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Impact of AR and VR in Industrial Revolution

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Abstract: ***Augmented Reality (AR) and Virtual Reality (VR) are state-of-the-art technologies for superimposing information onto the real world, has recently started to have an effect on our everyday lives. There has been an increase in the maturity and versatility of applications based on AR and VR technologies in recent years. Consequently, this improves user productivity and accuracy and offers economic benefits to companies. A wide range of augmented reality applications are now possible thanks to recent advances in the internet of things, smart sensors, and sophisticated algorithms. Currently, many research pieces are being done to expand the application of augmented reality and enhance its effectiveness in industrial production processes. The purpose of this paper is to analyze some use cases and the prospects associated with industrial augmented reality in order to highlight its critical role. This article explores the main future directions for industrial augmented reality applications in industry 4.0 through a systematic analysis. Various applications of this technology and their impact on improving production conditions are discussed in the article. In conclusion, this technology's challenges and research opportunities are discussed.***
Keywords: AR, VR, Industry 4.0

I. INTRODUCTION

Nowadays, the manufacturing industry is undergoing an industrial revolution deemed industry 4.0. Figure 1 illustrates the first industrial revolution, which was characterized by mechanization of processes. This was followed by mass production and automation in industry 2.0. Industry 3.0 introduced a swarm of robots and sensors to the shop floor and automated many manufacturing activities. I4.0 is known as the new industrial stage where the integration of Industrial Production Systems (IPS) and Information and Communication Technologies (ICT), especially the Internet of Things (IoT), happens.

Augmented Reality (AR) is known as one of the main pillars of the I4.0 paradigm, and it can bridge the gap between the real and the increasingly crucial digital environment for its user. Furthermore, I4.0 is a synthesis of technologies with two aspirations: 1. Accelerating the remaining manufacturing activities requires human expertise and skills and 2. Integrating intelligence into the automated infrastructure makes autonomous robotic systems able to make decisions from data.

It is difficult to find a commonly accepted definition for AR due to its wide use in various fields. Yet early academic research defined AR as combining the real and virtual environments in three dimensions and allowing them to interact in real time.

In manufacturing application AR is discussed as a potentially powerful tool in order to improve productivity, process efficiency and flexibility. On the other hand, AR is still not widely spread in manufacturing and offers great potential for use and improvement.

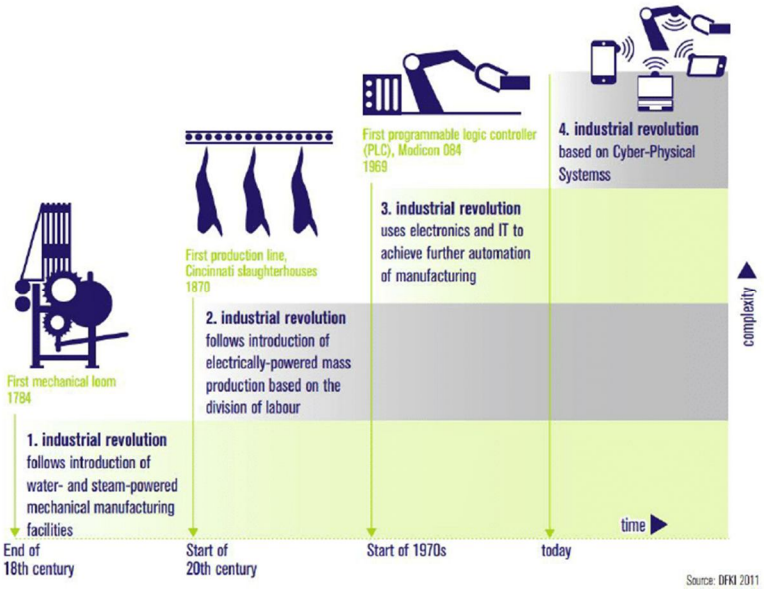

Fig.1

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II. AUGMENTED REALITY

Although the core technology described in this study is AR and VR, it is also appropriate to determine the difference between AR, VR and MR. While AR is a technology which enables the access to digital information and overlays that information with the physical world, VR allows users to take part in a simulated reality experience. When compared to AR, MR (Mixed Reality) allows users to interact with digital objects placed in their surroundings. The above-mentioned terms were set into context by Paul Milgram, who defined the Reality-Virtuality Continuum as shown in figure 2. In Milgram´s definition of AR, the whole area of real-to-virtual environment is described. Milgram introduces 4 main sections.

1) Real Environment
2) Augmented Reality
3) Augmented Virtuality
4) Virtual Environment

Here, augmented virtuality was defined as a component of the mixed reality continuum in which real and virtual objects are combined. In contrast to augmented reality (AR), which is based on the real world, both VR and AR operate in a virtual environment.

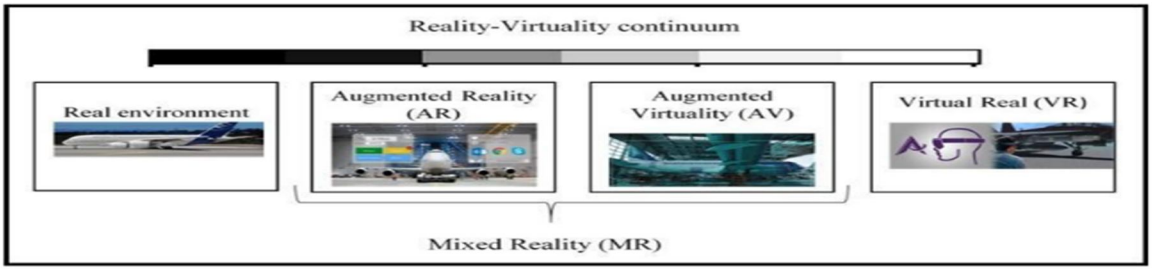

Fig.2

III. FIELD OF APPLICATION

As previously indicated, augmented reality (AR) has a wide range of applications, including in the military, marketing, navigation, aviation, maintenance, assembly, and repair.

In the medical industry, AR has significantly reduced risk. For instance, real-time scanning of the patient and dissemination of the information to experts not present during the procedure might significantly increase efficiency.

The convenience of the user experience in navigation is significantly improved by the integration of the AR principle with GPS in smartphones.

Tactical Augmented Reality (TAR) is a rather well-known military application of AR. According to reports, TAR will fundamentally alter how military personnel receive information and conduct operations, moving away from squad-level information exchange and training to segmented vision.

Marketing is a very important field of use. As it appeals to different senses of the customer and creates emotional attachment it is a very important marketing tool with big potential. That is why currently clothing, cosmetics and furniture companies make use of AR opportunities. Figure 3 is just an illustration of this application.

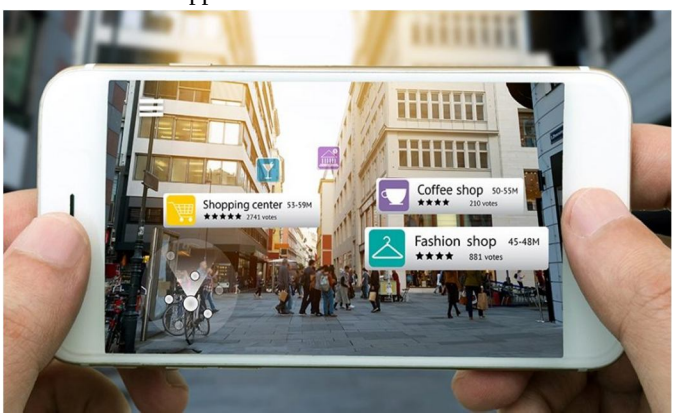

Fig.3

In the following section industrial AR/VR and its application in manufacturing will be defined more deeply.

A. *Manufacturing*

More and more manufacturing and engineering businesses are realizing what AR and VR can do for them. Industry sectors taking advantage include aerospace, automotive, energy, defence and medical. Prime manufacturers are increasingly integrating their supply chain SMEs into their AR and VR set-ups, with digital models and cross-functional teams directly plugged in. Also, for SMEs, regional providers are increasingly keen to help smaller businesses access and use AR and VR facilities.
Main fields of application of AR in manufacturing are Assembly, Quality Control, Automation or Repair and Automation.

B. *Assembly*

Complex assembly is an essential process in modern manufacturing. The number of components which need to be assembled together in often very complicated and precise sequence of operations within a very short time can be very challenging.
Implementation of AR system in this area can reduce the need to study pdf or video manual and can replace it by interactive instructions.

C. *Maintenance*

In manufacturing, the AR system's maintenance support is fairly well developed. Feiner provided the first description of the initial AR maintenance operation. When a machine breaks down, it is no longer necessary to call a service technician because of the AR maintenance support. The machine can be scanned and the problem can be found using augmented reality technology. Additionally, repair instructions can be projected into the real world in real time, eliminating the need to read lengthy, in-depth documents.
The required external expert does not have to travel to the plant to examine a complicated machine failure. Through the augmented reality (AR) system, the expert can assist the worker with the maintenance tasks. This reality ought to probably build the productivity of the specialists as they can uphold more issues simultaneously without the need to go to the site. As a result, the experts' travel-related expenses and time are eliminated.

Fig.4

D. *Automation*

An important AR technology is automation. More jobs are being automated as a result of recent advancements in smart manufacturing.AR systems have had a significant impact, particularly on robot programming (see Figure 5). In order to correctly programme industrial robot, it is needed to respect faultlessly the working space both in real and virtual environment. Operator safety improves as a result of AR technology. Additionally, it aids in the development of workers' abilities. the manufacturing industry, a properly set AR system for robot collaboration can significantly increase productivity.

Fig.5

E. Quality Control

From conception and design to realization, the product's development and production are extremely complex processes.Even though the manufacturing industry places a significant emphasis on increasing productivity or efficiency, the quality of the final product must not be compromised.

Quality control procedures are therefore a huge priority in manufacturing industry. AR presents an effective solution to manage quality at various levels of production process.

Because inspectors are able to directly compare the actual product to its ideal visual model, augmented reality technology provides an intriguing solution. Companies like Bosch and Porsche use AR systems for quality inspection.

Fig.6

IV. INDUSTRY 4.0 AND AR/VR TECHNOLOGY TRENDS

A study by International Data Corporation (IDC) estimates that the VR and AR market will reach 15.5 billion euros by 2022. It is estimated that AR and VR spending will reach $18.8 billion in 2020, an increase of 78.5% over $10 billion, with a five-year annual growth rate (CAGR) of 77.0%.

A study by Goldman Sachs Global Investment Research indicates that consumer applications such as video games, live events, and video entertainment will result in $18.9 billion in market value in the next nine years with video games leading at $11.6 billion. Meanwhile, enterprise categories such as healthcare and engineering will generate $5.1 billion, real estate, retail, and education will capture $16.1 billion in market value.

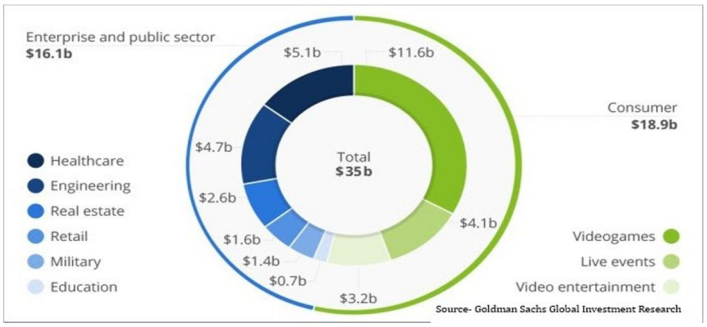

Fig.7

V. CONCLUSION

Overall, it can be concluded from the discussion above that AR has significant application potential in many industrial settings. Particularly in the field of maintenance and quality control. Moreover, it has been found to be useful in a variety of (less explored) areas, including remote assistance, training, facility management, and product design.

The cost of implementing innovative technological solutions is a major concern for entrepreneurs, despite their many benefits. In spite of the fact that not every business and company can be fully automated and modernized, AR/VR technology manufacturers are looking for innovative ways to open up virtual and augmented reality applications across a wide range of market sectors in order to continue to grow.

Therefore, many 21st-century businesses could find interest in the technical solutions used in Industry 4.0. However, management and/or owners must carefully analyze the decision-making processes for implementation in terms of their actual application.

Traditional businesses can be introduced to novel and more innovative practices that support them in national and international marketplaces through AR/VR technologies and IT systems.

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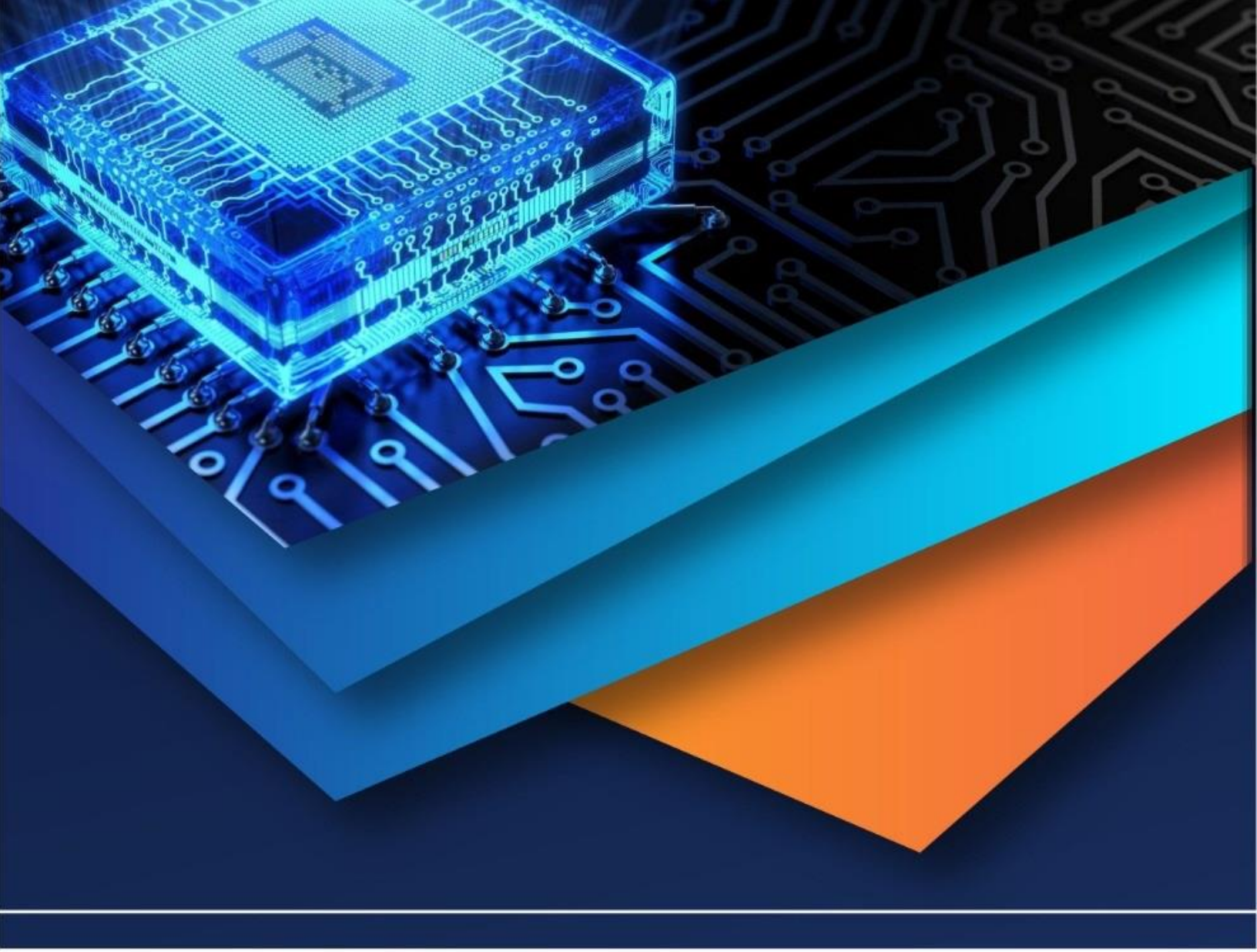

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