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Visual Computing

Technology Report

Vienna, January 2017

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Introduction

Dear Readers,

Vienna is among the top 5 ICT metropolises in Europe. Around 5,800 ICT enterprises generate sales here of around 20 billion euros annually. The approximately 8,900 national and international ICT companies in the "Vienna Region" (Vienna, Lower Austria and Burgenland) are responsible for roughly two thirds of the total turnover of the ICT sector in Austria.

According to various studies, Vienna scores especially strongly in innovative power, comprehensive support for start-ups, and a strong focus on sustainability. Vienna also occupies the top positions in multiple "Smart City" rankings. This location is also appealing due to its research- and technology-friendly climate, its geographical and cultural vicinity to the growth markets in the East, the high quality of its infrastructure and education system, and last but not least the best quality of life worldwide.

In order to make optimal use of this location's potential, the Vienna Business Agency functions as an information and cooperation platform for Viennese technology developers. It networks enterprises with development partners and leading economic, scientific and municipal administrative customers, and supports the Viennese enterprises with targeted monetary funding and a variety of consulting and service offerings.

Support in this area is also provided by the technology platform of the Vienna Business Agency. At technologieplattform.wirtschaftsagentur.at, Vienna businesses and institutions from the field of technology can present their innovative products, services and prototypes as well as their research expertise, and find development partners and pilot customers.

The following technology report offers an overview of the many trends and developments in the field of Entertainment Computing. The term Entertainment Computing describes B2C solutions (hardware and software), which can entertain a person in their free time. In the broadest sense, it describes all technologies which can be assigned to entertainment electronics (Consumer Electronics). In this report, we will accordingly include everything from digital film, book, and newspapers, from Smart TV to games.

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1 From scan to model

Picture processing technologies have found a new place of importance in both our economy and society. The data transfer of visual information which is being produced and communicated has increased dramatically over the last years with the introduction of digital cameras. In the beginning of 2008, Facebook celebrated the record of a total of 10 billion saved photos.[1] Currently, the average upload amounts 350 million photos per day into this social network.[2] Furthermore 76% of all Internet users who publish personal information post or share private photos. YouTube alone is responsible for more than a third of the data volume in the Internet worldwide. Every day, videos with a total duration of several hundred million hours are reproduced as well as billions of views are generated on YouTube.[3]

The increasingly higher resolution, high-intensity sensors capture objects in a three-dimensional space. Scanners can scan and create virtual spaces with minimum delay. The digital eye is so exact that it is as well suited for quality control as it is for capturing a group of people together with their movements. Using this data, scenarios are simulated in virtual spaces which find an application in many areas. For example for planning purposes, the maximum capacity of streets can be calculated. During the traffic planning for the expansion of the S1 expressway in the Seestadt Aspern in Vienna, traffic was simulated in virtual spaces. Hotspots, access roads, and number of lanes were simulated several months before the start of construction, noted Werner Purgathofer during his presentation on the topic of Visualization and Visual Analytics. [4]

[1] https://www.facebook.com/notes/facebook-engineering/10-billion-photos/30695603919/
[2] https://www.omnicoreagency.com/facebook-statistics/
[3] https://www.youtube.com/yt/press/de/statistics.html
[4] Businesstreff Event „Visual Computing“ organised by the Vienna Business Agency on 19th November 2015.

However, the fields of application of the underlying technologies can be found in a wide range of areas.

In the production world, sensors and cameras enable quality control to take place faster and with fewer errors. Even minor variances are identified, and the data can be passed on to the remaining production process. This supports the planning process and allows for a fast response time to customer requests.

In the field of medicine, the smallest items can be portrayed with the capture of higher dimensional data. Not only body parts, but also chemical bonds can be made visible and touchable.

Big data: the more detail that the sensors and scanners capture in the surrounding area and of objects, the larger the amount of stored data. For the analysis of huge amounts of data, graphically prepared, multi-colored and -dimensional illustrations are an enormous aid. In contrast to tables, they turn scenarios into something visible and easily understood.

Optical sensors deliver additional information which makes them important as a way of displaying the environment in the computer, which, in turn, stimulates entire environment in virtual reality. If 3-D objects, modeled before implementation, are added to the live camera picture during space planning, then possible solutions can be visualized. Parameters can be quickly changed and facilitate decision-making.

Anonymous detection of people at airports and public spaces, as well as perimeter security, helps to increase security. Whether a cat or a break-in: location and environmental data is analyzed and movements are recognized and correctly classified. Lines and delays during passport control can be recognized early and controlled by the opening of additional counters.

Virtual und augmented reality are already important components in the entertainment industry. The background landscapes in computer games are becoming increasingly more realistic. Walls, woods, fabrics, as well as the simulation of weather and light are increasingly realistic. Visual effects and artificially generated backgrounds are taken for granted in movies, since this avoids the construction of elaborate and cost-intensive sets.

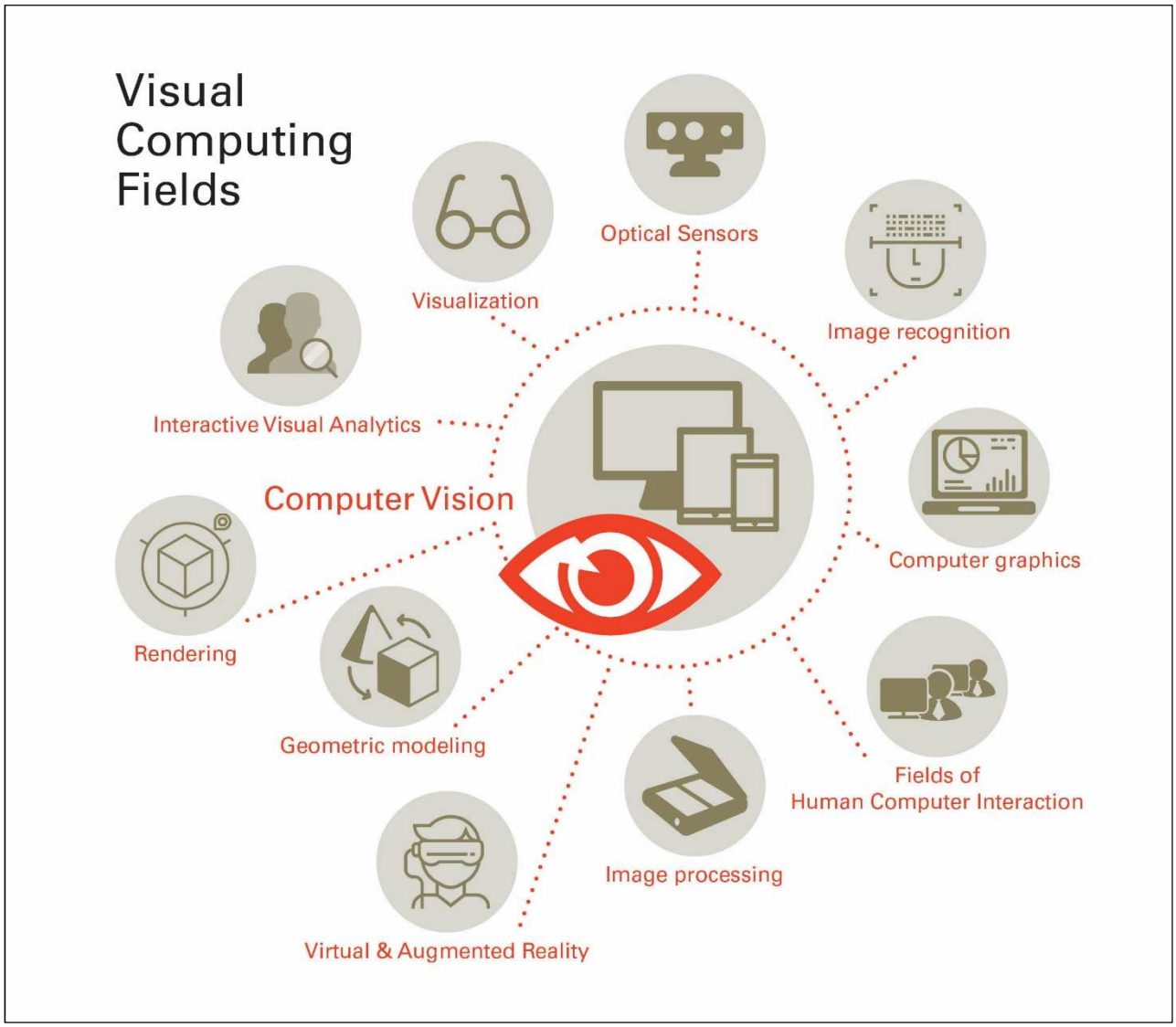
With the use of 3-D printing, models of complex architectural projects can be produced just as quickly and cost-effectively as prototypes in production technology all the way to models of rows of teeth in medicine. Patients receive a computer-generated, printed test model which can be tried on and fitted, replacing extensive medical procedures.

Since technology continues to develop, with sensors and cameras becoming faster with more accurate resolution, and the visualization process is becoming faster thanks to increasingly fast processors, increasingly more realistic images of our surrounding environment in which we move with our mobile devices will become possible. We will see which technologies of all the foreseeable future scenarios are becoming reality and the user ultimately really accepts.

2 Industry applications and technologies

The term “visual computing” is still relatively young. The disciplines which were established in 2005, which include computer graphics, picture processing, computer vision, and others which are similar in their method and use, were summarized under this new term at the first International Symposium for Visual Computing ISVC 2005[5], which was held in Nevada. Many of the methods in use here, including picture formats, filter methods, color models, programming methods, the processing of large amounts of data, and the use of graphic hardware are the same. Increasingly often, applications use techniques from several of the disciplines at the same time. “The term includes all disciplines of information technology which are involved with pictures. It is an interdisciplinary field, which, for many applications, will become part of everyday life and work”[6], says Werner Purgathofer from the Institute for Computer graphics of the TU-Wien.

In the following sections[7], different areas of application will be briefly discussed. Since the technologies and their importance in the respective areas of the still young information technology discipline can change quickly, the list is constantly being changed and expanded. The areas are differentiated by how far they are in their respective acquisition process, and according to their suitability for possible commercial applications.



[5] http://www.isvc.net
[6] derstandard.at/2000011821540/Mit-Visual-Computing-in-neue-Bilderwelten
[7] Written and revised by Werner Purgathofer, Institute for Computer graphics at the Technical University of Vienna

2.1 Computer graphics

For computer-supported creation and manipulation of pictures, graphic user interfaces are required. They must be perfectly adapted to the specific application. Complex forms are created in 3-D modeling, in which their structure can be changed. This plays an important role, for instance, in the entertainment industry, mainly in films and computer games. Computer graphics created in architecture and space planning are also the result of advanced computer graphic algorithms.

2.2 Computer vision – pattern recognition

Pattern and/or picture recognition describes techniques which can extrapolate information about the contents from provided pictures. Computer vision describes the capability of the computer to recognize the environment and to interpret it correctly. In this case, realistically modeled objects portray realistically detailed scenes. Human vision is re-created and allows the visual to be interpreted. Used in medicine, this allows organs to be portrayed and their function to be observed in detail. In the production world, the patterns which are to be recognized in control and manufacturing technology are important for autonomous systems and robots.

“Seeing” systems are currently being used in industrial manufacturing processes in the areas of automation technology and quality assurance. Other applications for use are in traffic technology– from simple radar traps to the car that can “see” – and in security technology (entry control, automatic recognition of dangerous situations).

2.3 Visualization

Keyword Big Data: the larger the amount of data, the more important the optical display. Large amounts of raw data gathered by sensors are no longer just displayed in tables; multicolored, three-dimensional graphics display the values according to viewpoints. In technical fields and in science, for example chemistry and medicine, large volumes of data and higher dimensions of data become more easily understood. Some examples in medicine include computer tomography (CT) and magnetic resonance (MR).

2.4 Interactive visual analytics

This is the visual analysis of multidimensional abstract data prepared by the visualization process. By changing the parameters, temporal progression and changes become visible in real time. This is especially important in order to understand large amounts of data, for example bank-, user-, or weather data and their changes over a certain amount of time. Werner Purgathofer: “The true challenge is to prepare data without any geometric components. It is like a glass cube which contains 100 black peppercorns. You can turn it, and look at it from all directions, until you recognize a pattern in the arrangement of the peppercorns”.[8]

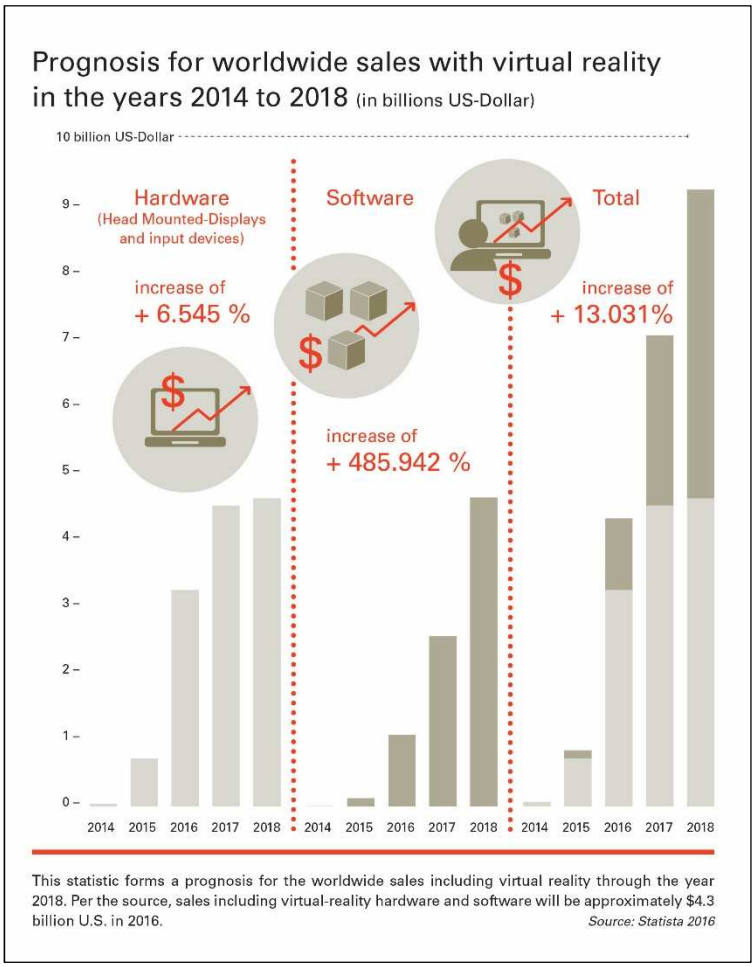
2.5 Optical sensors

Simulation of the environment: The environment is portrayed in the computer with the use of images and spatial samples. Environments can either be completely artificially reproduced using this method, or artificial elements can be combined with live camera photos.
“It is often desirable to have the capability to ‘run through’ complex and dangerous situations, before implementing them in reality”, knows Georg Stonawski, CEO of VRVIS. During construction planning, simulations show what is feasible and what the cost will be before beginning construction.
In the field of quality control, high-resolution sensors recognize the smallest variances, for example in manufacturing technology and automation. “Very fast processing of images is required in this case”, according to Markus Kommenda of AIT.

[8] derstandard.at/2000011821540/Mit-Visual-Computing-in-neue-Bilderwelten

2.6 Virtual & augmented Reality

Virtual Reality (VR) describes the three-dimensional simulation of entire spaces and environments, while in Augmented Reality (AR) scenarios the live picture is expanded by 3D generated elements. Developments in both areas can also be summarized under the term "mixed reality".



From special VR glasses through 360-degree camera shots and their presentation with simple Smartphone VR glasses as well as various camera techniques are all located in the area of virtual reality. VR glasses always replace the real image ("live" image), but allow interactions and movements. Through the use of more and more precise optical sensors as well as continuous research & development, not only in the hardware sector, the simulations become more and more realistic and credible.

In the AR area, on the other hand, the real image is always visible but is expanded by digital content. The real image can be displayed either by the use of transparent AR-glasses or displays, or through representation with the help of (smartphone) cameras. Video games and apps on the smartphone are usually using still existing sensors such as GPS to display additional information. Historical data on buildings and monuments can be displayed as well as navigation aids at the airport or current offers from shops in the immediate surrounding.

As a tool for salespeople, when rooms are being refurbished, virtual furniture can be placed into the live camera image and will give the customer the chance to view the end results and to change positioning as well as shape and size. Without using any live camera images, artificial, virtual rooms are used when planning houses, or for traffic simulation during street construction. The possibilities in both worlds are practically endless. One of the best-known forerunners for commercial applications are the AR glasses “Google-Glass”[9].

2.7 Rendering

Rendering, also known as image synthesis, is the process of creating photorealistic images. The visualized spaces and objects are rendered with elaborate textures for both individual images as well as image sequences (videos). The viewpoint of the visible object, including appearance, texture, material characteristics, light, shadow, and the covering of other objects must be taken into consideration. In movies and games, the interactive synthesis of images in real time, which is where the most hardware acceleration is necessary, is especially important. Not using the simulation of movement sequences and environmental parameters such as light and wind is unthinkable today.

[9] https://developers.google.com/glass/distribute/glass-at-work

Another field for application is the planning of houses and rooms. In offices, the reflections on glass panes and tabletops can be portrayed with light simulation, allowing lighting to be optimally planned. Realistic image synthesis is used in this case. This contrasts with interactive synthesis where high image quality or physical correctness is important and the calculation time required plays a less important role. Safety management is an area where this is used during construction planning. Events which are hard to predict, such as fires and floods, are simulated and evacuation scenarios are planned and calculated accordingly.

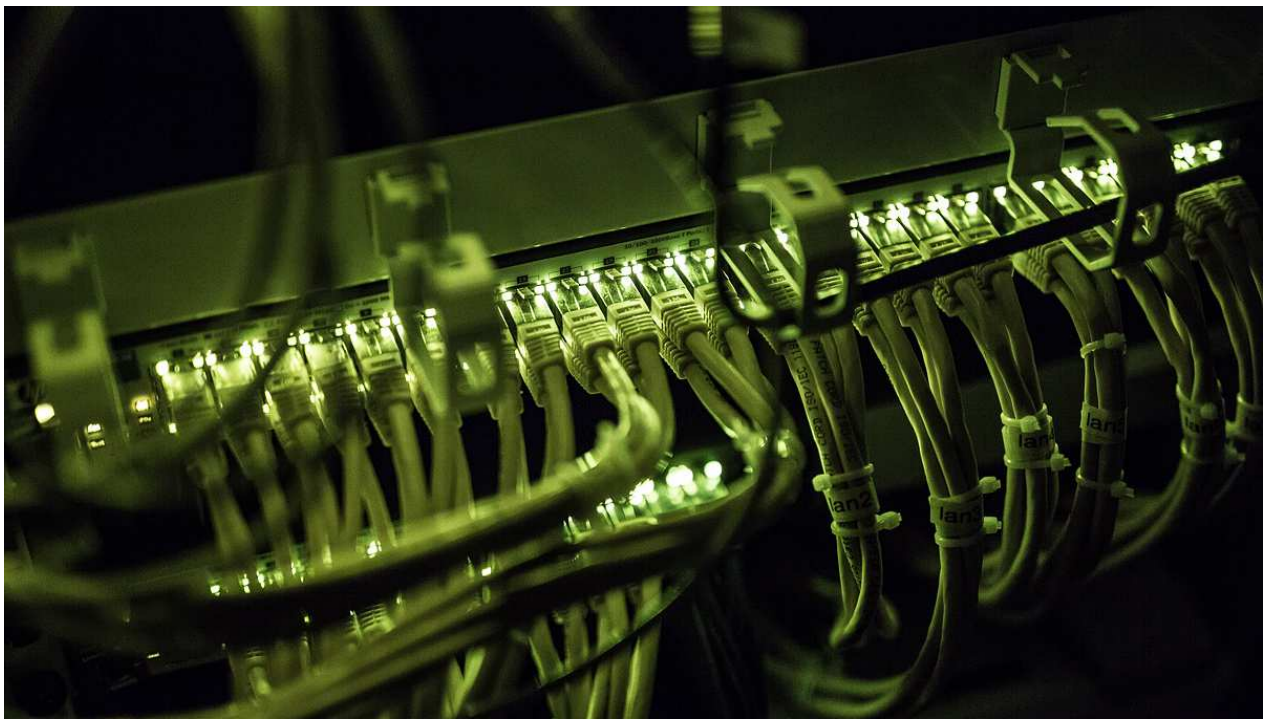
2.8 Geometric modeling & 3D print

The term “geometric modeling” means the special methods and data structures used to render realistic models out of the raw data from optical sensors. This can be used, for instance, to calculate distances from and to certain objects using photos taken from different positions. Spaces can then be copied using CAD systems.

Geometric models can be expanded from two-dimensional curves to three-dimensional surfaces. A distinction is made between different presentation schemes, which are common in a variety of areas. Finally, algorithms used for the efficient guidance of 3-D printers are also counted to the area of visual computing.

2.9 Fields of human-machine interaction

This is the interactive visual steering of elements. One subsector is human computer interaction - HCI, which is involved with the user-friendly design of interactive systems and interfaces. Knowledge of information technology as well as psychology (especially media psychology), work science, cognitive science, ergonomics, sociology, and design are all used.
It is useful for every application in which graphic elements are required for the operation of complex machines or processes. When controlling gripper arms, information gathered ahead of time such as weight and type of material can be blended into the screen. This can improve oversight by putting emphasis or markings on certain elements.



3 Education and research in Austria

Not only national experts, but the Austrian startup scene also agrees: in the field of visual computing, Austria – with its research and education centers – is internationally at the top of the field. “Austria does not need bold hide its face in front of Silicon Valley”, says Georg Stonawski of VRVIS at the Businesstreff event “Visual Computing” in Vienna. “Considering the size of the country, Austria has a remarkably large visual computing community”, says Purgathofer[10].

Many internationally recognized data visualization research projects, for example in the field of traffic, originated from Austrian institutes and are responsible for a rapidly growing startup scene.

3.1 Research in Vienna

“Application-oriented research in the field of ´Visual Computing and Computer Vision’ is a distinctly strong field in Austria and especially Vienna”, per Markus Kommenda from the Austrian Institute of Technologie - AIT. Research at the capital takes place at the Technical University of Vienna, VRVis, AIT, the University of Vienna as well as the Medical University of Vienna.

According to CEO Georg Stonawski, **VRVis** considers itself to be the intersection point between the Universities and the industry – meaning those companies who have the desire and the ability to use the knowledge, especially that gained from current research projects. VRVis is a research and development company whose projects are separated into four areas: rendering, visualization, visual analysis, and computer vision[11]. An important example is the simulation of the environment, where complex and dangerous situations are first subjected to a “dry run” before they are implemented. This includes traffic construction planning and management of dangerous situations in cases of fire and floods. With the use of specially developed software, traffic jams can be simulated just as the speed and

[10] http://derstandard.at/2000011821540/Mit-Visual-Computing-in-neue-Bilderwelten
[11] http://www.vrvis.at/research

distribution of overflowing water during flood situations and the evacuations that it leads to. This allows countermeasures to be planned and, in turn the results to be simulated. The Software Visdom[12] supports the creation of flood water management plans. With this software, it is possible to create different types of barrier configuration by use of visualization. They can be then tested, and the results compared, in several simulation runs. Visdom is also available as a web-based system, calculations are carried out in real time on a distant server.

Visualization and simulation solutions have one thing in common: they present large amounts of data in a way that it can be easily viewed and understood. The goal is: "To effectively prepare data for the mayor so that the right decision can be made quickly", according to Stonawski.

Under the guidance of Werner Purgathofer, research is conducted at the **Technical University of Vienna**. Lectures in the field of Visual Computing are held at the University's Institute for Computer Graphics, which was created specifically for this purpose.[13] The bachelor program Media Informatics and Visual Computing combines the sharing of key technologies and technical processes in the fields of Computer Vision, Computer Graphics, visualization and Augmented/Mixed/Virtual Reality, with an education in the design of innovative interfaces.[14] In the Master's program, techniques in the fields of acquisition, representation, processing, analysis, synthesis, and use of visual information, along with images and image sequences in the context of time and space.[15]

The research field Intelligent Vision Systems at **the Austrian Institute of Technology – AIT** is separated into three key areas. The first is quality control and industrial inspection. Until recently, the recognition of errors and scrap was left up to the human eye. The goal is to develop solutions for automated visual recognition systems, which can be easily operated in a trustworthy manner. An example is the recognition of errors during the printing of banknotes. The second area deals with autonomous driving systems and assistance systems, which may be used soon in public transportation (tram and underground).[16] The servicing of heavy construction equipment will be improved using overview detection systems, which will offer more protection from collisions.

The last area deals with the monitoring of, and safety during, the recognition of groups of people. In the 2D-3D Flow and Scene Analysis project[17] the movement patterns of groups of people, for instance at airports, are measured to be able to calculate the optimum number of terminals at passport control. At the security check, the number of people entering a body scanner will be calculated. In this case, for example, one should be able to differentiate between a piece of luggage and a child being carried.

At the **University of Vienna**, Faculty for Computer Science, research takes place in the research group Visualization and Data Analysis (VDA)[18] in the fields "Design studies", "Parameter space analysis", and "Sampling and reconstruction", as well as in the research group Cooperative Systems (COSY)[19]. COSY research is a cooperative system with emphasis on "IP-based technologies in core and access networks", "Net-based information- and communication economy", "End-user and communications ecosystem", "Subjective quality of service", "Usable Security" and "Culture over IP".

Under the term "Medical Imaging", research is conducted at the **Medical University of Vienna** in the research cluster medical imaging.[20] This is one of the five areas of concentration in which the University conducts research. Their procedures have led to findings about genetic, biochemical, and cellular processes in living organisms and, in addition to allowing an exact presentation of morphological conditions, the presentation and quantification of organ-specific functions.

Furthermore, the techniques and technologies from the visual computing sector are, of course, also used in other disciplines and research units. For instance, there are research projects about digital imprints at the University dental clinic Vienna. The digital support by simulating a planned treatment, promises to improve the levels of success in dental care for both patients and medical professionals.

[12] http://www.vrvis.at/publications/pdfs/PB-VRVis-2011-018.pdf
[13] https://www.cg.tuwien.ac.at
[14] http://www.informatik.tuwien.ac.at/studium/angebot/bachelor/medieninformatik-und-visual-computing
[15] http://www.informatik.tuwien.ac.at/studium/angebot/master/visual-computing
[16] http://derstandard.at/1392685511860/Mit-den-Augen-einer-Bim
[17] http://ivs.ait.ac.at
[18] https://informatik.univie.ac.at/vda
[19] https://informatik.univie.ac.at/forschung/forschungsgruppen/cooperative-systems/
[20] https://www.meduniwien.ac.at/homepage/content/allgemeine-informationen/forschungscluster/medizinische-bildgebung/

The **VARAA - Virtual and Augmented Reality Association Austria** is an independent association of professional VR/AR users and companies in Austria. The focus is on awareness-raising in dealing with VR/AR and promoting and increasing public awareness. Furthermore the targets of the association include the areas of market observation and trend analysis, identification of application areas and the presentation and support of companies in the VR area.[21]

The working group Visual Computing[22] at the **Austrian computer society OCG** deals with the support and expansion of the field of research and industry, industrial quality control, medical image processing and visualization, measurement, robotics, multimedia systems, Virtual Heritage, visual effects in movies and TV and computer games.

3.2 Research in Austria

Furthermore, there is an impressive number of institutions with visual computing projects in the rest of Austria. For example:

At the **Institute of Science and Technology** in **Klosterneuburg,** Bernd Bickel's group conducts research on the development of new modeling and simulation methods and is working on efficient presentation and processing algorithms for materials and functional objects.[23]

The research group **Media Computing** at the **University of applied Sciences St. Pölten** is dealing with the concept, design, and implementation of interactive systems. The key areas are in the fields of human-computer interaction, game design, information visualization, visual analytics, multimedia signal processing, computer vision, and multimedia retrieval.[24]

At the **Kepler University** in **Linz,** the **Institute of Computer Graphics** is working on computer graphics and computer vision in the key areas of light field technology and visual analytics.[25]

In upper Austria, the **University of applied Sciences Wels/Hagenberg** is also conducting research and teaching classes in the field of visual computing.[26]

The business operations of the **Fraunhofer Institute** for Visual Computing is headquartered in **Graz**. The key fields of research include the areas visual decision support for the planning of production facilities, virtual engineering, for example for the optimization of interior guidance and navigation systems, and digital society.[27]

3.3 Educational situation

Computer graphics, computer vision, rendering, and 3-D animation are included as sub-disciplines in many training courses. Along with the Bachelor[28]-and master degrees [29] at the **Technical University Vienna**– and the already mentioned University of applied Sciences Wels and Hagenberg, are some additional examples:

The **Technical University Graz** offers the course *Mobile Visual Computing* by the **Institute for Computer Graphics and Vision -** Concepts and Methods for 3D- Graphics for Mobile Devices in Connection with GPS Data to Determine Location.[30]

Visual computing topics and key areas are also available at the **University Klagenfurt, Salzburg** and **Innsbruck**. In Salzburg, three labs for the section Visual Computing and Multimedia have been created: Computational Geometry and Applications Lab, Multimedia Signal Processing and Security Lab, and the Multimedia Communications & Security Lab.[31]

[21] https://www.varaa.at
[22] http://www.ocg.at/de/visual-computing
[23] https://ist.ac.at/de/forschung/formalwissenschaften/bickel-gruppe/
[24] http://mc.fhstp.ac.at
[25] http://www.jku.at/cg/content
[26] https://www.fh-ooe.at/campus-hagenberg/
[27] http://www.fraunhofer.at/de/vc.html
[28] http://www.informatik.tuwien.ac.at/studium/angebot/bachelor/medieninformatik-und-visual-computing
[29] http://www.informatik.tuwien.ac.at/studium/angebot/master/visual-computing
[30] http://www.icg.tugraz.at/Members/gerhard/mvc/mobile-visual-computing
[31] http://uni-salzburg.at/index.php?id=38595&L=1

3.4 International comparison

Visual Computing is being researched and taught as a priority at many universities and research facilities. In Germany, this includes the **University of Applied Sciences Dortmund**[32], the **Hochschule Bonn-Rhein-Sieg**, **Sankt Augustin**[33] and the **Fraunhofer Institute** for graphic data processing in **Darmstadt**.[34]

International institutes include just as examples, the Visual Computing Group at **Harvard**[35] and the Visual Computing Center at the **KAUST** in **Saudi Arabia**.[36]

Furthermore, many technology companies such as **Microsoft**[37] and **NVIDIA**[38] have created their own research centers.

[32] http://www.inf.fh-dortmund.de/personen/professoren/peters/pages/research/Research.html
[33] http://www.ivc.h-brs.de
[34] http://www.igd.fraunhofer.de
[35] http://vcg.seas.harvard.edu
[36] https://vcc.kaust.edu.sa/Pages/Home.aspx
[37] http://research.microsoft.com/en-us/groups/vc/
[38] http://www.nvidia.de/object/visual-computing-de.html

4 Market overview

Due to the large amount of research and education offered in Austria, many companies have been established which have already implemented ideas and projects in the field of visual computing. Several of them were created from the areas researched by universities and competence centers, and are continuing in cooperation with them or independently. This report can only introduce a selection of them.

Imagination, which originally began in the field of research, was founded in 1998 as a spinoff from the Technical University of Vienna. The mobile app Magic Lens is an augmented-reality standard solution. The app was developed for use in conventions, showrooms, and outside services. It recognizes object and expands the live camera image with additional information. When doing this, the objects and any additional information can be texts, images, videos, or 3D visualizations. The user can give his customers a view to the inside of the solution, or can vividly present several products.[39]

The more than 30 Apps by **ViewAr** create dynamic AD models, for example for room and apartment planning, as well as for product and furniture placement. They can be used as visualization tools for end customers, for sales teams, or for tools to be used in industry. If requested by the customer, ViewAr will customize the app to specific requirements.[40]

The applications of the company **CogVis** run on accounting systems of all current platforms, hardware, and peripheral devices such as cameras and movement sensors. The software aims at vertical markets such as security, trade, industry, or medicine for the analysis of content in images, videos, and 3-D data. In addition to computer vision algorithms, design, functionality, and usability for the user are the focus. Operation takes place over a web browser.[41]

[39] http://www.magiclensapp.com/de/mehr/
[40] http://www.viewar.com/app-showcases/
[41] http://www.cogvis.at/produkte/

INS Insider Navigation is an augmented reality navigation solution for trade fairs, shopping centers, airports, and public areas. Using the positioning data and the live camera images, routes or additional information such as current sales are added to the live camera image. The mobile phone or the tablet computer is turned into an interactive information and navigation platform.[42]

The engineering offices of the **Geoconsult-Group** offer planning and faulting services in all disciplines of construction. This includes tunnel construction, geotechnics, hydraulic engineering, construction physics, and construction management. GC Vision is a special division for visualization and 3-D simulations. In cooperation with VRVIS, interactive visualization systems are created out of raw Geo-data. These have been used in projects including the Asfinag for the expansion of the S1, outside ring expressway at the Seestadt Aspern, or 360° panorama tours, such as the cargo center at Wien Süd of the ÖBB, and can be called up online in a web browser.[43]

Z.koor develop software, computer systems, and services for data collection, position control and computer graphics in a three-dimensional space. The product zactrack was conceptualized for the automation of theaters, stages, and shows. Zacturn is a visualization solution for displays and architectural use, while zackview simulates themes on theater stages and in show design, for example lighting, or the building and dismantling of backdrops.[44]

3D sensor technology for the recognition and measurement of objects is offered by **Emotion3D**. With Stereoscopic Suite X the company has also developed a tool for post-production of 3-D movies. This allows a simple cut when using two cameras for spatial effects.[45]

The company **vrisch** has specialized in the use of interactive 360-degree video as well as Virtual Reality marketing applications. There are different levels of Virtual Reality in the sense of different technologies - from the use of low-cost "Cardboard VR glasses", which in combination with smartphones allow simple immersion in other worlds, up to 4D Virtual Reality setups in addition to professional VR glasses and input devices including fans, headphones, or other equipment to create a more intense virtual experience.[46]

[42] http://insidernavigation.com/features/
[43] http://www.geoconsult.eu/index.php/projekte.html
[44] http://www.zkoor.com
[45] http://www.emotion3d.tv
[46] http://www.vrisch.at/

5 Visual Computing Trends

"In this digital world, marked by images and videos, Computer Vision has proven itself to be one of the greatest drivers for economic success and a core technology of the future", says Markus Kommenda of AIT. Per industry estimates, the transmission of visual data will dominate all data transfer within the next several years. The transfer of data over mobile devices (smart phones, tablets, etc.) is expected to increase at three times the rate as data transferred over conventional Internet pathways.

With the rapidly increasing computing power of mobile phones, soon everyone will be carrying a mobile computer vision workstation. The newest mobile graphics chips, which can be already found in every affordable smartphone or tablet PC, allow the calculation of highly complex algorithms. This required the use of a large calculator less than 10 years ago.

In the industrial and in the consumer field, VR and AR glasses and tools are almost at market maturity. Many of the large players, including Google, Microsoft, Nvidia, LG, HTC and Sony are working on solutions[47] which will be designed for the mass market with user-friendly operating concepts. Additional Visual Computing apps are expected to be released for tablets, including some from Austrian developers as already mentioned.

The increasing networking of cameras serves to protect critical infrastructure, but the data cannot be analyzed without modern computer vision. Traffic systems (cars, trains, autonomous systems, etc.) and the cities of the future are increasingly relying on optical sensor technology. Additionally, efficient and demanding production processes and the associated quality control can no longer be performed without image processing technologies.

[47] http://www.vrnerds.de/vr-brillen-vergleich/

6 Services Offered by the Vienna Business Agency

The objective of the Vienna Business Agency is the continuous development of international competitiveness by supporting the Vienna-based companies and its innovative strength, as well as a sustainable modernization of the business location. To achieve this, the Vienna Business Agency provides free consultations to all entrepreneurs in Vienna on the topics of business creation, business location or expansion, business support and financing. Furthermore, networking contacts in the Viennese economy are also made available.

The Vienna Business Agency supports and helps businesses complete their research and development projects with both individual consulting and monetary funding. Depending on requirements, they will receive information about sponsorships, financing opportunities, possible development partners, research service providers, or research infrastructure, according to their needs.

The Vienna Business Agency sees itself as a network of the Viennese ICT industry and supports businesses with consultations, as well with distribution and networking among themselves. Events and workshops on topics from the field of ICT are held regularly.

Additionally, the Vienna Business Agency helps company relocations or internationalization services. Help is provided to business founders and young entrepreneurs in the start-up area. Free workshops and training sessions on topics of everyday business are offered as well as small, affordable office spaces.

vienna business agency

A service offered by the City of Vienna

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ICT DATA SOURCES: Statistics Austria, G. Haber, METIS, TU Vienna, VRVis, University of Klagenfurt, KMU Research Austria, Economic Database

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Technology reports are available on the following topics:

- Cloud Computing
- Big Data Open Data
- Mobile Apps
- E-Health
- E-Government
- Emerging Technologies
- IT Security
- User Centered Design
- Enterprise Software
- Entertainment Computing
- Visual Computing

The digital versions can be found at https://viennabusinessagency.at/technology/technology-location-vienna/

At technologieplattform.wirtschaftsagentur.at Viennese can present their innovative products, services and prototypes as well as their research experience to enterprises and institutions in the technology sector and find development partners and pilot customers.

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