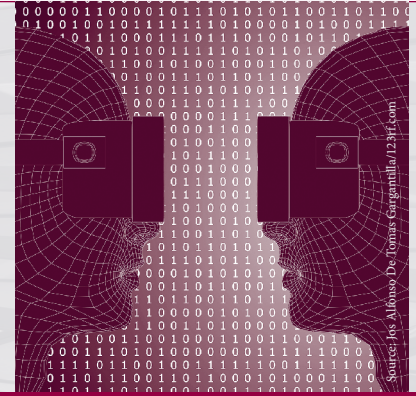# Virtual and augmented reality

TAB-Fokus no. 19 regarding report no. 180 — April 2019

Summary

› VR and AR technologies have progressed to the point where an increased diffusion into different fields of application takes place.
› The use of VR requires specific hardware, whereas many AR applications can be used with smartphones or tablets.
› In addition to consumer markets, industrial fields of application are also increasingly being tapped.
› While German research makes a decisive contribution to VR and AR development, German industry has difficulty exploiting VR and AR.
› The use of VR implies legal and ethical issues that are still largely unre-solved.

What is involved

Virtual reality (VR) is a computer-assisted, software-generated **simulation of realistic or fictitious environments** in which users can immerse themselves by using suitable hardware. In contrast, augmented reality (AR) refers to a **computer-generated extension of the perceivable reality**, for which additional information such as texts, images or virtual objects are superimposed into the users' field of vision.

The detection of objects as well as their position and motion in space are carried out by means of camera and tracking systems or controllers. For the simulation of virtual worlds and objects that extend or completely superimpose the perceived reality, mainly so-called game engines, i. e. development environments for computer games, are used. In addition to PCs, game consoles and mobile devices that can run with different operating systems are also significant target platforms.

The provision and distribution of content requires specific distribution software and platforms. As a general rule, content for VR and AR solutions is available via these platforms – which are comparable to those intended for the purchase of software (app stores). Moreover, specific rendering devices are required. Head-mounted displays (HMDs) are usually used for the visual rendering of completely virtual content, while mobile devices or smart glasses are usually used for the presentation of augmented content. Visual perception is complemented by devices for auditory or haptic rendering. The latter still represents a major technological challenge. It includes experiencing temperature changes, air currents or acceleration, but also sensing three-dimensional objects by touch. Fragrances and flavours are even more complex and can hardly be rendered so far to create the impression of simulated smelling and tasting.

From the point of view of the innovation drivers, VR and AR applications will characterise the way in which sports events or news will be watched in the future, the means by which medical treatment is provided, how products are presented and purchased or how machines can be constructed and maintained. Furthermore, there are potential applications in healthcare, e. g. for the treatment of mental disorders. Finally, there is also potential for the public sector, primarily with regard to participation (e. g. in building projects) as well as prevention and safety (e. g. for disaster control and rescue services).

It can be assumed that VR and AR will further advance the digitisation of everyday life by promoting the **integration of social interaction, media use, consumption and entertainment in the digital space** and contributing to an entanglement of these fields. Currently, however, there is still a lack of tangible applications providing an added value that would encourage potential users to invest in hardware. This is why potential providers of such solutions often are reluctant to take the development risk, as the market still

seems too small to them due to the fact that end devices still are not very widespread.
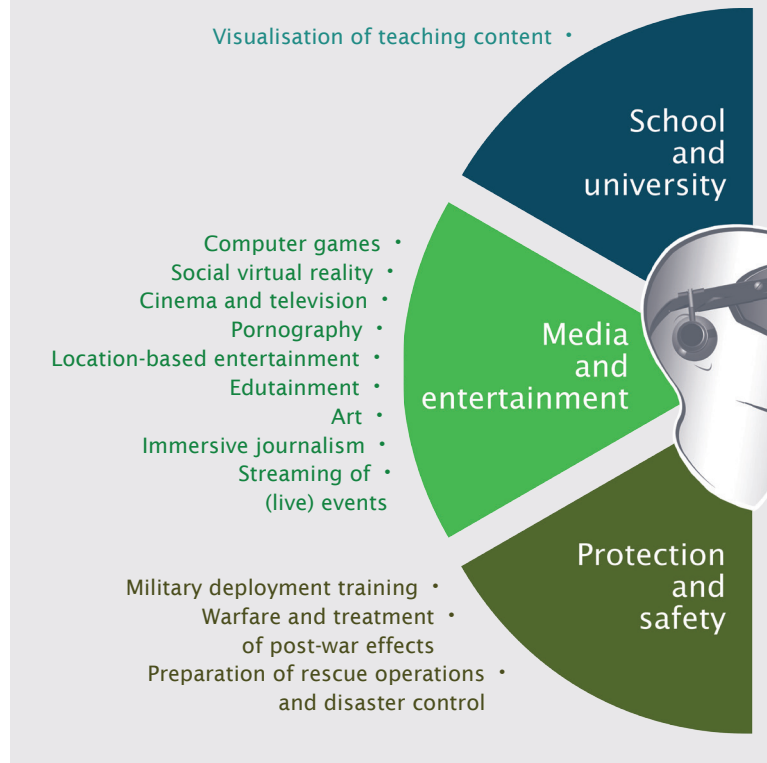
Market potentials and developments

With regard to the economy, VR and AR offer great innovation and develop-ment potentials for many industries due to their broad range of applications. **VR and AR will create new markets and change the markets that already exist**. The players of the German innovation landscape can position themselves very well in international competition primarily due to the development and marketing of applications in the B2B sector, e. g. in industry (for example with assistance systems in production) or in medicine. If economic value creation currently occurs in particular via VR and AR hardware, it will clearly shift towards the creation of content in the future.

At present, the market for VR and AR is primarily characterised by VR hard-ware and commercial VR applications in the gaming sector. The drivers of this development are either large tech companies that develop and market high-quality HMDs or companies that offer lower-priced glasses. In addition, there are other providers offering additional equipment, such as cameras and sensors or infrastructures for the distribution of applications and content. According to current market forecasts, the ratio of added value generated by hardware and software with VR and AR is likely to shift significantly towards applications. In this context, the **B2C sector is expected to account for approximately 60 % of global sales by 2025 and the B2B sector for 40 %**. In the years to come, computer and video games as well as live events and video entertainment will be the key sectors for VR and AR. Further significant growth potential is expected in the production and retail market segments (including real estate), followed by the education and military sectors.

In addition to the major technology providers, the market for VR and AR has also been characterised by start-ups for some years now. Recent acquisitions of VR and AR start-ups by major players (such as Google, Facebook and Apple), however, point towards a consolidation of start-up activities. Nevertheless, start-ups can be expected to make a decisive contribution

Fields of application and examples

Visualisation of teaching content ·

School and university

Computer games ·
Social virtual reality ·
Cinema and television ·
Pornography ·
Location-based entertainment ·
Edutainment ·
Art ·
Immersive journalism ·
Streaming of ·
(live) events

Media and entertainment

Military deployment training ·
Warfare and treatment ·
of post-war effects
Preparation of rescue operations ·
and disaster control

Protection and safety

to the economic and technological development of new applications. Particularly in industry-relevant areas, entrepreneurial opportunities for German players are emerging.
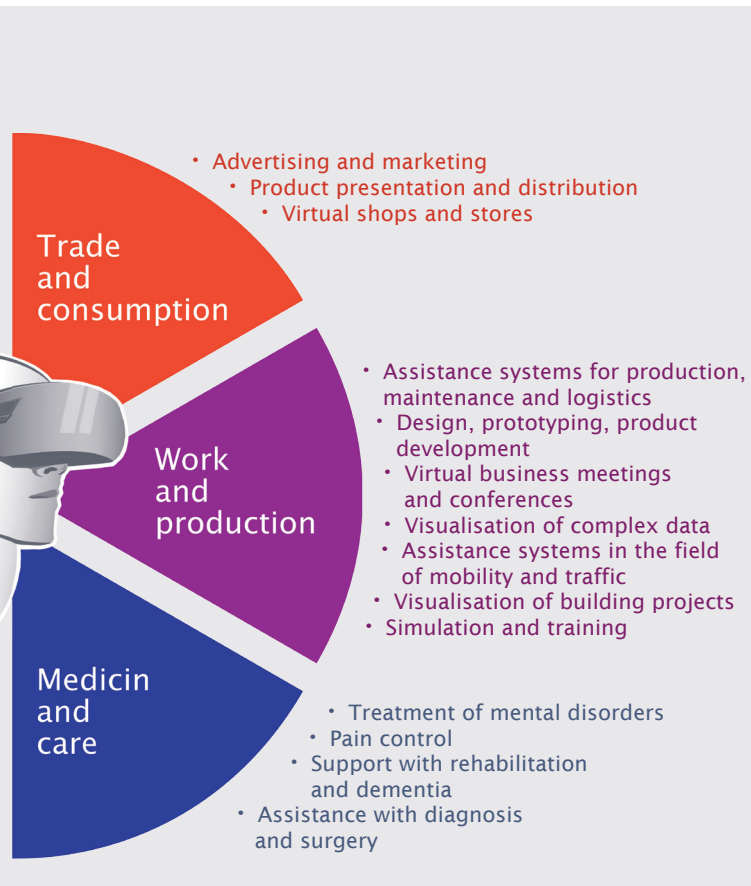
Basically, large IT companies and manufacturers of consumer electronics (such as Sony, Samsung, HTC or Oculus) have structural advantages in this competition, as they have already positioned enabling technologies and system platforms throughout consumer-related markets – albeit not yet with a high degree of market penetration. In principle, this limits the value creation opportunities for new market players and particularly for smaller companies and can also create dependencies for German companies in the long term if they want to establish themselves on the market, e. g. with specific applications that are based on the systems of other manufacturers.

1
Adapting laws and rules for the virtual space
› Data protection
› Data security
› Copyright and exploitation rights
› Personal rights

2
Shaping the innovation landscape
› Research and development with regard so standardisation
› Specific funding in the field of (serious) games
› Interdisciplinary and application-oriented research funding
› Involvement of small and medium-sized enterprises and start-ups

- • Advertising and marketing
  - • Product presentation and distribution
    - • Virtual shops and stores

Trade and consumption

Work and production

- • Assistance systems for production, maintenance and logistics
- • Design, prototyping, product development
- • Virtual business meetings and conferences
- • Visualisation of complex data
- • Assistance systems in the field of mobility and traffic
- • Visualisation of building projects
- • Simulation and training

Medicin and care

- • Treatment of mental disorders
- • Pain control
- • Support with rehabilitation and dementia
- • Assistance with diagnosis and surgery

Risks and opportunities for society

The opportunities of VR and AR for society primarily arise in the field of education and due to new formats and channels of social interaction. Thanks to AR and VR, new interactive formats of knowledge transfer will emerge in school, vocational and academic education as well as in (further) qualification. Thus, training in virtual scenarios will become just as possible as a clear and vivid conveyance of theoretical teaching content.

As particularly VR provides an interface for location-independent immersive communication, the technology can further expand the already high social significance of digital media. In immersive communication, the users dive into a virtual space and interact via avatars, which significantly increases the intensity and physicality of communication.

However, this reveals **ambivalence with regard to the effects** that can arise for VR users due to their immersion in virtual worlds. **While this technology can help overcome social isolation by means of new forms of communication, virtual reality can also seduce into living in a dream world – which might result in isolation and alienation.** Moreover, in the future, VR and AR content will also become the target of manipulating and manipulative intentions, which can be experienced by the user with the corresponding intensity. In addition, virtual reality can entail the danger of the users' empathy or sense of reality being blunted. Furthermore, in addition to providing deliberately faked content, VR and AR also create new technological possibilities for manipulating the reactions and emotions of users via suggestive content and advertising.

Needs for action in case of an increasing spread of VR and AR

In virtual reality, people will leave a comprehensive digital footprint – although it is still unclear which data will be collected and used for which purposes and how personal rights can be protected. **By using VR and AR applications in professional environments (such as the use of smart glasses), trade secrets or highly confidential personal information of patients (when using VR for medical treatments) can be recorded. The issue of how this data can be protected represents a major challenge.** Moreover, copyright and exploitation rights are also affected. It remains to be clarified how producers of VR content can protect themselves against copyright claims by clients and third parties. For this reason, it is of major significance to which extent existing laws are actually sufficient or need to be adapted accordingly. VR and AR technologies enable misuse through manipulation. The manipulation of perception could influence people's buying behaviour or even deliberately deceive people, e. g. by intentionally misrepresenting objects or environments. Moreover, the high degree of immersion in VR applications, the experience from a first-person perspective and the resulting stronger identification, e. g. with one's own avatar, can lead to harassment being felt even more strongly. In this context, for example, dealing with sexual assaults and cyberbullying in virtual space is a relevant issue.

3

Investigating physical and psychological consequences

- › Research on causal links between using technology and staying longer in the virtual reality

4

Preventing the misuse of technology

- › Strengthening media literacy among children, young people and adults
- › Creation of quality labels

In order to prevent technology misuse, there is a need for **media literacy training for children, young people and adults** through basic education on how and by whom content can be manipulated and how content, services and opportunities in the virtual world can be critically evaluated. For example, a quality label proving the quality of the underlying data could be a possible complementary approach for attesting that the represented content is true and of serious origin.

The **physical and psychological consequences of long-term use of virtual reality** and their causal interactions with using virtual technologies are still largely unknown. Assumed consequences that might occur in case of (longer) stays in virtual environments include personality change, alienation, social isolation and impacts on the human body. The psychological and neuronal effects, the influence on vision – especially in children and young people – as well as a possible influence on behaviour are also still unclear and require further research.

Potential for shaping a future-oriented research funding

With regard to VR and AR, **German research is positioned very well in the international scientific discourse due to many research projects, publications and its leading role in expert committees**. Compared to other European countries, German applied research and technological development with the participation of companies are also in a very strong position. In particular, the institutes of the Fraunhofer-Gesellschaft are significantly involved in funding projects related to VR and AR throughout Europe.

In the long term, this will offer opportunities for German research to gain knowledge leadership in areas such as e. g. medicine or industrial applications and decisively shape international discourse. Due to the fact that, in Germany, a comparatively interdisciplinary scientific community already deals with VR and AR, research on social and ethical issues regarding the use of VR and AR also has a good starting position.

Despite its excellent positioning, the German innovation landscape faces a fundamental challenge with regard to actually tapping the existing potential and sustainably securing it. Future funding in Germany should **focus on interdisciplinary, application-oriented research in B2B areas**. The focus could be on medicine/medical engineering, mechanical engineering, the building sector and generally on production, automation and Industry 4.0. With regard to the B2C area, further potential could arise due to specific funding in the area of (serious) games, suitable applications for consumers or social VR.

In this context, it should be ensured that small and medium-sized enterprises and start-ups are involved in technology development. Moreover, the integration of start-ups in VR and AR funding projects is just as suitable as a specifically aligned, technology-oriented funding of start-ups and their economic development. Furthermore, there is also a need for targeted funding with regard to a standardisation of formats and for the establishment of development interfaces.