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The Role of Augmented Reality in the Age of Industry 4.0

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5.1 Introduction

- ▶ Human beings perceive their environment as much as the capabilities of their five senses allow. Humans cannot see what is not in their environment or cannot touch an object which does not exist physically. Therefore, the interaction with the outer world and access to the relevant information about any given task is rather limited.
- ▶ For example, a junior engineer who fixes an automobile engine cannot troubleshoot the malfunction that s/he does not have knowledge about without conducting to an expert or a manual. In short, we need other means when we need extra information about the items that we interact in our daily life.
- ▶ These means could be internet, a paper based manual, a colleague, etc. The way these means are accessed also affects the quality of the interaction or experience with the objects. For an enhanced interaction, humans need to get the nonvisible information related to the interacted object as quickly as possible and within an understandable form.
- ▶ Augmented Reality (AR) technology has been considered as an innovative way of interaction for this purpose. Thanks to the AR, humans can explore more than that of their five senses perceive. The main aim of AR is to enhance a humans perception about the environment by overlaying additional computer generated visual information onto the vision of the user through specific devices, such as, camera of the smartphones, head-mounted displays (HMD), projection devices, etc. The computer generated visual information can be images, videos, 3D models, texts, sounds, speech instructions etc.
- ▶ **Augmented Reality (AR)** identifies the set of technologies which allows viewing the real world environment in an augmented or enhanced way through computer-generated graphics.
- ▶ By superimposing this type of augmentation onto the real vision of the user, the user is able to get the hidden information about the interacted objects or the environment, which makes the AR an efficient technology. Augmented reality has varied applications such as, gaming, sports, advertising, shopping, education, military services, medical surgeries as well as industrial purposes, etc., but manufacturing is one domain which can be most attractive for the world of augmented reality.



Fig.5.1 – Augmented Reality

- ▶ Concerned with various processes to transform raw materials in the finished goods by adding value to it, Augmented reality can be a real game changer. This is because real-time information is needed at the various stages of product life cycle. From design to prototyping, to production and assembly, maintenance, each stage has its own sets of challenges.

- ▶ Augmented reality can be a boon in these complex processes as it is capable to simulate, assist, and improve the processes even before they are carried out. A lot of manufacturing unit is now open to this idea of utilizing Augmented Reality and simulate the processes and reduce the downtime and streamline the operations.
- ▶ AR augments the real-world scene whereas VR creates completely immersive virtual environments. Virtual Reality (VR) is a computer-generated simulation of an alternate world or reality. It is used in 3D movies and video games. It helps to create simulations similar to the real world and "immerse" the viewer using computers and sensory devices like headsets and gloves.
- ▶ AR got a lot of attention in 2016 when the game Pokémon Go made it possible to interact with Pokémon superimposed on the world via a smartphone screen. Since then, augmented reality has become more and more popular. Apple introduced its ARKit platform in 2017, and Google launched web API prototypes later that year. And then there's Apple's AR glasses, rumored for launch later this year, which will let wearers have AR experiences without looking down at a phone.

5.2 AR Hardware and Software Technology

5.2.1 AR Hardware

In general, an AR system contains four hardware components;

1. **Computer:** The computer is responsible for not only modelling augmentations and controlling all the connected devices but also adjusting the position of augmentations in the real scene with respect to the position of the user by using the information gathered from the tracking device.
2. **Display device:** A display device is necessary to display the augmentations on top of the user's real vision. The choice of the display device depends on the type of interaction. The most widely used technologies are a see-through Head-Mounted Display (HMD), which the user wears on his head, a Hand-Held Display (HHD), such as a tablet or a smartphone, or Spatial Displays (SD), which is designed using several projectors.
3. **Tracking device:** The tracking device is responsible for tracking exact position and orientation of the user, and then registers the augmentations properly to their desired positions. Using the tracking device, the computer provides assistance to the user by processing the user's movements, gestures and actions while the user interacts with the objects in the real world.
4. **Input device:** The input device is used for enabling the user to interact with the system. Some examples of the input devices are microphone, touchpads, wireless devices, mouse and haptic devices. The choice of each component depends on the application scenario. If the application is designed for the technicians working in a factory, it is logical to choose wireless see-through HMDs, since in most of the tasks they need both their hands to complete the job; so HHDs are not efficient in this case. In addition, see-through HMDs provide mobility and are considered more suitable for outdoor applications.

Augmented Reality (AR) is known to be one of the most promising technologies at the moment. After the smartphone revolution, everybody carries a mobile device, and all these mobile devices typically contain a processor, GPS, a display, camera, microphone etc, which is all the hardware required for AR. As for the future of AR hardware, it's becoming more evident that smartphones, Augmented Reality glasses and headsets will coexist and expand significantly the range of possible AR experiences of tomorrow. *Microsoft HoloLens, Magic Leap One, Epson Moverio and Google Glass Enterprise Edition* are some of the examples of Augmented Reality glasses and headsets.

5.2.2 AR Software

There are a lot of Software Development Kits (SDK) especially developed for making AR application development easier. Metaio, Vuforia, Wikitude, ARToolKit, ARCore, MaxST, EasyAR, Kudan, ARKit, ARMedia and Hololens are the most popular SDKs and provide functionalities and detailed documentations, which give the opportunity for developing AR applications to a developer with low coding skills and experience.

5.3 Industrial Applications of AR

There are a lot of applications coming up. It's becoming very popular in the enterprise as well as the industrial world, These are the top four applications:

Training - every industry needs to train the new recruits. AR is used to create training programs and step by step instructions are given to the trainees. This creates more engaging and interactive training programs.



Remote collaboration - in every industry there are times when workers need to collaborate with a remote expert and with AR it goes a step beyond the usual teleconferencing. The expert is able to guide the worker, and with various AR tools they can draw on the screen and highlight certain areas. So, it enables better collaboration.

Assembly industry - in industries, such as automotive or semiconductor, where all the workers assemble components, they used to rely on paper instructions or remember all the steps. But with augmented reality they are given step by step instructions, simplifying their job.



Warehouse logistics - AR applications are increasingly being used for order pickup in warehouses. So AR applications are basically combining a lot of other capabilities, such as image recognition, barcode scanning, indoor navigation, and everything is being integrated with the warehouse management system.

Maintenance: After the assembly, maintenance is another aspect where Augmented Reality can play a crucial role. Currently, most of the workers confirm the maintenance manually using a manual. This process can be time-consuming and not hundred percent error-free. Mitsubishi Electric has been developing a technology which is maintenance-support using AR based on the 3D models. This would enable the users to confirm that the order of inspection is followed and inspection results can be added. More specifically, the machine's status can be checked only via glancing it through AR glasses which can be a powerful maintenance tool.



Expert Support: In the event of a disturbed manufacturing process, an expert may need to travel to the worksite. There may be numerous technicians available, but only a few experts are available. Augmented Reality can reduce this expense and can let an expert see the issue through the eyes of a technician. This can let them support and inspect from anywhere in the world. They can also guide the technician about the feature they may be interested in.

Popular augmented reality examples and use cases in the business world

1. **Manufacturing:** 3D augmented reality saves time and money
2. **Education:** Interactive concepts better engage students
3. **Healthcare:** Organ modeling helps save lives
4. **Marketing:** Augmented reality makes ads pop
5. **Fashion and beauty:** Try before you buy
6. **Travel:** Take 360-degree tours of vacation destinations right from a phone
7. **Navigation:** Smart glasses make driving directions a snap
8. **Retail:** AR helps consumers imagine products right in their homes
9. **Food and beverage industry:** Diners can have nutritional info at their fingertips
10. **Enterprises:** Businesses can connect with clients face-to-face.

5.4 References

- 1) Industry 4.0: Managing the Digital Transformation by Alp Ustundag and Emre Cevikcan, Springer.
- 2) The Concept Industry 4.0 by Christoph Jan Bartodziej, Springer.