going to become part of our daily lives and in what form it comes.

1.2 Research question

Are we on the brink of a computer revolution, ascending from a limited two-dimensional screen to interactive 3D environments and how likely are these technologies becoming mainstream consumer appliances in the next few years?

1.3 Limitations

The interest in MR has spread across a wide range of product developments.

Some of these seem to have limited possibilities for becoming mainstream yet – I shall therefore not be talking about contact lenses capable of data visualization since they are not consumer ready just yet.

Although their work carries important weight for the industry I have also excluded smart-glasses, or wearable display systems with external processing units (EPU) such as the Google Glass or Atheer glass.

Smartphone companies has begun to develop accessories to their phones enabling them to be used as MR capable devices. Examples of these accessories are Google Cardboard and Samsung Gear. These two products are just a mount for the head where the user can insert the phone and experience Virtual Reality through applications from the app stores. The reason for me to exclude these is the fact that after experiencing the apps content, the user need to dismantle the phone from the HMD and change the content.

They are not one whole product, the HMD acts as a mere holster and was launched more as developer tool, not a wearable MR enabled computer.

I have decided to exclude these from my research because I wish concentrate on the emerging market of standalone independent devices. Which may still develop their own form-factors.

For this thesis I am defining a MR as a hybrid of both AR and VR. It doesn’t focus on the exact technology in the system, but summarizes the above into one.

1.4 Definitions

API - a set of functions and procedures that allow the creation of applications which access the features or data of an operating system, application, or other service.

AR - Augmented Reality. A see-through lens that displays interactive media into the surrounding environment based on sensor data.

CLOUD COMPUTING - By having users download an app, the user can use all downloaded devices combined processing power to run the application.

CLOUD INFRASTRUCTURE - a type of Internet-based computing that provides shared computer processing resources and data to computers and other devices on demand. Applications and user data is not device specific but travelling with the user.

CLOUD SERVICES - means services made available to users on demand via the Internet from a cloud computing provider's servers as opposed to being provided from a company's own on-premises servers.

FIRMWARE - a type of software that is implemented into the device under manufacturing and can be updated remotely later. If you buy a product, it might come with more features when the firmware is installed.

HMD - Head mounted display

HCI - Human computer interaction

IMSI CATCHER - metadata access remote.

MACRO - Ability to control the big picture, long term overview and plan for achieving the task with tactics.

MICRO - Ability to control with precision, speed and simultaneously many things at the same time.

MR - Mixed or Meta Reality. A hybrid of both AR and VR, doesn't focus on the exact technology in the system, but summarizes the above into one.

PHYSICAL WEB - is a discovery service powered by blue-tooth low energy beacons. Smart objects broadcast relevant URLs that any nearby device can receive, common as push notifications.

PLUG-IN - a software component that adds a specific feature to an existing computer program. When a program supports plug-ins, it enables customization.

SLAM - Indoor navigation and positioning system. Finnish example company Visumo dealing with materials scattered in visual environments.

SAAS - service as software

UI - User interface. How the user use and navigate and control actions within the system.

UX - User experience. Experiences within the system. In this thesis I will use the term to describe navigational feedbacks and signals such as system feedbacks (haptics or visual indicators such as content vibrating or moving in response to gesture signals). Indicators that tells the user that a command is understood or under process. UI and UX are design guidelines how the user communicates with the system, common also under a combined name: UIX.

VR - Virtual reality. VR-headsets block the users field of view (FOV).

WEB-APP - In computing, a web application or web app is a client–server software application in which the client (or user interface) runs in a web browser.

XAAS - Anything-as-a-service refers to the growing diversity of services available over the Internet via cloud computing as opposed to being provided locally, or on premises.

2 METHODOLOGY

My methodology spans numbers of techniques. I under-talk empirical research in the opening parts of the project, I then conducted several interviews at events and private meetings during a period of a year and a half.

I followed this up with online and desk research and joined professional social media groups such as Slack and Facebook, in order to get the latest news and opinions from professionals working within this field.

2.1 Empirical research

I have tested most VR HMDs myself, and had the chance to even try AR enabling technologies such as Microsoft Hololens and Google Glass. I have been active at the Finnish VR association (FIVR) connecting with field experts and content developers.

Practical experiences were conducted during Ultrahack and Junction hackathons in 2016, and Arcada AR/VR theme-day beginning of 2017.

The company representatives named in this thesis were interviewed during my internship period as a technology journalist at ArcticStartup from February to May 2016.

2.2 Qualitative research

I have conducted a qualitative research from interviewing experts in the field, as well as tested hands-on most of the products mentioned in this thesis.

Most significant insights from interviewees by:

CEO of Etsimo, Thomas Grandell

CEO of Arilyn, Emmi Jouslehto

Hubmaster at FIVR, Tuomas Karmakallio

CEO of Solu Computers, Kristoffer Lawson

CEO of Dispelix, Antti Sunnari

Aalto University and VTT, Professor Charles Woodward

More about people interviewed and related devices can be found in the Appendix of this thesis.

2.3 Quantitative research

Statements and data has been gathered from developers, entrepreneurs and big profiles within the business.

Cases were mapped by conducting interviews from entrepreneurs in the field and by independently actively looking in to cases and benchmarking them.

I have conducted many short interviews in a standardized format to gain comparative data across a spectrum of time.

2.4 Desk research

Follow-up on experts reports through social media channels and live seminars dating from September 2014 up until March 2017.

Most significant subscribed people for this thesis:

Founder of Magic Leap, Ronny Abdowitz

CEO of Apple, Tim Cook

Founder of Haptic.al, Deniz Erguel

Creator of Metavision, Meron Gribenz

Creator of Hololens, Alex Kipman

Tech evangelist, Robert Scoble

During a time of 18 months, the most significant sources of technical business, economic and technical journeys has been:

Business Insider

Facebook groups for developers and FIVR Slack channel

Futurism

IEEE

Virtual Reality

Wired

Unity

I also searched for and read academic papers covering various outlines in order to understand current trends and predictions for future activity in the area covered in this thesis.

3 BACKGROUND STUDY

The term "augmented reality," or AR is an incredibly practical technology, in it’s essence it integrates digital information with the user's real environment in real-time. Virtual reality on the other hand creates an entirely artificial environment blocking off all other stimuli.

Companies with flagship products include Facebook with their Oculus Rift, HTC with Vive, Samsung Gear, Microsoft Hololens and Sony PSVR who all released their HMDs (Head Mounted Displays) in 2016.

There are several companies listed to launch their MR product in 2017 including Apple, Magic Leap, Google, AMD, Avegant and more.

One of the very first AR applications in the app stores was Pokemon Go which reached huge popularity with over 500 Million downloads.

Snapchat is another success story with their "selfie-filter" that distorts the image and overlay graphics onto the image or camera feed. Also a display of Augmented Reality technology.

Today Snapchat is valued at 25 Billion USD, one of the most successful software companies to date.

Both Snapchat and Pokemon Go are quite simple demonstrations of Augmented Reality technology where the user looks through the phones camera for digital overlays in the surroundings.

Future applications of AR could be name icons floating over people's head on the street, like a business card with contact information. Tim Cook, CEO of Apple believes that in a not so distant future people will talk with holographic people in the same fashion as people talk over mobile phone today.

Perhaps the overlaid graphics will communicate with restaurants about food allergies or help a user navigate in cities better with time-tables and routes directly in the field of view. Imagination is the limit for this up and coming technology.

3.1 Historical overview

Virtual Reality has its humble beginnings in the early 1960s with Morton Heilings 'Sensorama' – a projection booth with a 3D display, stereo sound and a vibrating seat.

A few years later in 1965 Ivan Sutherland created the 'Sword of Damocles' which many considered the first Mixed Reality enabled headset. It had a head tracking system suspended from the ceiling to match movement with the stereoscopic screens.

Virtual Reality headsets aimed for gaming were introduced on the market in the early 1990's by the Virtuality Group. This VR machine sold to video game arcades and was equipped with joysticks and a big visor connected by bulky wiring to an arcade computer. This product found success only temporarily in arcades and theaters. The hygiene of the Head Mounted Displays became an issue. A turn-off for mass appeal.

The year after that in 1991, Sega VR was announced but it never made it to any store due to the consumers seemingly unimpressed reaction to the Virtuality Groups product.

The Sega VR console appeared only as a competitor in Arcades and was laid off from production.

The Atari Jaguar VR in 1993, and Nintendo Virtual Boy in 1995, suffered a similar fate. Both taken out of production due to low sales.

Forte Technologies Inc created a simple VR helmet in 1995, called the ‘VFX-1’ which came with a handheld controller and performed flight and driving simulations.

In 1999 another flight-simulation headset was released, the SEOS 120/40 HMD. Noteworthy about this HMD was that it’s Field of View (FOV) matched the FOV of the human at 120 degrees. This is a feature companies 20 years later such as the Oculus Rift, HTC Vive or Microsoft Hololens struggled to compete with.

Oculus Rift first prototype was created by Palmer Luckey in 2011 and ‘Oculus VR’ Kickstarter campaign launched in 2012 and raised 2.5 million dollars. Two years later Facebook acquired Oculus Rift for 2 billion dollars.

Google cardboard, a low-cost VR viewer was announced in 2014. The Cardboard built up expectations and put VR on the lips of people again.

After a 25 year journey Virtual Reality had come from bulky arcade machines accessible to everyone anywhere - the mobile phone.

Today AR/VR content is accessible from an app store and graphics rendering can be done on a cloud server which allow smaller products designs.

Mixed Reality is already accessible for anyone, but as with the hygiene issue for the 1991’s Virtuality HMD, to today, the issue is a conveniently usable product design.

3.2 Current situation

A milestone for Mixed Reality was at the Facebook Keynote October 2016 when Mark Zuckenberg and the Oculus Rift team introduced new features for the Oculus Rift VR system. This event gave the public a glimpse of the envisioned future for VR and MR.

In this presentation Mark demoed the Oculus Rifts compatibility with other devices such as wearables and 360 cameras.

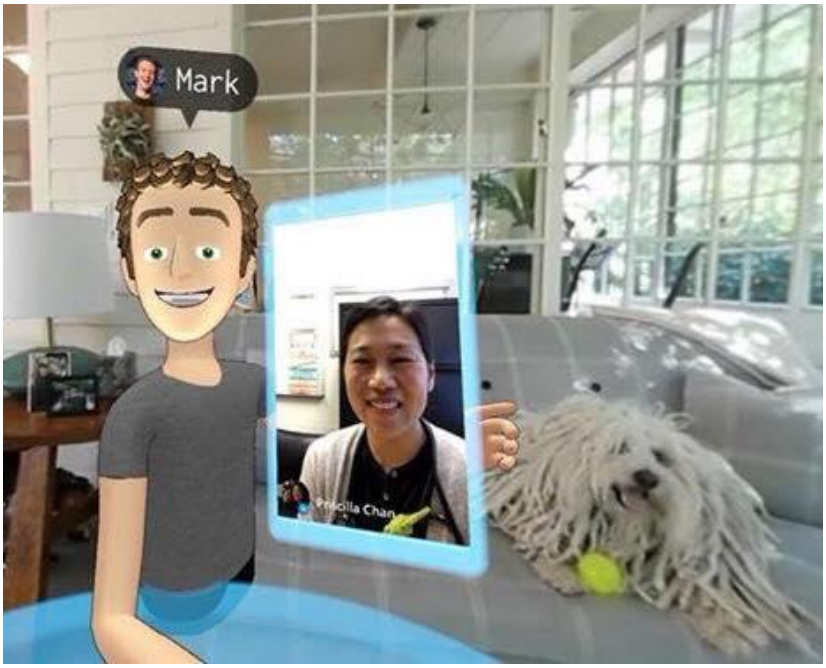

Figure 3. Picture taken from Mark Zuckenbergs (CEO of Facebook) Facebook timeline 9.10.2016.

This image illustrates Mark Zuckenbergs virtual representation (avatar). This avatar and his co-workers are virtually visiting Marks home. The audience got to see a glimpse of Marks living-room and a dog playing with a ball in real time.

While virtually travelling, Mark got a Facetime-call (video messenger service), and a window popped up in the virtual space. All these layers of real-time media (Avatars, Facetime call in a 360-camera stream of the house) overlap each other to form a unique digital environment.

Mark answers his incoming call by flicking to the right on his smart-watch. The caller, Priscilla, can see both the dog from the camera-stream as well as Marks virtual representation in real time.

To commemorate the moment, and to make an impact on the public, Mark summoned a virtual “selfie-stick and took this picture which was uploaded on his Facebook wall moments after.

The relationship of this image with what one can do today with a VR headset is that you can get together with a group of friends, see their virtual avatars and visit real places on earth or even space in real time.

In a way, the demo of this technology allow our consciousness to travel to places limited by great distances, time or the laws of physics.

3.3 Current drawbacks

While most of concept level services are fantastic and might be essential for a revolution in 3D computing, the systems are still early stage and not ready to compete with traditional computers just yet.

According to professor Charles Woodward at VTT, the first applicable areas of AR is in industrial maintenance, asset management, training, construction and engineering. These fields will benefit through AR technology by enhancing spatial understanding and by being able to share views with field professionals and guide them through a process.

On the consumer side there are problems still to be resolved such as precise tracking. A review of the Meta 2 head mounted display by tech-evangelist Robert Scoble show that interaction is tracked at millimeter scale, which still leaves room for improvement. The average user will find this level of precision still quite rough. Other than interaction there is still the vast amount of content needed to become available to have any sort of appeal for the big audience.

The primary inconvenience of AR is invading privacy and there hasn’t been a general consensus over how things should work. Numerous reviews about the subject are concerned about AR enabled tech revealing statuses or tweets from strangers without people knowing it, which can cause cumbersome consequences.

An example of privacy invading but with tremendous benefit, is the current software extensions for Alibaba groups facial recognition software which identify a user in an instant by identifying someone through the camera lens. This would come as a software update. To be aware and in control over ones own internet security is important and something the average user might not be aware of how to take necessary precautions.

Utilizing Alibaba Groups facial recognition software with e-shopping and money transfers makes the process of identifying the customer and how she pays for a service, quite a smooth and quick transaction.

Other than these general issues there are 3 areas of such significance that they need to be discussed separately. These are nausea, occlusion and lack of precision.

3.3.1 Nausea

Professor in Information Technology at Aalto university, Tapio Takala describes the VR nausea as following: When the eye see something that the organ of balance can't comprehend, it might cause dizziness, sweating and nausea. When being physically active and when the device isn't measuring the movement of the head properly or with latency - VR environments can make the user feel physically ill.

An interview by Wearable News with specialist in motion sickness, Professor John F. Golding from University of Westminister, confirm these motion sickness observations symptoms.

Golding explained that there are several symptoms of travel sickness caused by visual mismatches in virtual environments. It boils down to a conflict between the inner ears vestibular balancing organ and our visual or kinaesthetic inputs.

Most of those who experience nausea has been feeling physically ill within 10 minutes into the VR experience, those who don't rarely show these symptoms. Professor Golding also noted about 5-10 millisecond lag can make people lose balance and fall.

3.3.2 Occlusion – misinterpreting focal planes and objects

In terms of 3-D graphic design, occlusion is an effect of objects that are displayed in 3-D space blocking another object from view.

When in an artificial environment it is important to be aware how two objects move together in space. Many objects in these virtual worlds are meant to be played and interacted with.

Occlusion can be caused by lacking information about the 3D space or objects interfering the physical space.

This can make accurate estimations of distance and separation of boundaries difficult which might lead to strain on the eyes and potential headache and fatigue.

Today there are Unity 3D APIs or plug-ins to deal with occlusion for developers.

3.3.3 Lack of precision

When in a fully immersive VR landscape, the mind is tricked into believing being somewhere else and you rely solemnly on vision.

Sometimes, when physical actions do not respond to commands and the user needs to put thorough focus on completing a gesture pattern rather than intuitively executing a command - it feels wrong and frustrating.

This is very straining because the body thinks something is going to happen and expects to get visual confirmation of an action.

When there is a “glitch in the matrix” it might have rattling consequences and the impact on the user should not be under-estimated.

An example from my experience at YLEs demo-space while trying a VR experience can perhaps illustrate a practical example of how such an impact can feel like.

In this experiment, I am high up in a city landscape. Standing on a tower of unstable blocks with a beam going from one tower to another. The aim is to get across to the other side balancing over this beam.

The sound landscape is windy and subtle distant traffic noise from streets.

When you are starting to balance over the beam, the wind is getting so strong that it suddenly moves the beam under your feet and the user falls down a hundred meters to be squashed into the pavement.

There is a physical beam on the floor that is programmed to do a tilting movement by a robot after taking a few assuring steps on it. But this is unknown for the unsuspecting VR visitor.

The unexpected input from the robot disrupts the focus of the user and causes an error in the body between what the brain is telling you is happening, and what is physically happening.

The result is that the body gets into a chock of dysfunctionality, sense of touch and feel of gravity disappear since we rely on the visual information so much that it overtakes the rest. We genuinely believe we are falling.

This will not continue for a long time - but the body is out of synch for 2-5 seconds until it realizes that we are in a simulation and that everything is going to be okay!

During this experience, I was dead certain that now my time has come to meet my maker, quite absurd and eye-opening.

Physical control of your own body diminishes when it subconsciously reacts to the visual stimuli we perceive.

As an aspiring future industry-professional I have taken lessons from this experience. The mind and body can be fooled in incredible and foremost convincing ways and this should be kept in mind during the whole design process.

When subtle movement get wrongly understood or overlooked, the user experience gets ruined and results in frustration or as in my experience, a dysfunctional body.

3.4 Current market

Before looking at the core technologies of Mixed Reality, it might be useful to briefly stop and note from the following graphs that this market has already begun to show rapid growth. We should not understand these core features as the start of development but as a continuing refinement of built upon existing technologies.

The growth potential in these markets according to IDC (International Data Corporation) estimates that the Virtual and Augmented Reality markets will explode from $5.2 billion in 2015 to $162 billion in 2020. Another source from Global Market Insights estimate AR will be a $165 billion business by 2024.

The first of the following graphs concluded by Digi-Capital illustrate the revenue forecasts of MR technology.

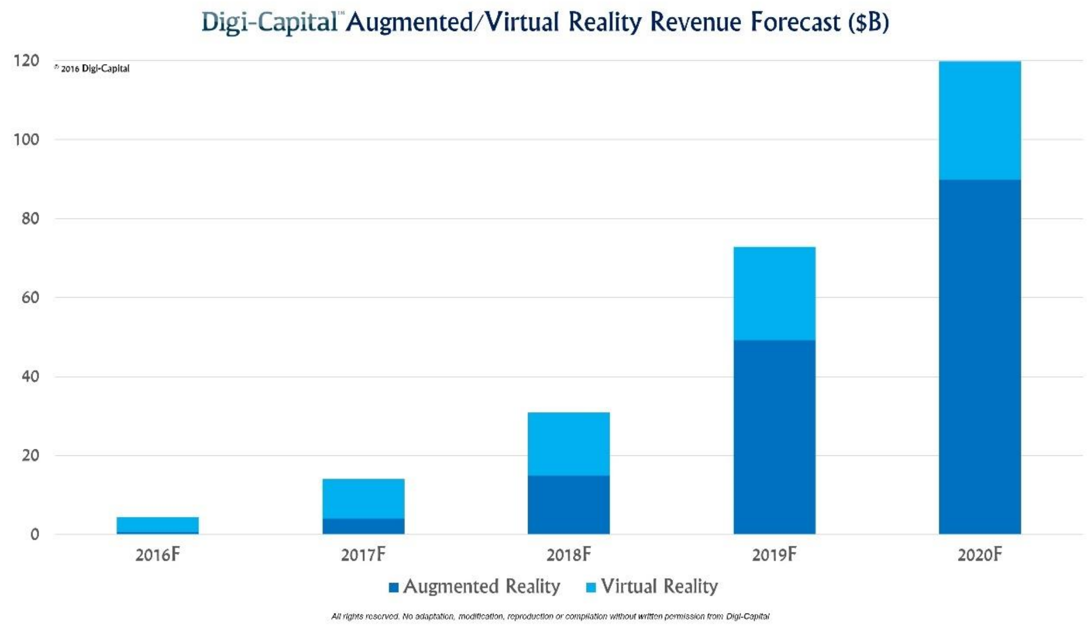

Table 1. Digi-Capital 5 year forecast of Mixed Reality revenues. Hitting 120B dollars in revenue by 2020. Augmented Reality expected to overtake Virtual Reality in 2018-2019.

The second graph show estimates of how many MR enabled devices already are out on the market and how the future.

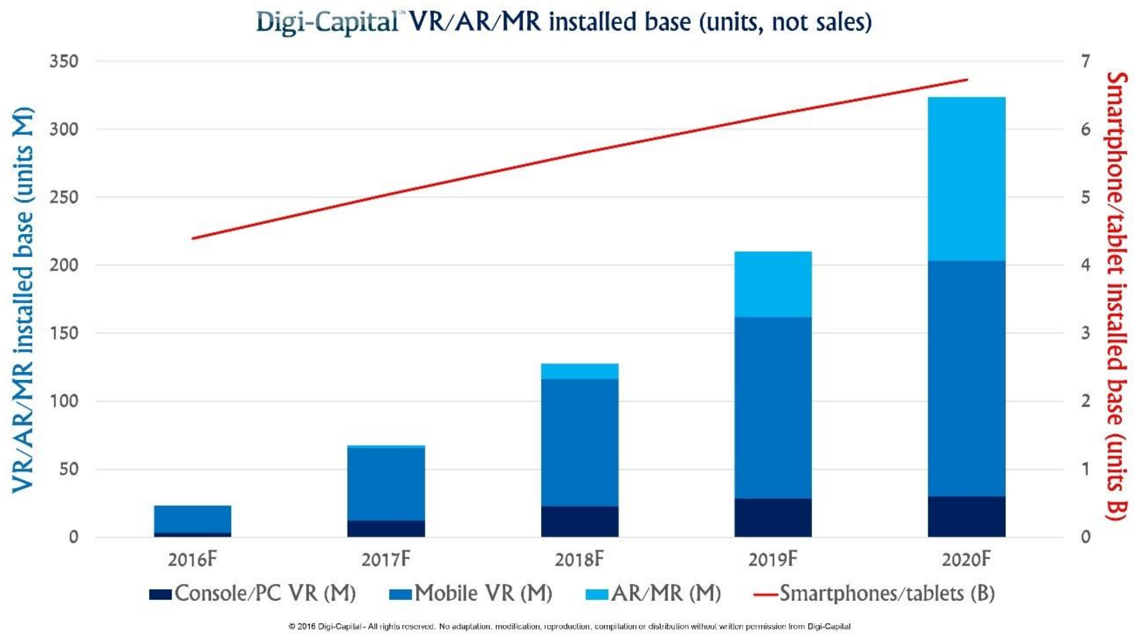

Table 2. Shows by year 2020 we will have an estimate of 2.5 Billion Augmented Reality enabled devices out on the market. The AR market is expected to grow exponentially every year.

3.5 Possible future applications

Mixed Reality technology has the potential to enhance most tasks we do in everyday life, and act as a bridge to unlimited comprehension of unknown frontiers of science.

It is not possible to limit this technology platform to some specific niche. It is important to understand that this is a platform, an entire computer, meant to execute the same tasks as a mobile phone or a personal computer but to display what we see in 3D blended with our natural environment.

It is possible MR technology will become a vital part of future projects such as space engineering or drone and robot remote-control. The first areas going to adopt MR are most probably the educational sector in schools and companies, engineers or architects and in general fields where spatial understanding is an important part of workflow.

4 MIXED REALITY

Mixed Reality consists of four core technologies as the image illustrates below. These sub-categories in technology are already in use by a majority since they are included in most of smart-phones today.

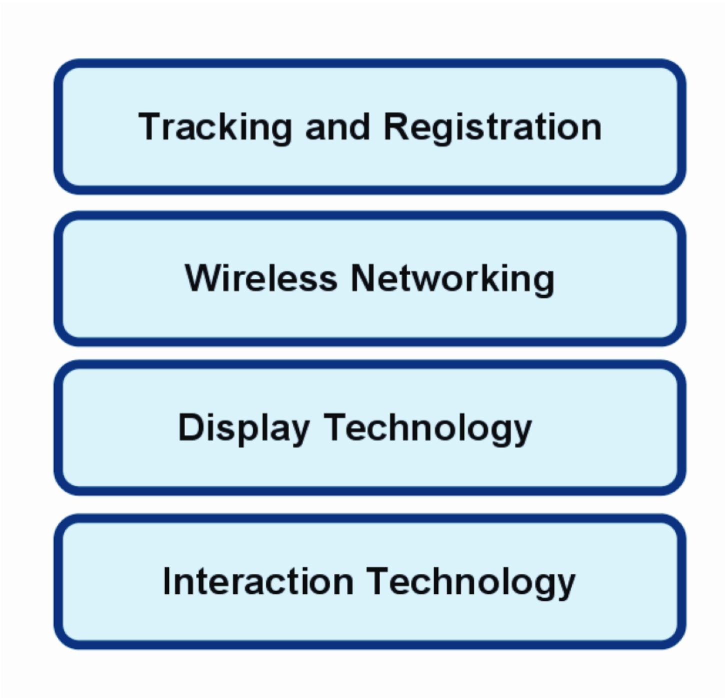

Figure 4. The four hardware types used for MR systems in a whole.

We will take a deeper look in display technology in the next chapter.

Transparent displays have been very expensive to manufacture and even then the end result has been bulky optics, nothing resembling a fashionable set of glasses. However, the technological landscape promise very rapid advancements in this field. Some of the breakthroughs has been driven by VTT and Aalto university here in Finland.

Wireless networks transfer data, tracks and register how we interact with our technologies.

The whole chapter 6 is dedicated to showcase products that track the user and send our positional data (wirelessly) to be understood by a machine, i.e. user interface (interaction technology).

Mixed Reality devices show digital content in 3D, it is only natural for the user-interface to follow.

Evidence suggest that physical controls such as a mouse, round-sticks or a mobile phone, will only temporarily act as controllers for 3D systems before moving on to wireless micro-devices reading our presence with a precision hundredfold the accuracy we see today.

4.1 Display technology

In this chapter we will benchmark four of current Mixed Reality capable devices, or independent HMD computers to get an understanding of how the products look like today, at what stage of development they are, and what problems they aim to solve.

The display acts as the mean of combining technology with how humans perceive computer generated imagery. For a very long time we have been limited to two dimensional (x and y axis) screens.

When talking about MR or AR the content is displayed in 3-dimensions, adding depth, the z-axis to the equation in form of how we perceive the data as well as how we interact with it.

In this part of the thesis we exclude VR systems or systems which does not have a fully transparent screen.

Important from this section is how wide the FOV (field of view) is and what kind of content there is and what kind of users the devices attract.

As a reference for the next chapters, the human eye has a field of view (FOV) of 120 degrees.

4.1.1 Display technology case: Microsoft Hololens

Price: 5000 dollars for Enterprises.

Price: 3000 dollars for Developers

Stage of development: Shipment started Q3 2016

Niche orientation: Business, Engineering, Architecture, Medicine, Multimedia channels, Enterprise infrastructure.

Figure 5. Demo of Hololens home desktop view for those connected to AR. Several widgets and layers scattered around in the home.

Microsoft HoloLens is the first fully self-contained, holographic computer, enabling you to interact with high-definition holograms in your world. It operates on familiar Windows 10 OS.

The field of view (FOV) is said to be at 120 degrees but several reviews note that the actual area is something more like 80-90 degrees, stated by famous tech-evangelist Robert Scoble.

Mixed reality blends 3D holographic content into your physical world making holograms real-world context. This allows users to interact with both digital content and the world at the same time.

The user can create own MR videos featuring holographic characters and effects and then place, resize and record holograms in the real world for a new take on storytelling.

4.1.2 Display technology case: Metavision Meta 2

PRICE: 950 dollars

Stage of development: 1st Shipments of Beta Q4 2016

Niche orientation: Work, Development, Art and Engineering, Neuroscience

Figure 6. Retrieved from Metavision, the Meta 2 HMD device profile.

Metavision's optics include a 90 degree field of view and 2560 x 1440 high-dpi display. The HMD makes everything beneath the eyebrows completely transparent and obstructed for easy eye-contact with others, even when wearing glasses.

The user interface they call a “neuroscience-driven interface design” a principle to allow access, manipulate and share digital information easily and naturally. They call it “the neural path of least resistance” (trademarked). According to Metavision this UI (userinterface) is a new zero-learning-curve approach to computing.

The hands command the environments. Based on pre-learned behaviour-patterns how we engage with our environments naturally. There is a sensor array on the HMD that tracks the movements and gestures within the action-area of the arrays range.

The Meta HMD offers an operating environment where the user can arrange holographic objects and apps freely. Styling out an office where objects stay right where they are put. The environment also allows multitasking between several users simultaneously and can simulate other people through holographic calls.

4.1.3 Display technology case: Avegant light field

Price: Unannounced

Stage of Development: Announced, under development

Niche orientation: Learning

Avegant is known for their previous product, the Avegant Glyph released in 2014. The Glyph is an immersive portable movie theatre using millions of micro-mirror arrays and a retina projector to display media, something resembling a VR-headset.

Figure 7. Engineering prototype displayed at CES 2017.

The Avegant Light Field is a Mixed Reality platform for visualization of objects at multiple focal planes which has been a real challenge since it interrupts the user from feeling natural in an artificial environment. Virtual objects can appear right at the users fingertips or farther away, the objects which are not in the users focus, will be blurred.

This breakthrough product is a solution for occlusion and help the human brain to interpret distances and dimensions intuitively.

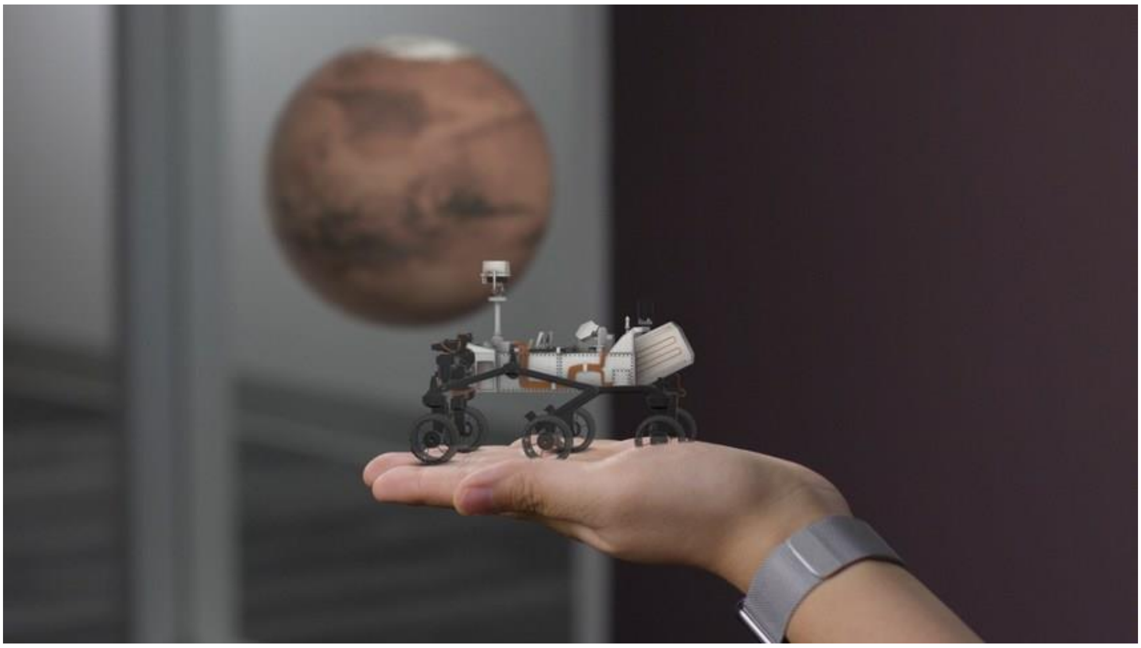

Figure 8. Avegant Light Field technology solved one of MR's greatest challenges by enabling virtual objects to appear at distances both near and far (Occlusion).

Avegant Light Field did what Magic Leap claimed to have solved, focusing on different focal planes, or "light fields".

As the development team at Avegant describes the technology: "It uses a number of fixed digital focal planes, and then interpolate the planes between them. These focus planes have many of the same characteristics as classical light fields, but require much less image data to be simultaneously presented to the eye and thus saving power on generating and displaying as much image data, much of which the eye will not see.

President and founder of several Silicon Valley tech-companies, engineer Karl Guttag claims, that the focal plane demo is optically the best on the market so far, even though the product is in very early stage of development.

4.1.4 Display technology case: ODG R-7

PRICE: 2750 dollars

Stage of development: On demand.

Niche orientation: Industrial work tool, construction, logistics, aviation, engineering.

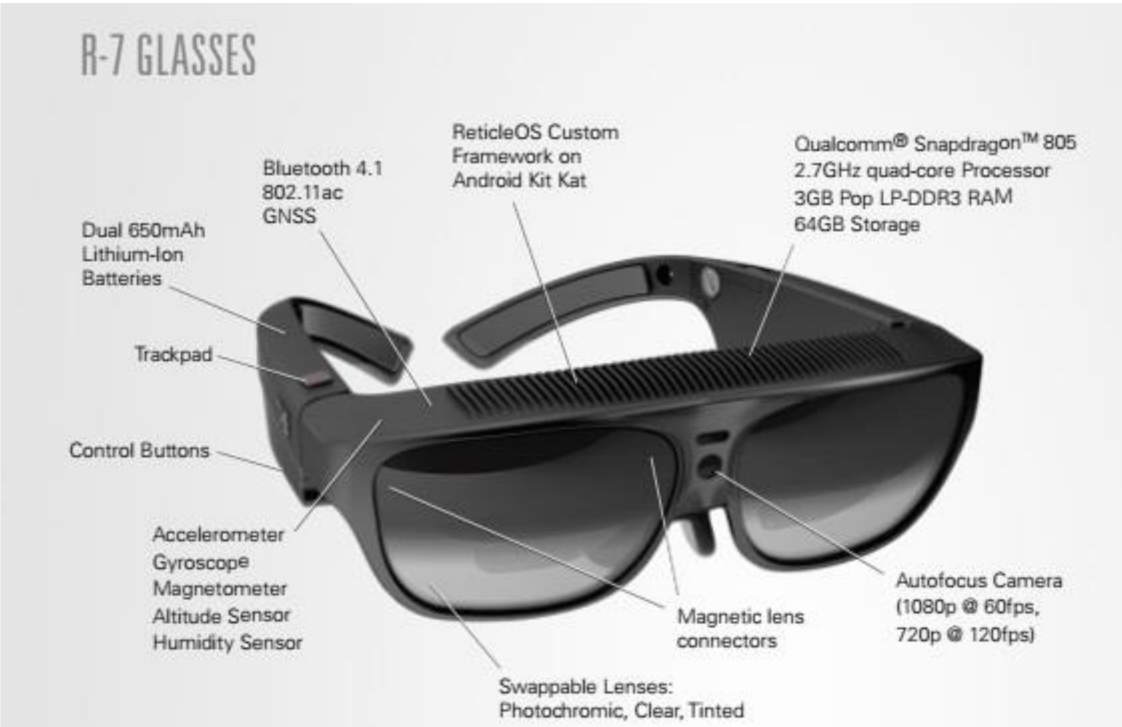

Figure 9. ODG R-7 smart glasses microelectromagnetic systems layout and specifications

This is a robust HMD targeted for enterprise customers equipped with processing power equivalent to a Nexus 6 mobile phone. It’s compatible with most AR operating systems and use touch via Android. It runs its own Reticle OS on top of Android v. KitKat.

The ODG R-7 (alongside with Epson BT-300 Moverio) is considered to be one of the most powerful smart-glasses utilizing mobile computing technology as a platform, according to CEO of Augmenta, Tero Aaltonen and the Hubmaster at YLEs Finnish Virtual Reality Association (FIVR) Tuomas Karmakallio (2016).

Such a platform lack the strength of a HMD computer but is a considerable part of today's market with an established market adoption.
The optic properties provide a 30 degree FOV displaying screens in 1080p at 60fps or 720p in 120fps with an 80% transparency.

5 HURDLES IN SCREENING TECHNOLOGY

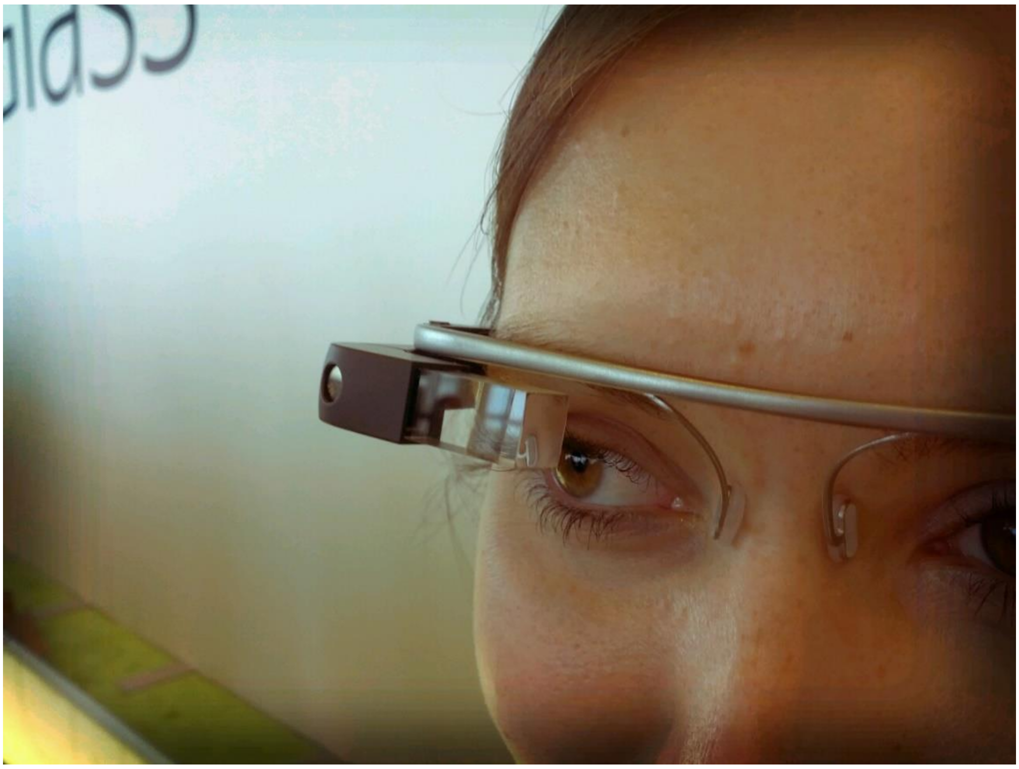

Figure 10. The crystal connected to the framework is the light-guide which splits the light signals to light humans perceive.

When Google announced the Glass product in 2013, it was considered a flop with its 15 degree FOV, a wired mouse-like controller and the almost 2 cm thick light-guide. It was not practical but it worked.

This crystal light-guide in the picture above splits the beams of light into a form that our eyes understand. Also as the image above shows, the lenses are so thick that it is hard for anyone fashion conscious to buy such a thing for a price over 2000 USD.

This is relevant for the adoption of such devices and marketing. So far there has not been a viable alternative for these light-guides.

This guide is hard and expensive to make which also keeps the product price up and above what the majority can afford.

One could argue that “ugliness” is a threat for the field of transparent lenses and smart glasses - and hence also Augmented Reality. Not only that, Google Glass became a flagship of what Smart glasses are, and they are considered a norm in design. This is what I hear a lot when talking with less informed people about Augmented Reality and what it is.

Also, the flop of Google Glass acted as a warning to investors about the field since obviously the light-guide and the lens were too obvious and bulky - it didn’t impress enough with its design and much limited field of view. Compatible with Android yes, but limited to half of the horizontal width of a mobile phone and hence there was no content to keep even enthusiasts active.

A major hurdle for AR was light-rays colliding, making the content blurry. This issue is called in short the rainbow effect. When outdoor light collide with the light from the retina projector it splits and travels everywhere - creating ripples in the image, making the Google Glasses quite situational.

In the next chapter we will take a look at what has changed.

5.1 Crossing hurdles in screening technology case: Dispelix

Optics technology and mass manufacturing of M/AR supporting lenses.

Price: 300-600 dollars

Shipment: Q3 2016

This light-guide technology developed in the Centre of micro- and nanotechnology, in Spektri business park, Espoo. Dispelix lenses are currently among the most advanced solutions for mass-manufacturing of optical see-through displays.

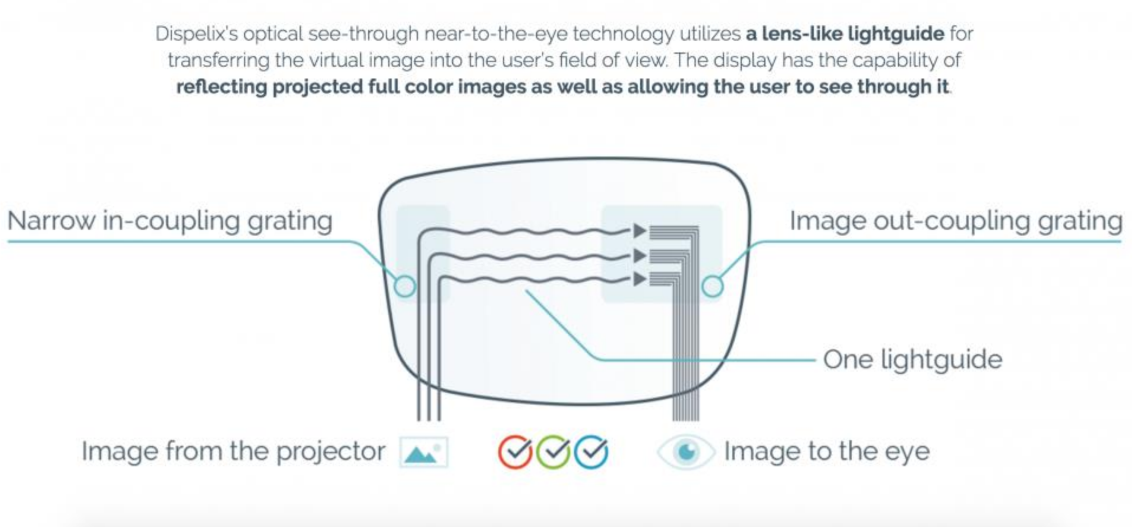

Figure 11. Description of process splitting light through light-guide through in – and out-coupling.

Dispelix is a fabless designer and supplier of optical see-through near-to-the -eye displays for developers and manufacturers of AR eyewear applications.

The technology was developed as a spin-off from VTT Technical research of Finland, founded late 2015 along the release of their first demo.

The problem they have solved is the alleged rainbow suppression of light. The rainbow effect is where additional light from other point-sources than the camera projector collides and cause a spectrum of light into the user field of view.

This solution grant the projected imagery to become considerably sharper than before and not as much affected by the sun nor reflections from shiny surfaces or snow.

This is kind of the missing piece for mobile computing as discussed in the previous chapter - an unnoticeable optical see-through near-to-the-eye display. So far the existing see-through displays has failed to combine aesthetic design with high image quality and volume production compatibility.

This solution promotes lens-like light-guides transferring virtual monochrome and full colour images into the user's field of view (FOV).

Inside of the less than 1mm thick light-guide there is an image out-coupling grating and a narrow in-coupling grating which allow the process of transferring the image from the projector to the eye via a light-guide that acts as a light-waste filter.

This image in-coupling area on the ultra-thin display light-guide can be hidden into a glass frame. It is a highly transparent image out-coupling area and looks like a part of the lens and displays a virtual image only visible for the user.

This lens technology allows smart glasses or computers to be designed with a new display/lens or viewport experience while being completely invisible for others to see.

5.2 Digital eye-wear fashion case: LaForge optical

Product: Shima Digital eyewear

Weight: 24 to 29 grams.

Price: 590 dollars

Shipment: Alpha 2017

Niche: Passive non-interactive

Market Orientation: Eyewear market

Figure 12. LaForge optical product Shima. Top: GPS view in car mode. Left: Unnoticeable design and camera. Right: Integration of some microelectromechanical instruments.

LaForge optical is one of the first companies who focus on stylish wearable computing eyewear. This product does not come with hand tracking compatibility just yet.

The lens technology they use allow other people to see the light but not the display. The projection system uses two unnoticeable lenses at 2mm thickness.

Shima interacts directly with your smart-phone to bring real-time updates to your field of vision. In beta phase the glasses recognize if the user is stationary, walking, or using a vehicle and then adapts the content as safety allow.

Through Bluetooth networks the Shima communicates with a smart-phone to display content.

If stationary, the user can control messaging and planning.

If walking the system allows other apps to be running.

While in a vehicle the user is limited to only following what the instructions given by the GPS and viewing messages.

This platform is not great for multitasking, has no video call support and is all in all a lightweight mobile computer.

It is however an interesting example of an unnoticeable display system and gives us an insight of future AR product designs.

The OS and interface is developed on Vuforia and is called Ghost OS for Android. Ghost OS is operated like from a smart-phone but the touch sensor/buttons are in the earpiece of the glasses.

Currently entertainment and media consumption is not suited for this lightweight product. For video, products like Hololens or Avegant are a better alternative according to the CEO, Corey Mack.

Shima is a digital eyewear which primary goal is to make sure you can see the world around you without interruption.

The most interesting feature of the product is its firmware scope and applications it is planned for to run.

Firmware is the true value for this product meaning that “you buy it one day, and the next it has new features”.

The software platforms API’s are going to be the strength of the system according to Corey Mack, CEO of LaForge Optical Online stream 26.7.2016.

6 TRACKING AND REGISTRATION TECHNOLOGY

Sensors track and register movement and things happening in the real world.

A Mixed Reality machine need to be aware of the surroundings. It puts contextually aware scenery where the user stands at, in the direction the eyes are looking to.

Contextual awareness for the machine means tracking and registering 3D space, in real time, in relation to the user and how the user controls the content she’s interacting with. Some of this content also needs to respond to real world objects in the physical environment such as cars or animals.

In addition, the system need to constantly track subtle finger movements and identify what is an input signal and what is just random movement.

Most of the data then is transmitted over various networks to the computational hardware or the cloud to be processed close to real time.

The kind of sensors that do this, to name a few are: accelerometers, gyroscopes, magnetometers, IR-depth cameras, Bluetooth sensors, GPS, radar, SLAM and other MEMS which are already in some extent part of every-one’s daily life.

6.1 Today in gesture control

The controllers today for Mixed Reality computers are usually device specific round-stick controllers or similar devices. These controllers translate intention of thought with what the user can see.

Microsoft Hololens and Metavisions Meta 2 are Mixed Reality computers combining AR and VR, these head mounted displays (HMDs) have the sensing equipment integrated above the display.

As long as the hands are in the field of view of these sensors, the hand signals are interpreted and things happen. By having these sensors integrated to the HMD it leaves the hands free to roam and interact with the real world.

The hands prove to be both familiar and precise instruments for navigating in artificial environments.

The wireless sensors on the head-mount, track the hands and translates it into a natural interface such as in cases 6.2 to 6.4.

Lately wireless ecosystems that translates gestures to the display has been field tested, and seen a rapid increase in precision thanks to the popularity of both Oculus Rift and HTC Vive and hype-wave of motion tracking and MR.

6.1.1 Motion tracking and gesture control

Gesture control is the mean of translating intention to execution between the human and the computer without any other accessories such as a mouse, round-stick or any physical surface.

Mimicking human natural behaviour and translating these ques and signals to a machine that interpret them as an input signal for some action, is what interface designers refer to as “an interface for the world” or “neuroscience driven interface design”.

Some market solutions such as Amazon augmented room system and HTC Vive use a technique with fixed anchor points in a room, in addition to wearable sensor arrays. These are stationary tracking fields common in studio rooms and quite reliable, but not in the price range of the average MR user.

The sensors in the room tracks the user in a limited space, not only from a point of view perspective but as an active whole in set action parameters.

This is one of the most trusted methods today to keep latency minimal and frame rates during movement stable. In short, the more sensors running simultaneously there is, the more reliable the whole system.

This method is optimal for use at home, but not for when the user is active, on the move. In the following chapters we are going to take a closer look at some of these measuring instruments for when the user is active and get a glimpse of how they work.

We will have a look at tools used on macro level, controlling the big picture, and then micro level for more, precise fine-tuned actions, and evaluate on what stage of development these sensing instruments are.

6.2 Tracking and registration technology case: Vico VR

Price: 175-215 dollars

Stage of development: Shipping Q4 2016

Niche area: Full body tracking and multiple users

Figure 13. Showcasing the 19 tracked human body joints to simulate presence on Oculus Rift. This is a case of macro level presence and environment manipulation.

The Vico VR is a wireless Bluetooth sensor, an improved version of Microsoft Kinect sensor. It is a device that tracks how the body moves with a range from 0,5m to 4,5m.

The Vico tracks 19 different body-joints that make the user in VR responsive. This means that when the user looks at her own body and does any movements, the VR avatar of the user will match those movements and commands real-time in the simulated environment.

This device is very good for macro-movement, but lacking in micromanagement. This is because the 19 body joints cover the feet, knees, pelvis, chest, shoulders and arms but not fingers.

VicoVR provide wireless full motion and positional tracking to Android and iOS head-sets without a PC, wires or wearable sensors. This allows the user to roam around freely within mobile gaming worlds. VicoVR can be used as a stand-alone 3D gaming system or as an add-on accessory.

6.3 Tracking and registration case: Leap Motion Orion

Price: 70-100 dollars

Stage of development: Active

Niche orientation: Micro-management, 2D & 3D, wearable

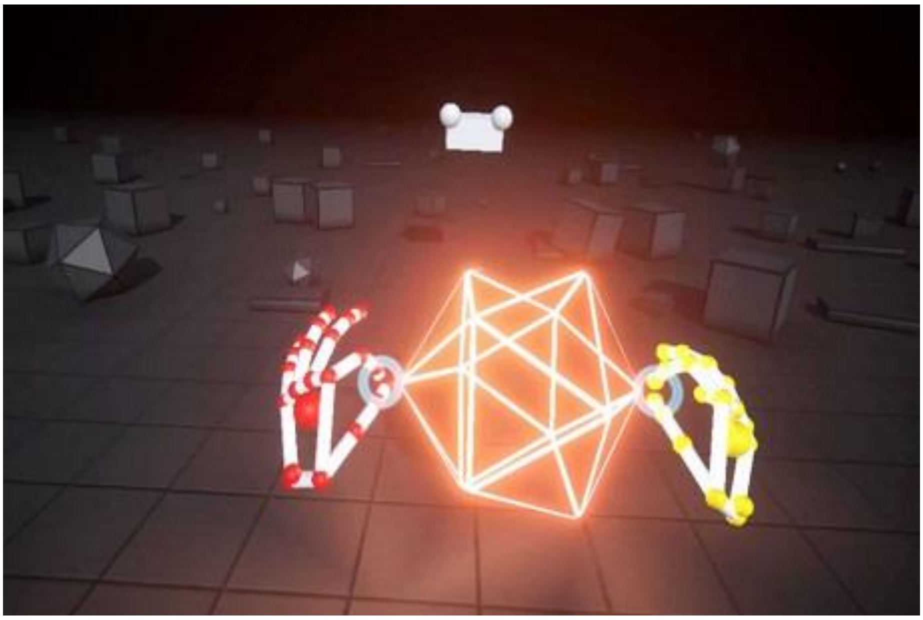

Figure 14. The Orion hand tracking sensor. All balls/joints in the picture are tracked in real-time and responds to real-world movement in VR.

Leap Motion is a company heavily associated to VR, and are one of the early pioneers in the field. Arguably from a "historical view" of the MR landscape Leap Motion and Oculus Rift are the early innovators of the field and thanks to their effort this technology is becoming something anyone could use and enjoy today. The sensor technology utilizes two monochromic infrared cameras and infrared LEDs for pattern-less IR light.

Leap Motion began as an indie project in 2008 and was the first hand-tracking device that could recognize miniscule movement and translate that into actions in a game.

The range of the Leap Motion is around a meter, significantly less than the earlier case of the Vico system but they also fill different niches, Leap Motion excelling at reading micro gestures and tracking finger and hand movements. In 2013 the device was reading gestures at a precision of 0.7 mm. The new version, Orion goes even more precise than that and is without a doubt the most used and trusted tool for robust gesture control.

This device is the size of a USB stick and is placed onto the screen of a computer, or directly onto the front of a HMD for VR. When the device is equipped and active it generates an action area that the sensors are aware of in front of the user right where we normally interact with objects and things naturally.

The shortcoming of Leap Motion is that the sensing range is in a limited field directly in front of the user and not by the sides or where-ever the hands might roam during a session. The hands need to be kept up in front of the Leap Motion to register movement and this takes away some of the intuitiveness of the gesture interface.

The latest model, Orion released on the market Q2 2016.

This version of the device has become an industry standard and is currently the most reliable and used accessory for gesture control. Orion is the frontrunner when it comes to precision and is currently holding majority of the market-share in wireless gesture tracking.

6.4 Tracking and registration case: Google ATAP Soli 60Ghz radar

Price: Intent - mass production and mobile device standard.

Stage of development: Beta Q4 2016

Niche orientation: Smart environments, homes, IoT & Interfaces

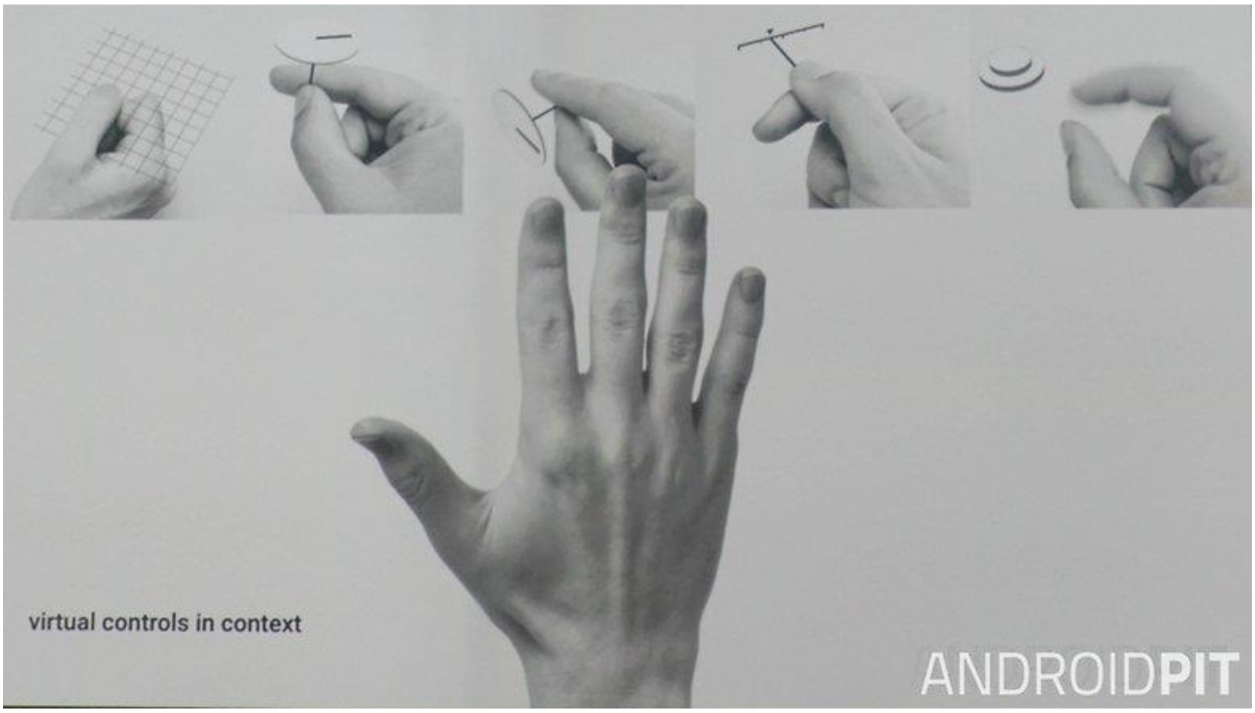

Figure 15. Demo of how fine-tuned precision from hands and fingers translates to existing user-interface patterns.

Google’s Advanced Technology and Projects (ATAP) department developed an alpha of a radar chip and array reading frequencies of 60 GHz.

It is a new sensing technology that uses miniature radar to detect gesture interactions of the human hand. This sensor reads sub-millimeter precise fine-tuned signals.

According to project lead Ivan Popuyev they are creating an ubiquitous interaction language that will allow people to control devices with simple universal set of gestures.

They envision a future in which the human hand becomes a universal input device for interacting with technology.

Out of all the sensors I have listed in this thesis the Soli chip is the smallest, 8x10 mm in size and precision.

Examples of what this little device can do is to match gesture with for example AR so that the user can turn on the volume of the radio from another room, change song or turn the volume up by just summoning an interface for it mid-air.

The beta comes with set sliders, buttons, switches and dials. Even though these controls are virtual the interactions feel responsive.

The feedback is taken from haptic sensation and pressure of fingers when they touch each other. When there are no constraints of physical controls these virtual tools can take the fluidity and precision of human hand motion.

This technology emits electromagnetic waves in a broad beam. There are objects within that beam that scatter small portions of energy. When these signals are reflected back to the antenna array, rich information about the objects characteristics such as size, shape, location, orientation, material, distance and velocity is measured into tangible data.

Soli then recognize gestures and fine motions of the fingers and hand. What is truly special about this sensor is that it doesn't require large bandwidth, high spatial resolution or much energy. It even reads signals smaller than our fingers are physically able to make, through walls and rooms.

The Soli SDK enable developers to access and build on the gesture recognition pipeline and is going to be manufactured at scale. Yet there is no information if this technology is going to become a component of mobile phones.

When several arrays of these radars are compiled into one system - multiple beamforming enable 3D tracking and imaging without any moving parts.

The radar also senses through most materials.

6.5 Tracking and registration case: Intel RealSense R200 depth camera (SDK)

Price: 100 dollars

Stage of development: Shipping

Niche orientation: Streaming, Gaming, Unspecified (close range indoor, long range universal)

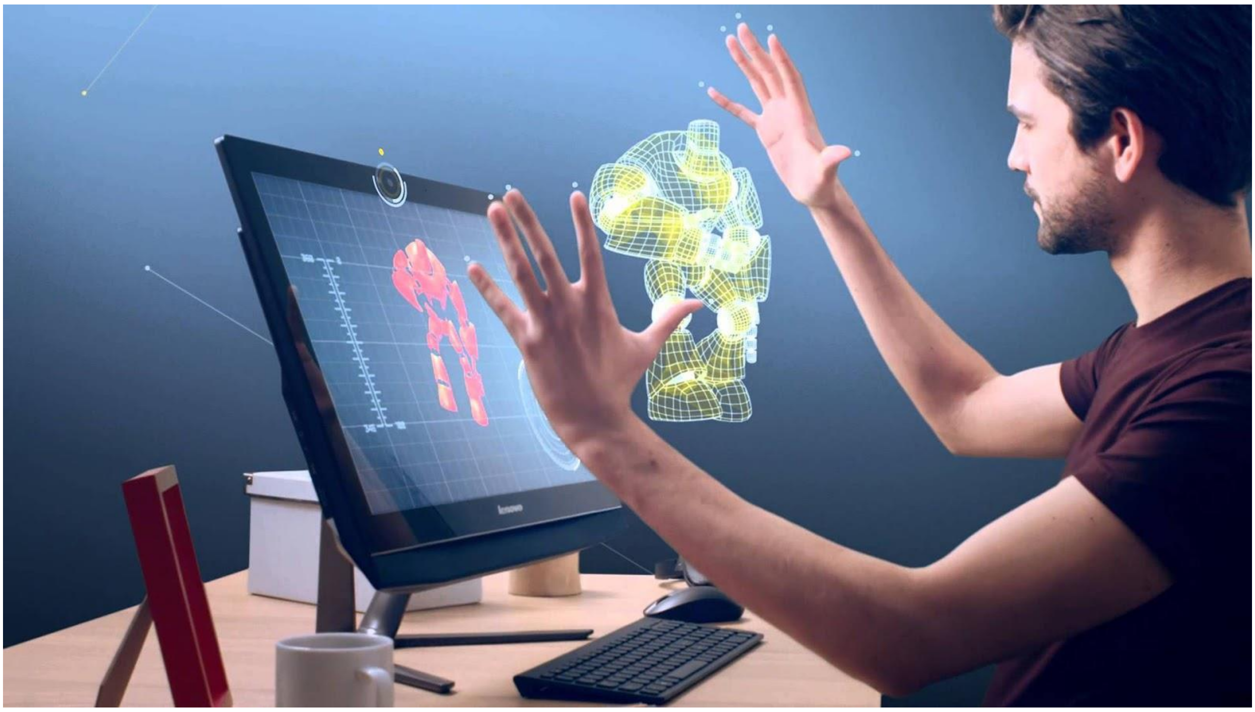

Figure 16. Intel RealSense hand tracking and 3D screening, a developer tool to view and manipulate 3-D objects and assets.

For the last case example of how tracking technology could be used for MR I wish to present for the sake of variety, an alternative to direct sensor gadgets and data identification software.

It sees the environment and then splits up what it sees into segments or layers.

These layers could be as an example, as the following:

Layer 1: Seeing a person in front of a computer

Layer 2: Close surroundings 0,5-3,5 meters.

Layer 3: The whole room or other people in background 10 meters.

Layer 4: Far away background - horizon and sky.

The depth sensing camera then, can render the background in real time allowing the user for example to inactivate all layers except layer 1. Then the user can switch to a static or active alternative backgrounds.

The R200 uses three different cameras. Two infrared cameras for positional tracking, RGB camera for colour and IR laser projector for depth sensing.

This camera technology is used in Intel’s robot and computer vision programs.

The Software SDK for this camera comes with hand and finger tracking, facial analysis, speech recognition, AR and 3d scanning.

This camera is compatible with most computers using higher than 4th generation processing units with Android compatibility under development. The next generation of this device will go under the name of ZR300.

Unity supports the R200 and is included in the SDK.

7 DEVELOPERS PLATFORMS

All software based services require a platform for initial programming and testing. The following cases are platforms most developers are familiar with, but each with their own niche area.

7.1 Developer platform case: Unity 5

Target market: Universal

Niche: Universal

Pricing: Personal - Free

Pricing: Plus - 35 dollars/month

Pricing: Pro - 125 dollars/month

Pricing: Enterprise - tailored setup.

Language options:

C#

Javascript

… Et al

Unity is the largest games and experience developer software tool to date. Out of games available on Steam, up to 90% of games today developed are made in Unity and it has the strongest device compatibility on the market.

Unity is the industry leader in multiplatform game engine support and development.

Figure 17. A 3-D model of a bedroom developed in Unity5.

In the Unity Asset store from the editor or browser, developers can connect with thousands of ready-made free or for purchase assets and production tools. Editor extensions, plug-ins environments and models can be downloaded and implemented, allowing fast iteration.

Unity is a universal developer’s tool for 2D and 3D experiences and games.

The Unity forum and community is one entity of open-source knowledge giving reason to make Unity the most popular tool for game developers in the world.

7.2 Developers platform case: Vuforia

Target market: Industrial, Enterprise

Niche: Augmented Reality

Pricing: 499 dollars one time, cloud extension 99 dollars/month.

Language options:

Java APIs

C++ /not required but compatible

XCode for iOS

Figure 18. Miniature model of a power plant in AR developed on Vuforias platform.

Vuforia is a designated Augmented Reality platform - currently the market leader with the biggest developers pool and application ecosystem.

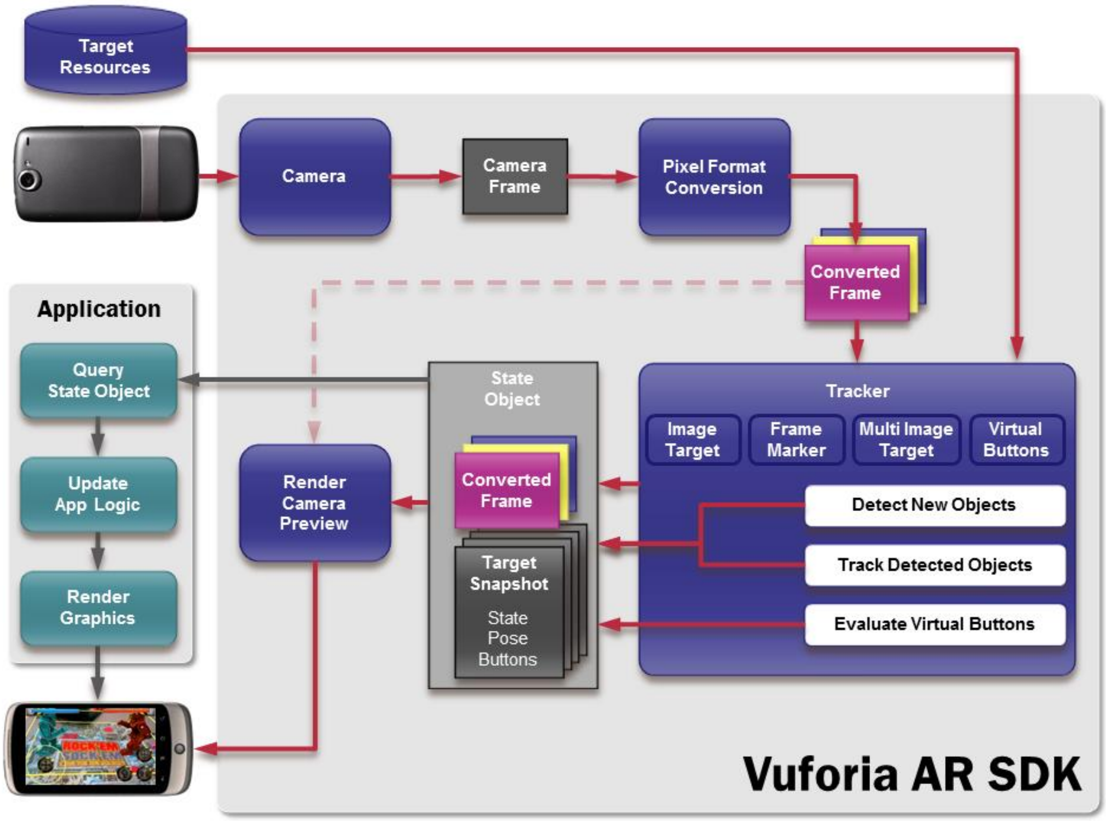

Figure 19. Case of Vuforia's SDK for Augmented Reality.

The latest platform is VuMark - a customizable visual code that is compatible with any product or machine. It uses a decal or is printed in the manufacturing process. Its meant for visually indicating to users about available AR experiences. As an example step-by-step instructions for an assembly line, cleaning, logistics, repair etc.

Vuforia also comes with a Universal Windows Platform (UWP) which allows Vuforia apps to run seamlessly on iOS, Android and Windows 10 (which is the main OS for Windows Hololens).

For Hololens Vuforia is important because it allows the option to attach experiences to specific things in the environment. In combination these two can create expanded or expansive (scalable) experiences such as virtual showrooms. Together with VuMark creating instructions, guides and step-by-step narratives become a robust alternative for developing.

Sample applications are available with native Hololens support getting integrated into the public SDK soon.

Vuforia uses a Cloud Recognition Web API - a scalable solution for hosting and managing image targets. This allows connection to large databases in the cloud.

Camera technology for Vuforia Android SDK: The advanced camera API enables computer vision algorithms providing access to the camera while Vuforia is running - allowing “multitasking” while tracking is active. Adjustments for non-standard environments and conditions are available for Android.

7.3 Developers platform case: Augmenta SDK

Target Market: Industrial, Outdoor harsh environments

Niche: Gesture interface for Augmented Reality

Pricing: By contact

Language options: The developing language can be chosen between three APIs:

Java for Android, Unity3D, C/C##

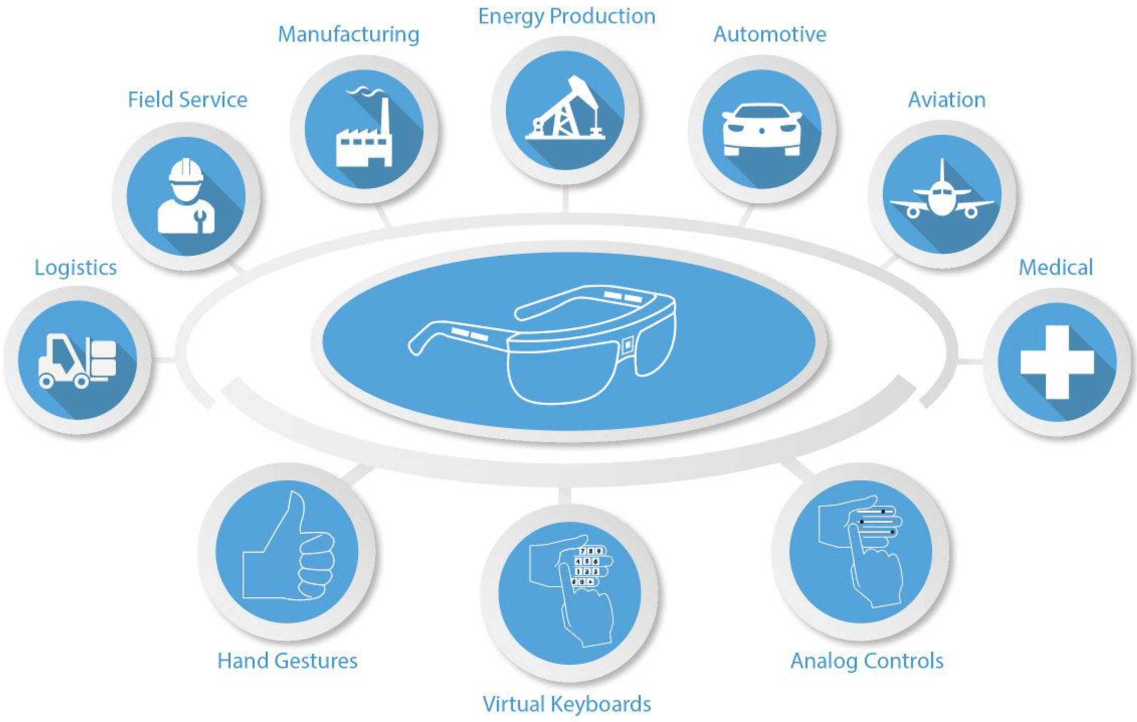

Figure 20. Image showing various industrial sectors where smart-glasses are already used and where there is a need for a robust gesture control UI.

This platform is suitable for industrial applications where you might need to equip a machine with a smart, flexible and secure gesture control user-interface. Examples of such are medical facilities, a mechanic's workbench or a factory floor for route and traffic management.

The Augmenta Interaction Platform SDK is for hand, gesture and virtual displays or surfaces. These methods are robust alternatives to voice and touch control and enable a rich data input in harsh field conditions.

The SDK is compatible for the ODG R-7, Epson Moverio Series, Google Glass and co-exist with toolkits that require a real-time camera access.

The SDK comes with example applications, including source code format for each.

8 CONCLUSIONS

It is important to understand that this constant state of technological innovation breaks traditional ways of how things work, new and better solutions pop-up faster than ever. What has previously been big company intellectual property, is today finding way to open source repositories and soon there-after improved modifications are in use.

Major tech companies such as Intel and IBM can't afford to keep in-house intellectual property since it will slow the development down. This has had a fast-forwarding effect in two ways: companies driving this field forward do not need to pour massive amount of money into research and development. And there is a global community developing this technology forward with the help of these tech giants, it's a new ecosystem, not only "isolated" engineers in corporate basements driving this industry forward.

We can see that despite criticism obstacles such as occlusion, rainbow suppression of light and the price of lenses has been overcome and implemented as standard. These halves of the equation have been solved by Avegant Light Field and Dispelix.

In future productions, cables and wires will become obsolete, and the MEMS (microelectromechanical systems) are getting smaller, cheaper and more effective (Moore's Law) which allow direct integration to the head-mounted display or glasses.

In near future, cloud rendering is going to be so powerful that the device enabling MR doesn't have to have expensive processing units, instead they share the task over several devices, which in turn bring the price of MR devices even further down.

The hardware of MR is mobile technology, most of the technology for MR is already in the hands and familiar to many. Granted that the user interfaces for MR distinguish itself from touch screens but the learning curve is quite quick and intuitive to pick up.

Major hits such as Pokemon Go and Snapchat (with over 1 Billion downloads together) have given the big public an insight of what Augmented Reality is or can be.

Put these various findings together and we have a very promising landscape for a revolution in computing. I believe based on my research that Mixed Reality is not just a hype, but the next megatrend in technology and a future standard, finding its way and disrupting almost any field and industry.

8.1 Important summary

Many pieces of the puzzle are falling into place paving way for the 4th wave of computing platforms. Most HMDs mentioned in this thesis has been out on the market for less than one year and are still in their beta-versions.

As development progress, we can see a new computing platforms taking shape. Platforms ascending 2-D operating systems for computers and touch for mobiles, to the next dimension, 3D computing and Augmented Reality.

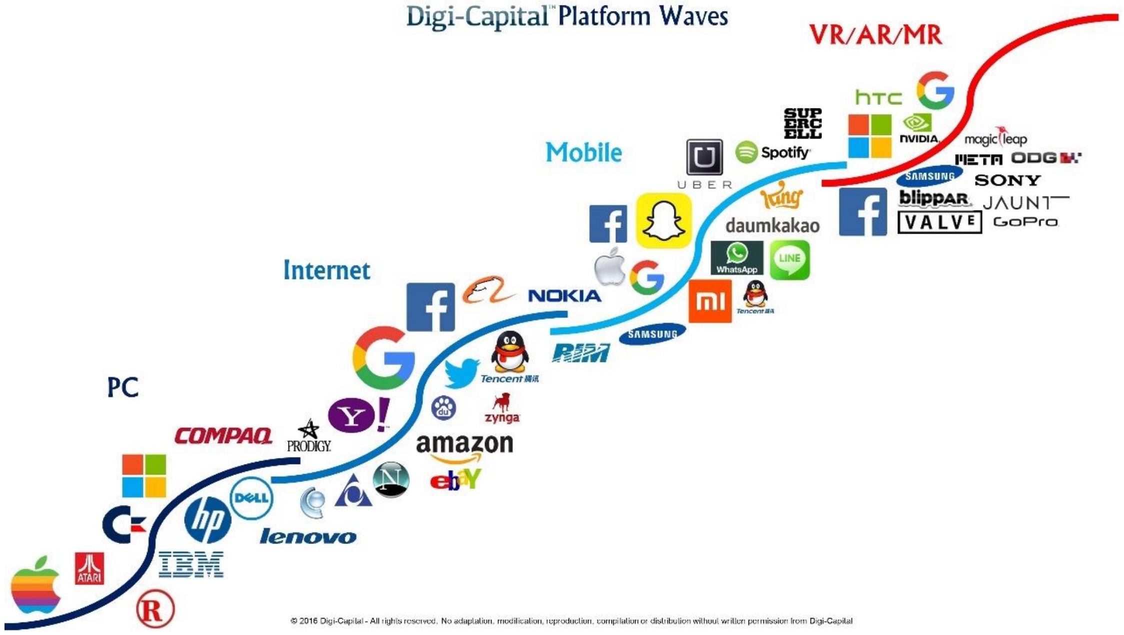

Table 3. The forth wave of computing platforms (3D computing VR/AR/MR), companies top right are driving 3D computing forward.

Robert Scoble (San Francisco based tech evangelist) describes in his blog Scobleizer, the platform waves as follows: "Spatial computing is the fourth visible user interface of the personal computer era. The first was MS-DOS. The second was the GUI, graphical user interface for Macintosh and Windows. The third was touch for I-Phone and Android and the fourth is spatial computing for MR."

Neuroscience-driven interface principles mimic how humans interact with each other and the environment.

With these design principles, developed by the father of wearable computing Steve Mann, there is close to a zero-learning curve for the user. Adapting a device with this interface (spatial computing) would feel natural and have little cognitive imposition on the user and greatly increase efficiency in intuitive and spontaneous tasks.

Most of today's mobile phones are Augmented Reality compatible, but the usability is limited due to the phones form factor. The user need to hold the phone with one hand, and interact with the other one. With a set of glasses or HMD the hands remain free to do other tasks and leaves the user completely free to roam around in her environment.

See through display systems only recently became affordable to produce in masse and so thin they become discreet. The light-guide essential for MR has gone down in size from a bulky 2 cm thick crystal to a seamless, less than 1 mm thick filament. This allow fashionable Mixed Reality enabled wearable devices and new product designs, similar in style with the LaForge Shima fashionable glasses.

Positioning systems and registering technology have already been field tested along with VR products and continue to see rapid development in precision.

8.2 Mobile phones vs Mixed Reality devices

The design no longer fit how we physically execute tasks.

The phone is designed as a phone, but is no longer used as one. I argue that the user is held back by the form factor of the product and that there is a need for novel ways of human computer interaction.

In my opinion a new novel way for HCI (human computer interaction) is neuroscience driven interface design with gesture control.

Something between functional glasses and shades provide another freer interface for all stuff that are not phoning.

Today a mobile phone is rarely used to phone, and with voice communication the phone specific interface isn't even necessary to use.

We can observe that some phones even talk and listen, meaning the phone doesn't necessarily even utilize its own interface.

Today mobile phones are used for almost any daily task and phoning itself is no longer the main reason for owning a phone, some could even say it is a minor use case.

Phones and tablets represent the third wave of computing platforms. MR/AR/VR all represent the 4th wave of computing platforms which display content in 3D.

Since MR utilize mobile technology it is a logical evolutionary step to move away from small screens to interactive 3D environments. Even though the micro-electromechanical systems aren't yet ready to be integrated into one seamless set of fashionable glasses, the progress show that within a foreseeable future this however is the case.

8.3 Drawbacks of the technology

Sensing equipment are still today a small drawback, latency and inaccuracy regarding the gesture control interface is a source of frustration for the user.

Even though most companies launching HMD computers come with gesture control as a standard, most still rely on round-sticks or a mouse and keyboard to work efficiently. The gesture control tracking is not yet competing with traditional control accessories.

The market is currently experiencing a major interference from law-suits between companies driving this field forward. (See Apple vs Magic Leap, HTC vs Oculus Rift).

This had a negative impact on how investors felt about Virtual Reality experiences and arguably put a plug in the hole for cash-flow and possibilities for engineers, developers and entrepreneurs.

8.4 Mixed Reality, hype or major innovation?

So far though there has been no consumer hit of seamless digital eye-wear. The first big hit wonder might shape pre-conceptions for the big audience about the technology.

Businesses and service providers however show interest in MR and many industries have adopted this tech into their daily work routines. More insights about this in the Appendix, companies affiliated.

Eventually there will be something that lures the customers into buying a device that'll replace the mobile phone or a home computer. I personally believe this shift is going to take place within the next 5 years.

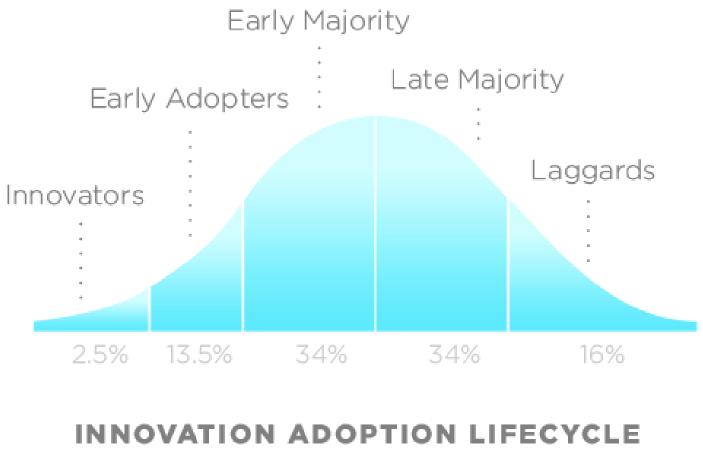

Figure 21. Graph above (Robert Bell's curve) show how masses of people adopt new products since its initial release to a period of 10 years.

MR has proven to be a great tool for spatial understanding, when a customer or designer can physically dive into the virtual world created and be present in this virtual reality, they get a more hands-on experience in scale rather than just another model.

Trying to map all the potential use cases for MR is a wasted effort since imagination is the limit.

So far the first adopters of MR in business are in the fields of medicine, education, engineering and real-estate. My research show that MR is currently a hot topic among most big technology companies who are betting big money on that now indeed is the time for MR.

Many technology executives estimate the AR revolution to have its major break-through in between 2017-2020 when the technology reaches a maturity level in comparison with mobile phones.

All-in-all I believe MR devices are going to become a device similar in popularity as a tablet or laptop computer. I also believe MR is going to revolutionize education, communication, engineering, logistics and play an essential role in automation of factories within the next 5 years.

I do not believe Mixed Reality is only a hype, but truly a major innovation and one huge influencer of society when matured enough.

9 APPENDIX

9.1 People interviewed

The people mentioned below are curious people with insights of the market and technology. I am grateful for the opportunity and time they have given to provide me with insight and expertise in the sub-fields this thesis relates to.

Thank you.

Jan Ameri & Dmitri Sarle, Co-founder and CEO - ArcticStartup

Tero Aaltonen, CEO - Augmenta API, entrepreneur

Shioumen Datta, Ph.D – MIT Massachussets Computer Sciences

Thomas Grandell, CEO - Etsimo browser

Ricardo Haratani, Game designer of Kumoon VR

Emmi Jouslehto, CEO - Robust North

Antti Jäderholm CEO - Vizor.io

Mikko Järvilehto - Ultrahack CEO, entrepreneur

Tuomas Karmakallio - YLE VR-Hub, Independent game developer

Kristoffer Lawson CEO, Joona Kallio Lead Design - Solu computers

Olli Sinerma Co Founder, Niko Rantala CEO - MindField Games

Didrik Steinsson, Marketing - MureVR, Breakroom, entrepreneur

Antti Sunnari CEO - Dispelix

Alf Rehn Ph.D - Lecturer

Kosti Rytkönen - FIVR, entrepreneur at Immersal

Tommi Ullgren - Mixed Reality consultant, entrepreneur

Professor Charles Woodward & ALVAR team – Aalto & VTT

9.2 Companies affiliated

Amazon
Android
Alcatel Lucent
Apple
Atheer Air http://www.atheerair.com/smartglasses
Avegant
Augmenta
Better Day – Elder care VR
Blippar - https://blippar.com/en/products/computer-vision-api/
Carl Zeiss - lenses
Darpa
Dispelix http://www.dispelix.com/
Facebook
Father.io
FIVR
Google
Google Glass
Gravity sketch VR
Hololens https://www.microsoft.com/microsoft-hololens/en-us
HTC - Vive
IBM
Intel - RealSense depth camera
Magic Leap https://www.magicleap.com/#/home
Metavision
Microsoft Kinect
Mure VR
Niantic labs
Nokia
Nvidia
LaForge Optical http://www.laforgeoptical.com/
Layar AR browser
Oculus Rift
ODG and Epson http://www.osterhoutgroup.com/home

Orbecc BT tracker
Robust North - Arilyn app http://www.robustnorth.fi/
Samsung Gear
Somo Optical Korea
Unity 3D
Valve – Steam VR
Vico VR
Vizor – Browser V
Vuforia
Vuzix
Windows10 OS
YLE
Quallcomm

10 REFERENCES

Avegant Light Field 2017.

Available from: https://www.avegant.com/blog/company-news/introducing-avegant-light-field

Retreived 18.4.2017.

Bloomberg 2016. Tim Cook and future of Apple regarding AR.

Available from: https://www.bloomberg.com/news/articles/2017-03-20/apple-s-next-big-thing

Retrieved 22.3.2017

Business Insider 2015. VR sales forecast 2015.

Available from: http://www.businessinsider.com/virtual-reality-headset-sales-explode-2015-4?amp%3bIR=T&r=UK&IR=T&IR=T

Retrieved 10.10.2016

Digi-capital 2016. Data from the 4th wave of information technology.

Available from:http://www.digi-capital.com/news/2016/07/virtual-augmented-and-mixed-reality-are-the-4th-wave/#.WLlZIPl95dh

Retrieved 29.7.2016

Dispelix 2016. Light guides for AR eye-wear.

Available from: http://www.dispelix.com/

Interview available from: http://arcticstartup.com/opinions/finnish-startup-promises-to-turn-any-glasses-smart-already-2017/

Retrieved 1.2.2016

FIVR official homepage 2015. Finnish Virtual Reality Association.

Available from: https://fivr.fi/

Retrieved 1.2.2016

Google Glass review 2017.

Available from: http://www.techradar.com/reviews/gadgets/google-glass-1152283/review

Retreived 18.04.2017

HTC official 2016.

Available from: https://www.vive.com/eu/

Retrieved 5.5.2016

Haptic al 2016. AR themed news-source, one of the most up to date channels and a daily source for my research.

Available from: https://haptic.al/

Retreived 15.04.2017

Humanvox 2016. Issues, pros and cons of AR.

Available from: http://www.humavox.com/blog/pros-cons-augmented-virtual-reality/

Retrieved 1.4.2017

IEEE 2015. Major issue for AR. Solution delivered Avegant 2017.

Available from: http://spectrum.ieee.org/tech-talk/consumer-electronics/gaming/4d-light-field-displays-are-exactly-what-virtual-reality-needs?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+IeeeSpectrum+%28IEEE+Spectrum%29&utm_content=FaceBook

Retrieved 29.3.2017

IEEE 2011. Augmented Reality in engineering.

Available from: http://ieeexplore.ieee.org/document/6079279/

Retrieved 15.4.2016

Johannesberg Summit 2013. Gerard Fittweiss on 5G networks and birth of industrial internet.

Available from: https://www.youtube.com/watch?v=_VXEPzQgpok

Retrieved 20.11.2015

Kguttag 2017. Avegant Light field product, engineering review.

Available from: http://www.kguttag.com/2017/03/09/avegant-light-field-display-magic-leap/

Retrieved 10.3.2017

LaForge optical Homepage 2016.

Available from: https://www.laforgeoptical.com/

Retreived 18.4.2017

Magic Leap Official 2017.

Available from: https://www.magicleap.com/#/home

Retreived 18.4.2017

Markets and Markets 2016. Full MR market analysis of AR and VR technology.

Available from: http://www.marketsandmarkets.com/Market-Reports/augmented-reality-virtual-reality-market-1185.html

Retrieved 1.11.2016

Microsoft Hololens official 2016.

Available from: https://www.microsoft.com/en-us/hololens

Retrieved 6.11.2015

Nordic Business Insider. Tim Cook CEO of Apple, Apple and Augmented Reality.

Available from: http://nordic.businessinsider.com/apple-ceo-tim-cook-explains-augmented-reality-2016-10?r=US&IR=T

Retrieved 3.10.2016

Oculus Rift Official 2016.

Available from: https://www.oculus.com/blog

Retrieved 5.5.2016

Osterhaut Group 2017. Smart glasses, AR enabled platform.

Available from: https://shop.osterhoutgroup.com/

Retrieved 15.9.2016

Scobleizer 2017. Robert Scoble official blog, computing platforms, gesture control interfaces and future AR landscape. Scoble a famous technology enthusiast with a considerable follower group.

Available from: http://scobleizer.com/

Retrieved 15.3.2017

TED 2016. Alex Kipman explains Mixed reality in an easy manner and showcase a holographic call onstage.

Available from:
https://www.ted.com/talks/alex_kipman_the_dawn_of_the_age_of_holograms?language=sv#t-426829

Retrieved 1.12.2016

Unity 2016. Assets Official:

Available from: https://unity3d.com/unity/editor

Retrieved 20.9.2016

Vuforia Official 2016. Developer platform for AR.

Available from: https://www.vuforia.com/

Retrieved 14.7.2015

VR-motion sickness 2016 – Why do some of us get sick and how to make it stop.

Available from: https://www.wareable.com/vr/vr-headset-motion-sickness-solution-777

Retrieved 15.4.2017

YLE 2016. Tapio Takala, Charles Woodward and other field experts on MR

Available from: http://areena.yle.fi/1-3660860

Retrieved 10.10.2016

YLE 2016. CEO of Unity, David Helgason on AR and business outlook.

Available from: http://yle.fi/uutiset/3-9211453

Retrieved 7.10.2016

Youtube 2016. Jack Ma, CEO of Alibaba in Hannover 2016 at CeBit conference, facial recognition, artificial intelligence, augmented reality.

Available from: https://www.youtube.com/watch?v=u0inSsAoFU4

Retrieved 1.4.2017

3Dvrcentral 2016. VR headsets will be as small as regular glasses according to Quallcomm. Available from: http://3dvrcentral.com/2016/10/18/vr-headsets-will-small-regular-glasses-soon-says-qualcomm/

Retrieved 18.10.2016.

10.1 References of visual materials

Figure 1. Google Glass 2013.

Available from: http://www.edudemic.com/guides/the-teachers-guide-to-google-glass/

Retrieved 3.3.2017

Figure 2. Alex Kipman on TED 2016.

Available from: https://www.recode.net/2016/2/18/11588018/burned-by-kinects-fizzle-microsoft-is-taking-its-time-with-hololens

Retrieved 15.3.2016

Figure 3. Zuckenberg on Facebook Keynote 2016.

Available from: https://www.cnet.com/news/facebook-mark-zuckerberg-shows-off-live-vr-virtual-reality-chat-with-oculus-rift/

Retrieved 9.10.2016

Figure 4. The four main hardware types of AR. Provided by Professor Shioumen Datta Ph.D, MIT Massachussets (2015).

Figure 5. Hololens widgets 2015.

Available from: https://www.gamespot.com/articles/microsoft-s-hololens-is-something-different-than-o/1100-6424809/

Retrieved 23.2.2016

Figure 6. Meta 2 HMD profile 2016.

Available from: https://www.slashgear.com/meta-2-augmented-reality-headset-dev-kit-release-the-oculus-of-ar-02430020/

Retrieved: 3.3.2016

Figure 7. Avegant engineering prototype 2017.

Available from: http://www.kguttag.com/2017/03/09/avegant-light-field-display-magic-leap/

Retrieved: 9.3.2017

Figure 8. Avegant Light-field Occlusion demo 2017.

Available from: https://www.avegant.com/blog/company-news/introducing-avegant-light-field

Retrieved 9.3.2017

Figure 9. ODG R-7 MEMS layout 2015.

Available from: http://forums.windowscentral.com/microsoft-hololens/336356-hololens-compare-odg-products-spec-video.html

Retrieved: 19.4.2017

Figure 10. Google Glass light-guide 2013.

Available from: http://www.digitaltrends.com/mobile/google-glass-30-minute-videobattery/

Retrieved: 20.1.2016

Figure 11. Dispelix Light-guide solution 2015.

Available from: http://www.dispelix.com/

Retrieved: 15.2.2016

Figure 12. LaForge optical fashionable digital eye-wear 2016.

Available from: http://www.moa.zcu.cz/hcewiki/index.php/Laforge_Shima

https://www.laforgeoptical.com/shima/product-info

Retrieved: 1.10.2016

Figure 13. VicoVR Bluetooth and IR motion capture camera 2016.

Available from: http://vicovr.com/

Retrieved: 10.12.2016

Figure 14. Leap motion Orion 2016.

Screenshot, available from: https://www.youtube.com/watch?v=Ki2TDXMQcD0

Retrieved: 1.5.2016

Figure 15. Google Soli radar 2015.

Available from: http://tech.firstpost.com/news-analysis/google-io-project-solis-radar-based-gesture-control-could-redefine-wearable-interfaces-269005.html

Retrieved: 12.11.2015

Figure 16. Intel RealSense depth camera 2015.

Screenshot, available from: https://www.youtube.com/watch?v=uINRC83tlTA

Retrieved: 10.1.2017

Figure 17. Unity5 3-D model of bedroom 2015.

Available from: https://blogs.unity3d.com/2015/11/10/bedroom-demo-archviz-with-ssrr/

Retrieved: 19.4.2017

Figure 18. A demo of AR showing a power-plant model 2013.

Available from: https://developer.vuforia.com/forum/general-discussion/tell-us-about-your-vuforia-application-or-game

Retrieved: 19.04.2017

Figure 19. Vuforia SDK 2014.

Available from: http://developeriq.in/articles/2014/sep/25/developing-android-augmented-reality-applications/

Retrieved: 10.11.2016

Figure 20. Augmenta interaction platform 2015.

Available from: http://augumenta.com/

Retrieved: 9.4.2016

Figure 21. Robert Bell's curve 2013.

Available from: https://en.wikipedia.org/wiki/Technology_adoption_life_cycle

Retrieved 19.4.2017.

Table 1-3. MR field expected growth.

Avasilable from: http://www.digi-capital.com/news/2016/07/virtual-augmented-and-mixed-reality-are-the-4th-wave/#.WPdBStKGNdg

Retrieved: 1.10.2016.

11 SUMMARY IN SWEDISH

11.1 Introduktion

I denna avhandling utforskar jag uppkommande, lovande teknologier vid namn Augmented Reality (AR) och Virtual Reality (VR). En vanlig term för båda teknologierna är Mixed Reality, kort sagt MR.

Jag kommer evaluera hur troligt det är att denna teknologi blir en vanlig företeelse på marknaden under de kommande åren. Jag kommer att titta på själva teknologin, möjliga användningsområden, samt dess nackdelar.

Jag gjorde denna studie för att ta reda på ifall det endast är ett hype kring Mixed Reality eller står vi framför en revolution inom datavetenskap?

Enligt VD:n för Apple, Tim Cook, kan Augmented Reality inom ett decennium bli större än dagens mobil-industri. En person som ämnar bli professionell inom området digitala medier, bör inte ignorera denna teknologi.

11.2 Frågeställning

Hur sannolikt är det att vi övergår från tvådimensionella skärmar till interaktivt 3D-innehåll i och med Mixed Reality teknologi inom det kommande decenniet?

11.3 Syfte och motiv

Mitt syfte med denna forskning är att få kunskap att utveckla ett set av meta-reality glasögon som använder sej av mobilteknologi och tolkar handsignaler samt kroppsspråk som användargränssnitt.

11.4 Metoder och insamling av data

Jag har använt mej av följande metoder:

- Kvalitativ forskning: Som teknologijournalist för ArcticStartup utförde jag djupgående intervjuer av experter och entreprenörer inom fältet VR/AR/MR.
- Kvantitativ forskning: Kontaktade utvecklare och profiler inom MR med frågor i ett standardiserat format.
- Empirisk forskning: Testade flera MR set i samband med seminarier, hackathon och som medlem av FIVR (finska VR föreningen).
- Skrivbordsforskning: Följde regelbundet kanaler med den senaste informationen inom området, bland de viktigaste: FIVR slack kanalen, och Facebooks Virtual Reality grupp.

12 KORT OM MIXED REALITY

Mixed Reality är en allmän term för Virtual Reality (VR) och Augmented Reality (AR) samt holografiska datorer.

Augmented Reality använder sej av fyra delområden av teknologi för att forma en MR produkt.

- 1. Skärmteknologi; innebär det medium via vi ser innehållet.
- 2. Spårnings- och registreringsverktyg; positionerar innehållet där det bör vara.
- 3. Trådlösa signaler; spårar användaren på flera plan samt ger maskinen en kontextuell medvetenhet om vad som bör eller kan visas på vilken plats.
- 4. Interaktionsteknologi; hur vi är i växelverkan med maskinen för att få våra avsikter gjorda via användagränssnitt.

13 SLUTSATSER

Det är viktigt att förstå att detta konstanta tillstånd av teknologisk innovation bryter traditionella sätt hur saker och ting fungerar. Nya och bättre lösningar dyker upp snabbare än någonsin. Det som har tidigare varit stora företags immateriella rättigheter, hittas idag bland öppna källkods-arkiv, och snart är förbättrade modifikationer i bruk.

Stora teknologiföretag som Intel och IBM har inte råd att inneha in-house immateriella rättigheter, eftersom det kommer att sakta ner utvecklingen. Detta har haft en försnabbad effekt på två sätt; företag som driver detta område framåt behöver inte satsa enorma pengar i forskning och utveckling. Det finns en global gemenskap av utvecklare som för denna teknik framåt med hjälp av dessa teknologijättar. Det har dykt upp ett nytt ekosystem för jobb, det är inte längre bara ”isolerade” ingenjörer i företagens källare som driver denna industri framåt.

Vi kan se att trots kritik och hinder, såsom ocklusion och regnbågseffekten i linserna, har svårigheterna övervunnits och dessa nya lösningar används idag som standard.

Priset på linserna har också minskat kraftigt, och ser ut att forsätta sjunka. Dessa delar av ekvationen har lösts av Avegant och Dispelix som vi bekantade oss med i tidigare case.

I framtida produktioner kommer kablar och ledningar att falla bort från produkten (HMD)

MEMS (mikroelektromekaniska system) blir mindre, billigare och mer effektiva (Moores lag). Detta i sin tur möjliggör direkt integration till huvudmonteringen eller glasögonen själva och tillåter helt ny formgivning av MR produkter.

I en nära framtid, är moln-rendering så kraftfull att den anordning som utför det visuella för MR inte behöver ha dyra processenheter. I stället fördelas processen över flera enheter, vilket i sin tur sänker priset på MR-produkter ännu mer och samtidigt ökar anpassningen av nämnda anordningar. Vi kan observera att de MR produkter som idag kostar tusentals euro kommer att sjunka till några hundratals euro inom en nära framtid.

En trend som kommer att påverka hela industrin.

Hårdvaran i MR är mobil teknik, de flesta av de teknologiska instrument för MR är bekant för många.

Det som kanske avskräcker nya användare är att användargränssnittet för MR skiljer sig från pekskärmar och personliga datorer, men inlärningskurvan är ganska snabb och intuitiv att plocka upp.

Stora framgångar såsom Pokemon Go och Snapchat (med över 1 miljard nedladdningar tillsammans) har gett den stora allmänheten en inblick i vad Augmented Reality egentligen är.

Lägg dessa slutsatser tillsammans och vi har ett mycket lovande landskap för en revolution i datoranvändning. Jag tror på grund av min forskning att Mixed Reality är inte bara ett hype, utan i själva fallet nästa megatrend inom teknik och en standard för framtiden. Jag tror också att MR-teknologin kommer att hitta sin väg in i de flesta yrken och ha en enorm påverkan på flera industrier.

13.1 Viktig sammanfattning

De flesta huvudmonterade skärmar (HMD) som diskuterats i denna avhandling har varit ute på marknaden i knappt ett år och är fortfarande i tidigt utvecklingsskede.

Som utvecklingen framskrider nu kan vi se nya datorplattformar ta form. Plattformar med operativsystem annorlunda än de menade för 2-D datorer och pekskärmar eller mobiler.

Att hoppa till nästa dimension, 3-D och förstärkt verklighet (AR) är en naturlig utveckling. Eftersom innehållet visas i 3D, bör också användargränsnittet följa utvecklingen. Ett naturligt användargränssnitt är att mäta handsignaler i koordination med det vi ser.

Principer för användargränssnitt har tagits från neurovetenskap och efterliknar hur människan interagerar med varandra och miljön.

Med dessa principer, som utvecklats av fadern till "wearable computing", Steve Mann, har gjort det lätt för användaren att ta sej an, eftersom det kopierar hur vi är i växelverkan med vår omgivning och andra människor.

Att ta i bruk en enhet med detta gränssnitt (spatial computing) känns naturligt och har en mycket liten kognitiv belastning på användaren och ökar effektiviteten för intuitiva och spontana uppgifter.

De flesta av dagens mobiltelefoner är redo att möjliggöra AR, men användbarheten är begränsad på grund av telefonens formfaktor. Användaren bör hålla i telefonen med ena handen, och ge kommandon med den andra. Med ett set av glasögon eller en HMD blir händerna fria att göra andra saker och lämnar användaren fri att ströva runt i hennes omgivning.

Transparenta skärmar har nyligen blivit såpass billiga att producera för massproduktion samt så pass tunna att de blir diskreta. Ljusguiden väsentlig för Augmented Reality har gått ner i storlek från en två centimeter tjock kristall till en sömlös, mindre än ett millimeter tjockt filament.

Positioneringssystem och registreringsteknik har redan testats tillsammans med Virtual Reality produkter och självdrivande bilar som lanserades och testades under åren 2015-2016.

13.2 Mobiletelefoner vs Mixed Reality set

Utformningen passar inte längre hur vi fysiskt utför uppgifter digitalt. Telefonen är utformad som en telefon, men används inte längre som en. Jag hävdar att användaren blir trögare av produktens formfaktor och att det finns ett behov av nya metoder för interaktion mellan människa och dator (HCI).

Ett nytt sätt för människor och maskiner att vara i växelverkan är rörelsekontroll, att använda händernas precisa rörelser som användargränssnitt.

Vi kan konstatera att vissa telefoner kan tala och lyssna, vilket innebär att telefonen inte nödvändigtvis ens använder sitt eget gränssnitt.

Dagens mobiltelefoner används i nästan alla dagliga arbeten och att ringa i sig är inte längre den främsta orsaken till att äga en telefon.

Telefoner och tabletter representerar den tredje vågen av datorplattformar, MR/ AR / VR representerar alla den 4: e vågen av datorplattformar som visar innehåll i 3D.

Eftersom MR använder sej av mobil teknologi är det ett logiskt steg i utvecklingen att när chansen visat sej komma bort från små skärmar till interaktiva 3D-miljöer.

Även om mikro-elektromekaniska system ännu inte är redo att integreras i en sömlös uppsättning av ett par glasögon, visar de framsteg som åstadkommits hittills, att inom en överskådlig framtid kan detta landskap ändras.

13.3 Kort om nackdelar

Sensorer är än idag en nackdel, tid för respons och felaktigheter i rörelsekontroll begränsar hur flytande gränssnittet känns och är en källa till frustration för användaren.

Det har gått en del rättegångar angående patenträtter (se HTC Vive vs Oculus Rift, Magic Leap vs Apple). Detta har gjort investerare vaksamma och det kan argumenteras att detta har förorsakat ett stopp på pengaflödet för entreprenörer och utvecklare inom fältet.

Även om de flesta företag lanserar HMD datorer med rörelsekontroll som standard är de flesta fortfarande beroende av kontrollmoduler som en mus och tangentbord för att arbeta effektivt. Rörelsekontroll konkurrerar inte än med med traditionella verktyg som styrspakar, mus eller tangentbord.

13.4 Slutledning

Till slut vill jag säga att jag tror starkt att denna teknologi kommer att sakta krypa in i vardagen, som sträcker sig från hur vi använder transport i staden till hur vi styr och ställer i våra hem och socialiserar med människor.

Att försöka kartlägga alla potentiella användningsfält för MR är en bortkastad ansträngning, fantasin är gränsen. Men tiden verkar mogen för denna uppkommande teknologi och vi kan förvänta oss se flera MR enheter dyka upp på marknaden och finna sina niche områden och specialförmågor inom de kommande åren.