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Key Early Verticals, Challenges and Limitations in Implementation of Augmented Reality

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Synonyms

Augmented reality; Mixed reality; Virtual reality

Definitions

Augmented reality (AR) augments real world with virtualized contents (i.e., objects and/or supporting information) which appears to coexist in the same space as the real world (Palmarini et al. 2018). Its predecessor, i.e., virtual reality (VR), on the contrary, generates a completely artificial environment of the reality.

Key Early Verticals for Augmented Reality

Although the promising notions of AR and VR were coined several decades ago, the technologies enabling AR have just recently converged to a critical point enabling people to enjoy its experiences and to fully reap its benefits (Yuan 2017). AR is believed to be one of the key technology enablers for Industry 4.0 and is anticipated to disruptively change our world in many aspects. This section briefly depicts the key early verticals of AR in numerous industrial sectors, i.e., manufacturing, healthcare, logistics, design and architecture, military, and data centers (Syberfeldt and Gustavsso 2017; Chandler 2017) along with their salient characteristics.

Manufacturing: Connected devices and wearable products have rapidly penetrated across the manufacturing industry, hence opening new doors for innovative AR experiences. AR is currently making rapid strides in numerous areas. It is used for the monitoring and solving of pain points experienced on the shop floors, i.e., pain points along with key performance indicators (KPIs) could be directly projected to the engineers and maintenance teams in order to analyze and resolve the issues in real time. This is also efficient in case of production downtime due to a broken part of a machine, as teams equipped with AR capabilities can quickly respond to the hardware problems in almost no time. AR could further assist the production teams in the physical asset-based logistics

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and status of the physical stock on the shop floor, and the same can be superimposed in the form of digital content to augment the real-time views (Caricato et al. 2014; Uva et al. 2018; Chang et al. 2017).

Healthcare: Healthcare is one of the most dominant sectors impacted by AR in numerous ways, i.e., from training medical students about the human anatomy to counseling mothers struggling with breastfeeding by effectively allowing the counselors to *see through* the eyes of mothers via an AR wearable device, to assisting the patients to accurately describe their past and existing medical conditions to their doctors, to enabling nurses to locate human veins conveniently during intravenous injections, to facilitating the curious consumers of the pharmaceutical industry with the 3D views of drug actions and effects in the human body, to practicing minimally invasive surgeries by enabling the surgeons to *see through* the patient (without the need for opening them up) during the surgical planning and image-guided surgery, etc. (Herron 2016; Chen et al. 2017).

Logistics: One of the biggest waves of change anticipated in logistics industry is in the form of AR technology, i.e., in the warehouse operations, wherein, notion of *pick-by-vision* for providing a hands-free digital approach could be employed instead of a slow and error-prone *pick-by-paper* approach in order to optimize picking process (the software employed for *pick-by-vision* could have features like the barcode reading, indoor navigation, real-time object recognition, seamless integration with centralized warehouse management systems, etc.), in the warehouse planning to accommodate a number of value-added services by visualizing rearrangements by incorporating digital representations of envisaged future settings in the current warehouse environment, and in the freight transportation as loaders could have access to the real-time digital data about the next pallet to be loaded and its placement in the vehicle along with the pertinent loading instructions thus saving the tedious process of paper-based cargo lists and speeding up the freight loading process (Stoltz et al. 2017; Glockner et al. 2014).

Design and Architecture: Over the past few decades, one of the key challenges confronting designers was to dive deep into physical space of a structure or an object that they are conceiving. Traditionally, 3D objects were conceived over the 2D screens. However, as of late, more meaningful and lucrative ways have transpired and AR experiences undoubtedly lies at heart of the same, i.e., from the powerful 3D printing facilitating the companies and firms to rapidly transform their concepts into implementation thus ultimately leading to reduction in costs and securing of more clients to a collaborative design process for sourcing of innovative ideas, variants, and its feedbacks from the geographically distributed consumers during the product's planning stage, to equipping the architectural project teams and their clients to immerse in an interactive AR experience for monitoring progress of ongoing projects via a real-time digital modeling of a construction site, thus avoiding the tedious task of walking clients on the construction sites and preventing any unwanted accidents, to the spatial augmented reality revolutionizing the automotive industry by enabling the designers to assess curves and geometries more efficaciously by projecting virtual data on a real vehicle model during its development process (i.e., typical virtual data is often being displayed on monitors and its size is often scaled down and is not a precise reflection of the reality), etc. (Chi et al. 2013; Elia et al. 2016; Behzadan et al. 2015).

Military: AR has been making its stronghold in the battlefield, i.e., from projecting precise maps, navigation way points, friends or foe discrimination, and pertinent information to a soldier's field of vision, to integrating specialized AR gadgets to a weapon control system for enhancing the mission's effectiveness, to training of the combat personnel for complex conditions arising in the battlefield through injecting of virtual threats into a realistic environment for ensuring that the troops are skilled enough to quickly respond and operate the equipment in every possible scenario, to training fighter pilots for diverse battle scenarios and certain specialized cockpit operations, i.e., aerial refueling and missile deployment, as most of their trainings are conducted over flight simulators and setting up live combat operations could be very expensive (You et al. 2018; Karlsson 2016).

Data Centers: AR is anticipated to bring tremendous benefits to data center planning and to a wide range of its operations and processes, i.e., from remote management of the data centers to spatial tours via the 3D real-time imaging superimposed with pertinent contextual information so as to have a better understanding of local prevailing circumstances, to the navigational guidance in a data center for better identification of error-prone devices or installation of a new device along with installation instructions, to the color labeling of identical-looking racks and cabinets within a datacenter to reflect status messages (i.e., notifications, alarms, or warnings) or operational analyses along with troubleshooting instructions if any, to the identification of a device and device-related specific virtual information and real-time datasets by employing the QR scanner and many more (Deffeyes 2011; Emeis et al. 2017).

Challenges and Limitations in Implementation of Augmented Reality

Despite a number of potential applications of AR in modern-day industries, there are still several challenges and limitations that hinders its true realization (Akayra and Akayra 2017; Zhang et al. 2017). Some of these challenges and limitations are discussed as follows.

Low Latency Monitoring and Tracking: In order to have an essential AR experience, it is indispensable to precisely track and subsequently monitor an individual's location, the objects and people surrounding him/her, and more interestingly, what actions are being carried out through their eyes, hands, and voice and all in few milliseconds so as to ensure that the precise contextual information gets layered on the actual environment via an AR device. Hence, the design of a state-of-the-art real sense cameras (possessing the full five-finger integration), diverse sensors, and microphones for an AR device still poses a daunting challenge yet to be fully realized.

Seamless Optical Displays: A seamless optical display blending (both) physical and digital world adds another layer of complexity in the early realization of AR. It is pertinent to note that VR is already utilizing high-resolution innovative screens, in whose production, the smartphone industry has been actively involved over the past few decades. In case of VR, the user typically glances on the screen; however, in AR, it is essential to look through the screen so as to still experience the real-world environment.

Computing Power: Power is one of the serious challenges currently being faced by the AR industry. Today, with the continuous evolution of stronger yet ever smallest processors, there would certainly be (in the near future) powerful enough processors specifically for AR. Thus, powerful processors require powerful batteries and especially with characteristics, i.e., low consumption, high capacity, and small enough to be compatible with lightweight AR wearable displays. Complexity versus implementation is an issue and balance is still to be determined.

Scaling: Interpreting (or rendering) of the digital data into meaningful graphics and subsequently scaling it down to suit the perspective of individual's visual field adds a significant challenge in the vast implementation of AR.

AR Software: One of the indispensable components of AR software is its competence to efficiently accumulate, process, and analyze potentially diverse range of inputs simultaneously and transform them accordingly based on new digital information so as to provide the high-end AR experiences. For realizing the same, high-speed connections would thus be required to tie the AR software to the back-end services, thus ensuring the future AR-enabled devices to be the world's most capable Internet of Things (IoT) endpoints.

Conclusion

The notion of AR has grown by leaps and bounds over the past few decades, but very few of us know how far it has come in reality. At the time of writing of this article (2018), various tech giants such as *Google, Apple, Facebook*, etc., have launched their AR development kits and a new wave in technology has finally set in. Also, a number of industries have started embracing AR and specific applications are now being experienced in their initial forms. *But how big would the AR impact be?* In order to address this question, this article serves as a major reference for not only highlighting some of the key early verticals for AR in various industrial sectors but also deliberates on some of the critical challenges and limitations hindering its true realization. It is beyond any doubt that AR is soon going to be a mainstream product and either people would be wearing AR headsets for most of their time or AR would replace everything we do on smartphones, act as a new interface for laptops or desktops along with numerous specialized applications across all industrial sectors. This ultimately would lead to another revolutionary wave in the gaming industry too.

Cross-References

- ▶ History of Virtual Reality
- ▶ Mixed Reality
- ▶ Potential of Augmented Reality for Intelligent Transportation Systems

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