

IMPLANTATION OF MIXED REALITY TOOLS IN DESIGN ENHANCEMENT APPLICATION

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Abstract: The novel Mixed Reality Tools as part of Augmented Reality Technologies enables new approaches in design, education, presentation and collaboration in all aspects of human life. Industrial revolution 4.0 gives new possibilities for the development by extending the application of Mixed Reality to be used in all steps of the design process. Integration of the digital world in the real world gives a better view during the design process and helps designers collaborate all over the world today in real time. Using Hologlight AR 3S collaborative software, which provides the opportunity to see 3D models interact with the real world, gives full insight into fulfillment of ergonomic and functional requirements. AR 3S software helps understand very complex solutions and designs in great details. The possibility to use online meetings with complete interaction of all participants in Mixed Reality enables better understanding and collaboration. Using step by step guides in Mixed Reality environments provides enormous possibilities for presentation and education, letting users see holograms (stationary and animated), images and videos. Mixed reality in Microsoft Dynamics 365 Guides allows incorporate web-based information and documents in online real-time experience providing a chance to users to actively engage with the presented material. All the material within the guides is a cloud-based solution, enabling large numbers of the guide users to use it at the same time. As an educational tool, Microsoft Dynamics 365 Guides gives also feedback to the author in regards to how fast and how well the presented material is covered and understood. Using Microsoft Dynamics 365 Remote Assist allows the user to share the amazing Mixed Reality experiences with other users online when presenting concepts and designs to a large audience. All new Mixed Reality Tools will be, in the future, an integral part of education and presentation of design solutions.

Keywords: Mixed Reality, Collaboration Tools, Step-by-Step Instruction

INTRODUCTION

Augmented Reality (AR) is a novel technology that became an integral part of the new industrial revolution (Industrial Revolution 4.0). As a concept Augmented Reality gives an opportunity to augment and enhance our understanding of the world around us by adding, incorporating and embedding additional information, layering it for us to view. Augmented Reality has started as a way to incorporate a digital and a computer generated world into our real world environment.^{1,2}

Industrial Revolution 4.0 is a term that describes a new step in the evolution of industry. The best way to describe Industrial Revolution 4.0, is the total integration of IOT sensors (Internet-Of-Things), robotics, artificial intelligence and augmented reality, in order to get the most efficient, sustainable, ecological production of all goods. Augmented Reality, in this concept, is crucial because it connects points between humans and machines.³

Augmented Reality has been developed strongly in two distinct ways. The first and historically older one is a layered 2D user's interface tool incorporated in the sight of the operators and servicemen helping them in their work. It gives them the possibility to have all the necessary information for work in the most efficient way in their field of view. These kinds of tools enable remote assistance from experts, helping frontline work all over the world to overcome problems that may arise in day-to-day work. All information is presented using 2D images and videos, text, schemes, diagrams and tables while the workers' hands are free to do work. This is the reason why this kind of AR is named Assisted Reality. Secondly, the more advanced way of development of AR was the implementation of 3D objects mixed into the real world view. This new way uses the Mixed Reality concept that combines and integrates digital 3D computer generated objects and the real world environment as one. Mixed Reality does not exclusively take place in the physical or virtual world, but is a hybrid of our reality and virtual reality generated digitally.

Development of the different Mixed Reality tools gives us new possibilities in order to achieve a better and faster understanding of the world around us. The incorporation of additional information in the right time and in the real-world context enables new ways of work and collaboration between workers and colleagues. Mixed Reality has a strong educational potential giving industry a new tool for a fast, low cost and efficient training of frontline workers.⁴ All of these new industrial tools have a grand possibility of being implemented in other spheres of life, especially for designers in all creative industries, for education and for presentation as an advanced intuitive tool, as well as in helping people to work and collaborate at distance.

1 M. Esengün and G. İnce, *The Role of Augmented Reality in the Age of Industry 4.0*, Chapter 12, Springer International Publishing, Switzerland, 2018.

2 A. Ustundag and E. Cevikcan, *Industry 4.0: Managing The Digital Transformation*, Springer Series in Advanced Manufacturing, https://doi.org/10.1007/978-3-319-57870-5_12

3 T. Masooda, J. Eggera, "Augmented reality in support of Industry 4.0 – Implementation challenges and success factors", *Robotics and Computer Integrated Manufacturing* 58 (2019) 181–195.

4 S. R. Sorko, C. Trattner, J. Komar, "Implementing AR/MR – Learning factories as protected learning space to rise the acceptance for Mixed and Augmented Reality devices in production", *Procedia Manufacturing* 45 (2020) 367–372.

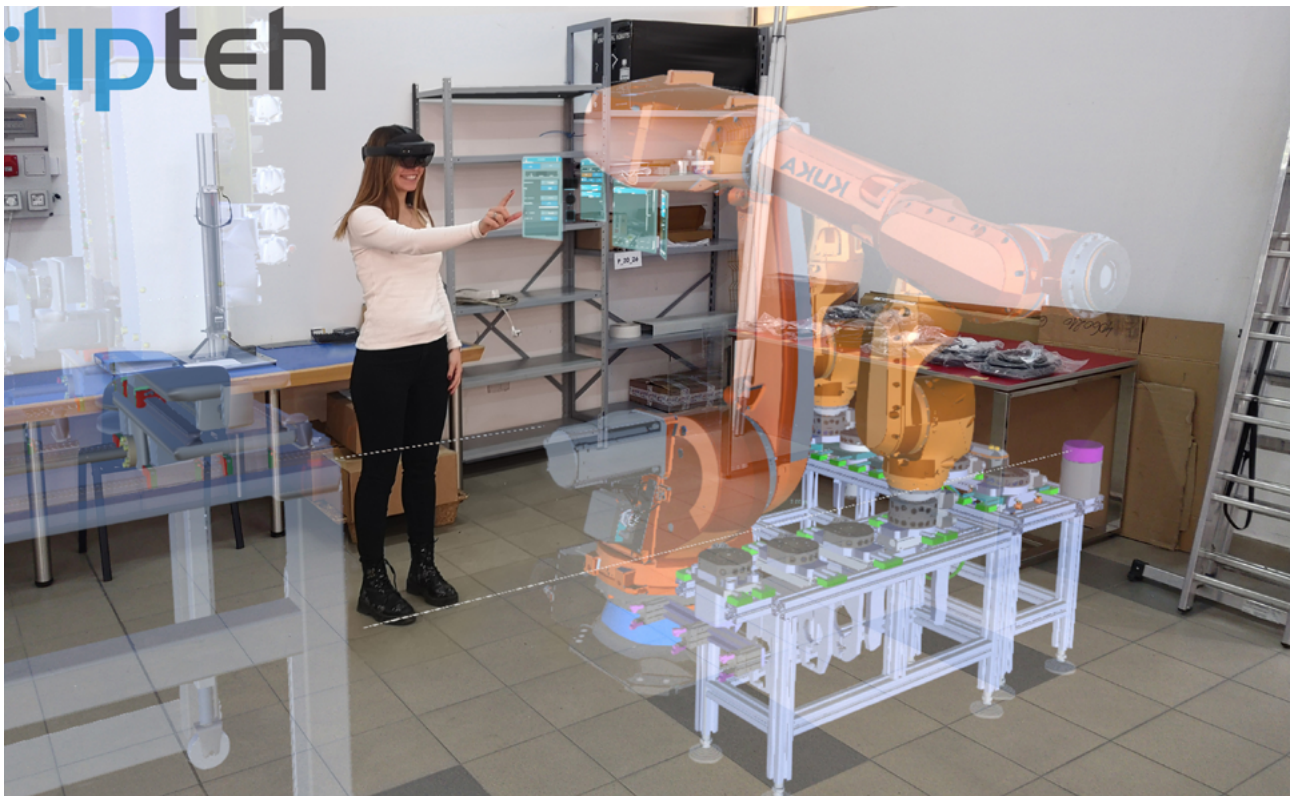


Fig 1

DESIGN COLLABORATION PROCESS

Mixed Reality technology in industrial practice provides a more natural way of interaction of the immersive environment in which virtual and physical objects can merge and coexist, as stated by S. Ke et al.⁵ MR includes both 2D augmented reality objects and 3D augmented virtuality elements combined with digital twin technology and, therefore, this hybrid reality is increasingly utilized for information visualization, remote collaboration, human-machine-interfaces, design tools as well as education and training.⁶ Operators' interaction in the Mixed Reality with 3D models of the automated robot cell is shown in Figure 1.

Mixed Reality makes it possible to comprehend elements and relationships in the product model that are otherwise not visible to the human eye, e.g., X-ray view, which contributes to a deeper understanding of the proposed CAD model and facilitates the presentation of new features, various design solutions and differences of competitive products. MR allows engineers to immersively create the 3D model known as the digital twin with virtual geometries, change its features, and relate to the environments and objects of the real world. Therefore, MR-supported design review allows engineers to see more faults in a 3D model than in the CAD software-based approach. Also, MR-supported analysis based on digital twinning data allows engineers to test functional behavior with higher confidentiality compared to testing by simulating using the CAE approach.⁷ MR is widely used for the interactive visualiza-

5 S. Ke, F. Xiang, Z. Zhang and Ying Zuo, "An enhanced interaction framework based on VR, AR, and MR in digital twin", *Procedia CIRP* 83, 2019, 753–758.

6 M. Juraschek, L. Buth, G. Posselt and C. Herrmann, "Mixed reality in learning factories", *Procedia Manufacturing* 23, 2018, 153–158.

7 A. Popovic, B. Bojovic, M. Suter, D. Niederer, Design parameters effect to magnetic flux distribution of the reluctance actuator, *FME Transactions*, Vol. 48, 2020, 504–510.

tion of the presented design in the targeted application environment and therefore provides early feedback, virtual design drafts and evaluation of concepts creation for a comfortable working environment with respect to the ergonomic requirements.⁸

Based on the classification of AR used⁹ the Design Collaboration Process (DCP) can be described as follows. Regarding the context-related criteria, at the center of DCP is a designed action of the digital twin model in the field of industrial engineering, supported by AR and assisted by synchronous collaboration at the same location as well as worldwide. Therefore, the distinction between reality and virtuality is desirable either for the process of design or redesign. The distinction is made today by enriching the existing CAD model and for the future by representation of an upcoming state of the CAD model.

The objective of DCP is to reduce costs and the product development cycle times during the (re)design of products, and according to D. Mourtzis et al,¹⁰ there is an evident need for highly customized products which could be realized using MR technology.

Generally speaking, design review is a cognitive process where communication has a substantial role. The exchange of messages and expert information, and conveying ideas to people with different skills and interests are essential in collaboration while at the same time necessary for efficient decisions. DCP requires transparency and versatility to ensure successful adoption and implementation of all ideas in order to accept solutions created through consumer reviews, product range enhancement and brand performance improvement. Instead of going vocally and textually through the developers, engineers and users, the incorporation of MR in DCP offers an effective tool for applying contextual information directly to the actual industrial product or even to technical drawings.

MR design review allows users to examine prototypes in a realistic way, starting from the earliest design stages to detect errors in products early on before the physical product is manufactured. One of the actual applications is resolving problems in communication among team members during the engineering design review process, as presented by Wolfartsberger et al.¹¹

MR devices can achieve interaction between the user and the virtual space via virtual 3D models projected into physical space through virtual reality peripherals (movable displays, data gloves, position trackers, and helmets). MR technology depends highly on the new IT generation (simulation technology, computer graphics technology and human computer interaction technology). Wearable devices are still dominating considering MR portability, for example in the Ford motor company,¹² manufacturing interactive see-through MR Head Mounted Devices (HMD) enables designers to change the outer appearance of a product by augmented drawings, making the design process more collaborative and effective.

8 A. Zunjic, G. Papic, B. Bojovic, L. Matija, G. Slavkovic and P. Lukic, "The Role of Ergonomics in the Improvement of Quality of Education", *FME Transactions* 43, 2015, pp. 82–87

9 D. Roltgen and R. Dimitrescu, "Classification of industrial Augmented Reality use cases", *Procedia CIRP* 91, 2020, pp. 93–100.

10 D. Mourtzis, V. Siatras, J. Angelopoulos and Nikos Panopoulos, "An Augmented Reality Collaborative Product Design Cloud-Based Platform in the Context of Learning Factory", *Procedia Manufacturing* 45, 2020, pp. 546–551.

11 J. Wolfartsberger, J. Zenisek and N. Wild, "Supporting Teamwork in Industrial Virtual Reality Applications", *Procedia Manufacturing* 42, 2020, pp. 2–7.

12 "Make Way for Holograms: New Mixed Reality Technology Meets Car Design as Ford Tests Microsoft HoloLens Globally", <https://media.ford.com/>. [Accessed: 5.5.2021]

The actual application of the developed system with Hololens¹³ shows the realistic collaboration experience. During DCP, the initial CAD design is completed in the desktop computer device and 3D CAD files are uploaded to the server. Then, when the team of collaborating engineers joins the online session in order to view or review the product design and discuss any alterations, they are enabled with several interactions to make changes in the existing product design. Depending on the contemporary device, they could use either HMD or Android devices, and the changes are accomplished with hand gestures and through touch buttons, respectively. Due to the different functions provided by contemporary devices, the different spectrum of interaction and capabilities of each platform are enabled. The MR user interaction expands to the removal, reorientation or repositioning of objects, resulting in different design solutions. Additionally, audio and visual combination enhances the collaborative environment immersion. In the context of a collaborating session, MR enabling-devices mainly focus on the preview and rough design changes of the product. On the other hand, PC devices are mostly used to perform all the high computational requirement actions. Afterwards, the ideas discussed during the session, in the form of text annotations on the 3D object are automatically uploaded to the Cloud database so that the product design can be accordingly revised.

A typical software solution that covers the area like DCP (Design Collaboration Process) with all the features described earlier is Hololight AR 3S (former name ARES – Augmented Reality Engineering Space). This software solution uses Hololens 2 platform to give the possibility of viewing and presenting CAD made solutions to multiple users in real time without the need to have them in the same place. Hololight AR 3S software is a great example of collaboration software that is primarily built for engineers who create and design in teams. While working in the team all members need to interact and visualize the solution in order to help each other understand how their parts interact and interconnect without any mistakes or problems. In this way they can avoid costly errors, enhance speed of the design process and overcome misunderstandings. Operators' view through Hololens 2 in real time can be seen in Figure 2. The operator sees simultaneously the automated robot cell 3D model and the real environment surrounding it.

The first 3D CAD model needs to be opened in AR 3S. It is possible to open more than one model at a time and to position them in Mixed Reality space. The space position of the opened 3D models in MR could be saved for easy future work. Every 3D CAD model is opened with their hierarchy tree. The hierarchy tree is important to select and interact with internal elements of 3D CAD models.

Hololight AR 3S has three main interaction parts: 1) visualization, 2) manipulation, 3) selection and analysis.

Visualization gives one the possibility of seeing intersections in a 3D model. It is possible to have an intersection using a plain, a sphere and a cube. All intersection tool positions and sizes are easy to implement relative to the 3D CAD model. This tool is great for seeing internal parts interactions.

Manipulation is used to move 3D models or their parts. This is important to position 3D models in MR space according to other 3D models or space features.

Selection gives one an easy way for selecting 3D models or their parts to be used with other interaction tools like manipulation or visualization.

¹³ D. Mourtzis, V. Siatras, J. Angelopoulos and N. Panopoulos, "An Augmented Reality Collaborative Product Design Cloud-Based Platform in the Context of Learning Factory", *Procedia Manufacturing* 45, 2020, pp. 546–551.



Fig 2

One of the great features of the Hololight AR 3S software is having an interactive meeting with multiple users who use Hololens 2 glasses or Apple iPad tablets. All participants at the meeting see the 3D CAD model from their point of view. It is possible to have a meeting with a participant from a remote site using a VPN connection. All the participants in the room see each other in MR and the remote participant is represented as Avatar so everyone knows their point of view. This is important during the collaboration process.¹⁴

Advanced features of AR 3S such as cloud operation and cloud licensing are new features that allow more intricate 3D CAD models with more than 5 million polygons, which could be inserted in the MR space.

Other examples of software that cover the area of Design Collaboration Process are: Kognitive Spark and Spatial. Each software has the same possibilities as the Hololight AR 3S but not as specialized and interconnected.

STEP-BY-STEP INSTRUCTIONS

The large fluctuation of work force has created the need for fast, efficient and low cost training and education of frontline workers. Workers all over the world need to be able to do complex tasks and jobs with no or very limited prior knowledge and experience. Augmented Reality offers a solution in the step-by-step instructions on both platforms: in the Assisted Reality and in the Mixed Reality. For frontline workers who are novice and have just started without experience and technical knowledge, Mixed Reality step-by-step tools have proved to be more efficient. The main reason is that our minds are created to work and easily understand the 3D environment and that is why we more naturally accept 3D presented instructions, shown in Figure 3.

¹⁴ Hololight ARES, www.holo-light.com

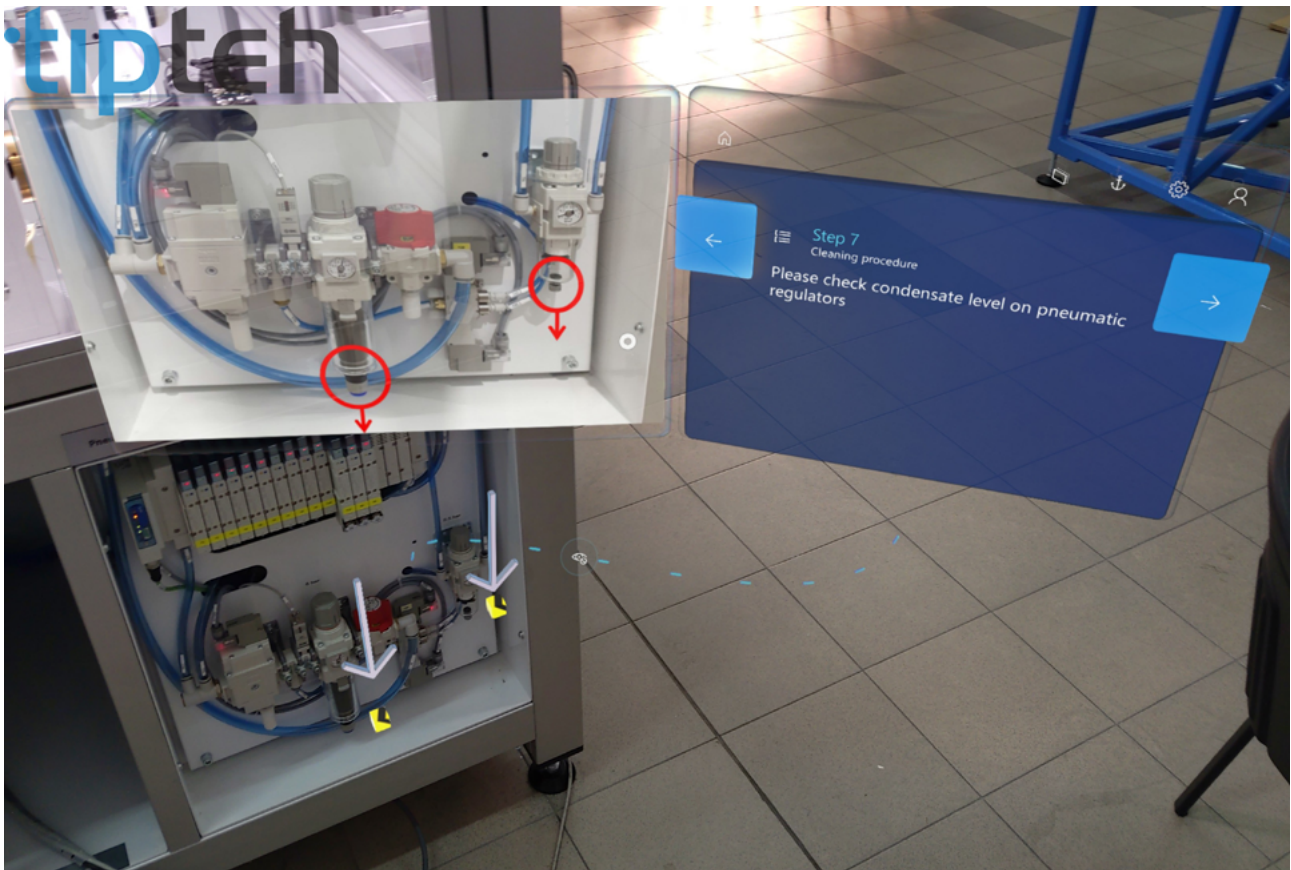


Fig 3

One of the most frequently used step-by-step instruction tools in Mixed Reality is Microsoft Dynamics 365 Guides (MS D365 Guides), and this application uses Hololens Mixed Reality glasses as a hardware platform. This new MR tool is part of the cloud based on the industrial software application bundle that covers all aspects of the industry: the production process, service, finance and marketing. MS D365 Guides consist of three modules: PC application, Hololens application and a cloud-based analytics application to get feedback from MS D365 Guides usage. Easy-to-use software is made to help workers go through the production process following step-by-step instructions one task at a time. Structured instructions are divided into tasks and each task is divided into steps. Sometimes a condition step is needed to follow the production process which depends on the environment, position of the worker on the factory floor, data or previous tasks. MS D365 Guides enable using condition steps, spatial triggers and end steps. All these elements help describe the production process in the most natural way.

The first step when using MS D365 Guides is to create the structure of the work process and to collect the necessary media files that will be used in the Guides. Good practice is to prepare a guide structure before starting work in PC MS D365 Guides application. When making Guides, the author divides the working process into essential tasks, and then every task is divided into steps. Each step fulfills one action of the operator who uses the Guides. In this way the author forms the Guides structure very quickly. MS D365 Guide PC application is very intuitive and easy to use. After inserting and forming the structure of the Guides, it needs to upload onto the cloud all the media and 3D model files that would be used to better explain action on each step. It is possible to upload and use 2D images and diagrams, videos and 3D models that would be inserted into the Mixed Reality environment. One of the

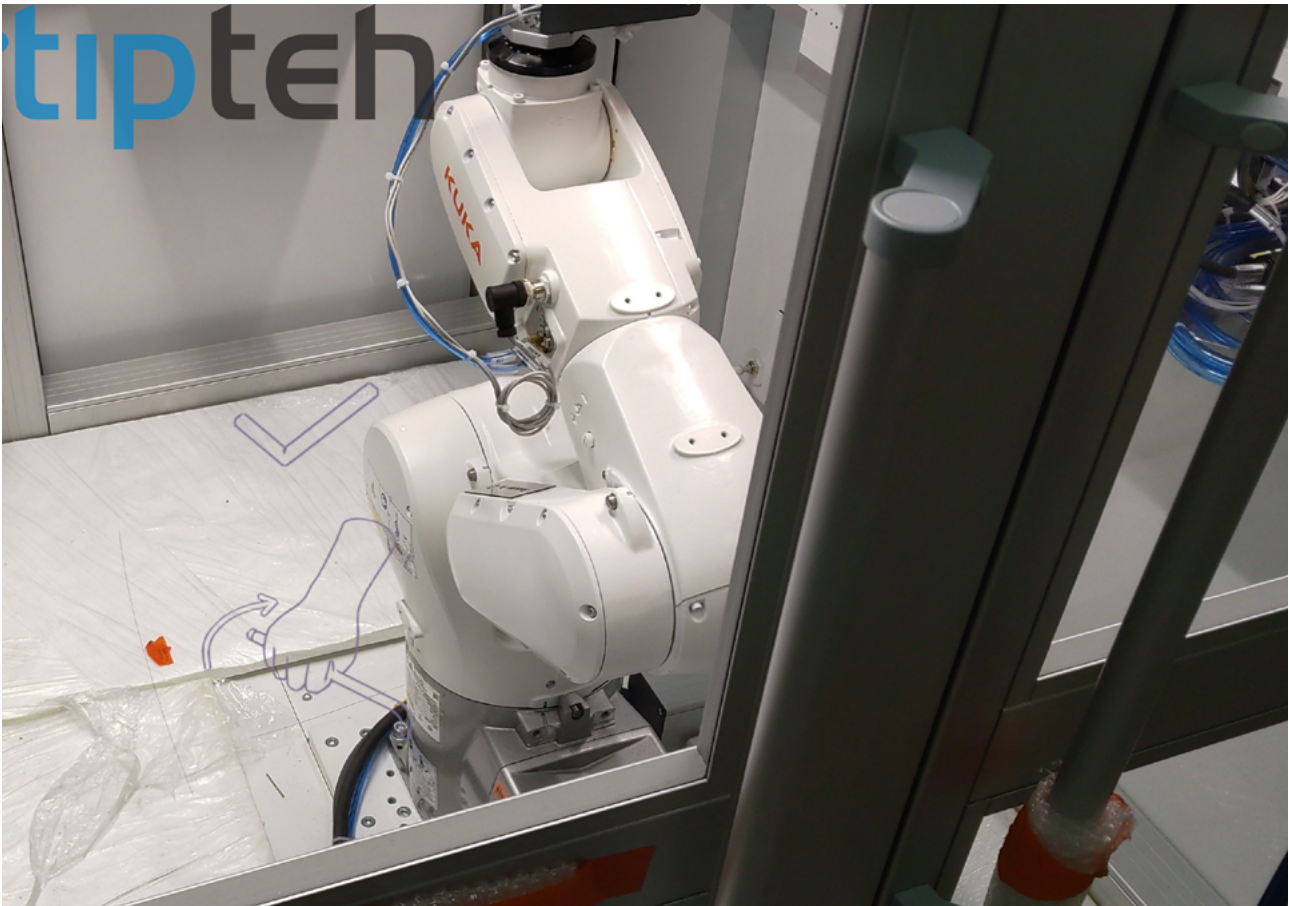


Fig 4

great features that MS D365 Guides offers is to import web links into the Guides or to connect the Guides to databases using Power Apps (Power Apps – easy to use, a cloud based graphical programming tool that helps interconnect different business software solutions and allows easy integrations with databases). Connecting MS D365 Guides with web sites gives one the opportunity to incorporate additional information and explanations, helping the Guides to be more efficient and helpful.

One of the most important things to form Mixed Reality is to establish the connection between the real world and the digital-generated world. It is done by using special kinds of markers called “anchors” that represent the connecting point between the real and the digital world as a reference point. MS D365 Guides uses three kinds of anchors: circular code anchors (historically the first anchor type), QR code anchors and digital model anchors. QR code anchors provide the best results, although sometimes it is not possible to use them. In this situation, digital model anchors are usually used. QR code is usually used as a sticker to fix an anchor position in the real world and all 2D and 3D elements that are used in the Guides will be referenced to it.

After finishing making the Guides structure in PC MS D365 Guides, the author uses the Hololens Guides application in the author mode to put 3D models and elements in the Mixed Reality world. Putting 3D models and multimedia elements in the exact position could make a better context for operators to understand and follow each step easily without any doubt or problems. One example of an animated 3D model explaining working procedure can be seen in Figure 4.

Operators use the MS D365 Guides application on Hololens in their work in the operator’s mode. The cloud application collects all the data of the Guides usage and



Fig 5

analyzes them. The author of the Guides uses this data to get the information on the working process, on each task and step, providing data as to how to upgrade the current version of the Guides, and helps to make the working process more efficient.

The MS D365 Guide has a great potential to be used not just in the production environment but also as an advanced presentation tool, as illustrated in Figure 5. It could be used for educational purposes, as well as a tool to do jobs from a distance.¹⁵

Today there is other software that is used for step-by-step instructions in AR and MR. Good examples are Scope AR and Team Viewer Frontline. Both give possibilities like the MS D365 Guides and are used in Industry today.

REMOTE EXPERT ASSISTANCE

Today, especially during the pandemic, the need for remote help and guidance for frontline workers has become a necessity. The number of highly trained and educated servicemen has been constantly getting lower during the last decade due to

¹⁵ Microsoft Dynamics 365 Guides, 2020.



Fig 6

the changes in the job market and changes in the educational systems all over the world. Training of servicemen that need to work in the field has become a large problem. One solution that is becoming popular nowadays is remote expert assistance because it helps new servicemen start working immediately, with no or little experience, with the backup knowledge of experts helping from a remote location. It means that remote assistance servicemen work on finding solutions to challenging problems relying on the help and advice of experts without any delay, as shown in Figure 6.

Basically, remote assistance uses a camera and a microphone so the expert from a remote location can see exactly what frontline workers see and help them on the spot with suggestions and advice, providing pointers, documents, images and videos. All these activities could not be executed easily without Augmented Reality. AR and especially MR could provide a great platform for smart glasses (Hololens 2, RealWear HMT-1, Vuzix M400, Google Glasses EE2, etc.) for remote expert assistance giving frontline workers the possibility to establish and sustain a connection in a hands-free mode while working.

Depending on the smart glasses platform, two different software solutions have become dominant. Using the AR assisted reality glasses like RealWear HMT-1 or Vuzix M400 TeamViewer Frontline is a great solution for remote expert assistance. This kind of smart glasses is more suitable for frontline workers and servicemen that are working outside buildings and factories in very difficult conditions. The TeamViewer Frontline software pack provides a high throughput communication, an encrypted connection, HD video and 3D pointers providing a secure link between

the expert and frontline workers. TeamViewer Frontline makes it possible to have a conference call (one or more experts talk with one or more frontline workers at the same time) to provide a faster response in order to overcome problems in the field.

The second solution is Microsoft Dynamics 365 Remote Assist (MS D365 Remote Assist) that uses Mixed Reality glasses HoloLens 2 as a platform for frontline workers. This software lets frontline workers use the voice command to initiate a call to an expert or experts to help them overcome problems they are facing. The expert uses standard Microsoft Teams software on his PC. After MS D365 Remote Assist makes the connection to the expert, the expert has the ability to see exactly what a frontline worker sees. During the Remote Assist call, the frontline worker and the expert have the possibility to draw and place the pointer in 3D space, capture images and exchange documents in pdf, images and videos. This interaction can help the frontline worker or servicemen solve complex problems in the field while working in hard conditions.¹⁶

Other software solutions that are currently used for remote assistance are also Kognitive Spark and Scope AR with their modules for the expert calls.

AUGMENTED REALITY (AR) ART

AR art is digital art that augments the physical world in a creative way. As a novel creative medium, it brings a new type of artwork into the physical world.¹⁷ Augmented Reality artwork can be in any place, of any size and of any structural and functional complexity because any part of the physical world can be used as an artistic canvas on a computer screen or in a gallery.

AR has the potential as a new artistic medium for effective and adequate visualization indoors and outdoors. One outdoors example is the prehistoric rock art paintings AR application (app).¹⁸ The AR application shows a recreation of a possible original composition full of motifs, targeting non-expert visitors with descriptive information, and therefore improves the current guided tour user experiences.

In the review paper by Z. He et al,¹⁹ the indoors AR utilization is explained as an auxiliary tool in the management of tourists' museum experiences. It manifests itself in two ways. The first way offers a new level of virtual presence of augmenting immersive scenes, such as a historical, natural, or cultural virtual environment that reflects the content of the exhibits. The second way offers augmenting digital assets of the exhibits that includes verbal descriptions, 2D or 3D visual appearances, or visual animation that convey an exhibit's transformation.

For the enjoyment of cultural heritage in a real case museum environment,²⁰ the Augmented Reality interactive installation system consisting of AR technology, mobile application and high resolution visualization has been developed. Visual

16 Microsoft Dynamics 365 Remote Assist, 2020.

17 V. Geroimenko (ed.), *Augmented Reality Art-From an Emerging Technology to a Novel Creative Medium*, eBook.

18 S. Blanco-Poins, B. Carrion-Ruiz, J. L. Lerma, V. Villaverde, "Design and implementation of an augmented reality application for rock art visualization in Cova dels Cavalls (Spain)" *Journal of Cultural Heritage*, Vol 39, pp. 177-185.

19 Z. He, L. Wu, X. R. Li, "When art meets tech: The role of augmented reality in enhancing museum experiences and purchase intentions", *Tourism Management* 68, 2018, 127-139

20 R. Pierdicca, E. Frontoni, P. Zingaretti, M. Sturari, P. Clini and R. Quattrini, "Advanced interaction with paintings by augmented reality and high-resolution visualization: a real-case exhibition", in: L. Paolis, , A. Mongelli (eds.), *Augmented and Virtual Reality*, New York, 2015, pp. 38-50. https://doi.org/10.1007/978-3-319-22888-4_4

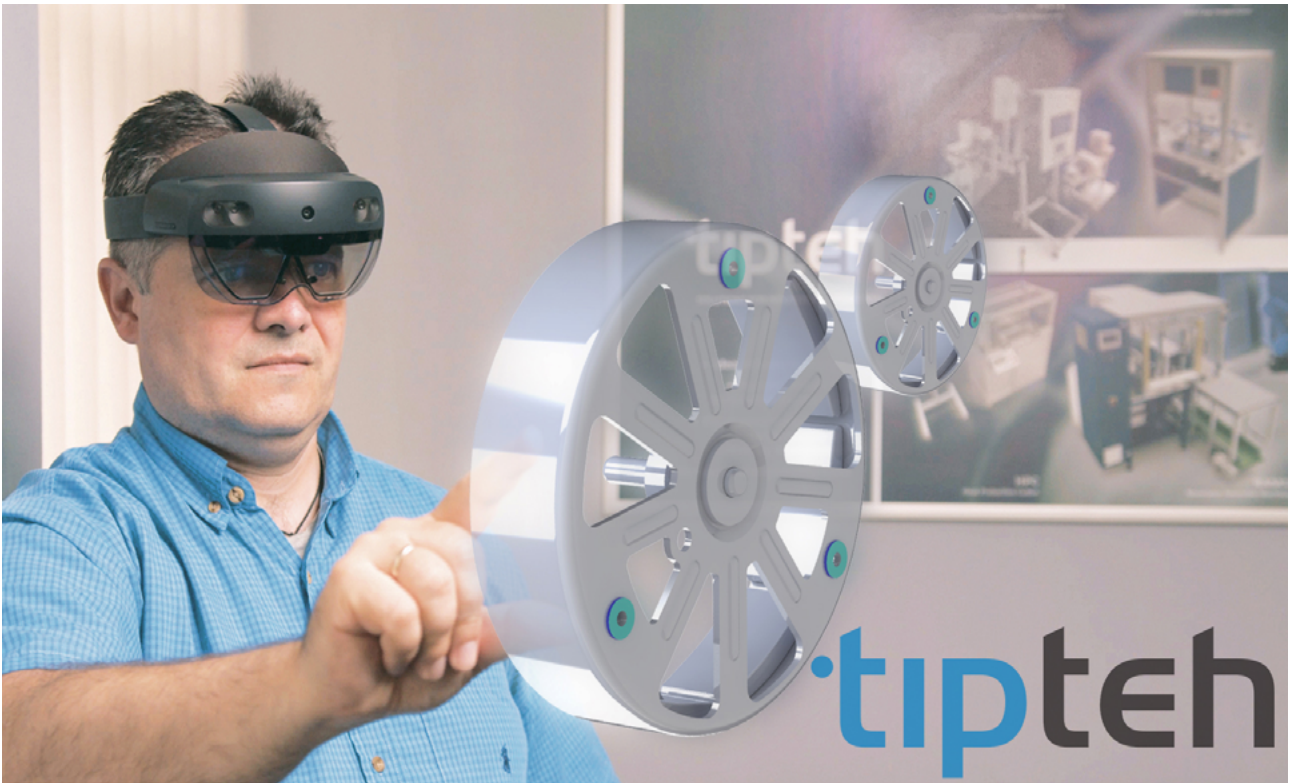


Fig 7

augmentation of the museum visitors' surroundings and the touch interaction technique to display digital contents, allows interaction with digital contents in an intuitive and exciting way.

AR has the potential to bridge the existing gap between live art performances and the second screen experience. The opera and other performing art forms with titles are suitable to engage the audience in the performance and enhance the theatrical experience. By using AR during live performance, the audience members experience an immersive experience, such as a director commentary, dramaturgical notes, concert program, additional plot information, or an explanation of musical elements. AR has the ability to educate and engage audiences²¹ in the manner that suits them most.²² Augmented Reality provides endless possibilities in art and design as shown in Figure 7.

CONCLUSION

Augmented Reality is a novel concept, an integral part of Industrial Revolution 4.0, which connects humans to machines in the most efficient and natural way. As a concept, Augmented Reality gives us an opportunity to augment and enhance our understanding of the world around us by adding, incorporating and embedding additional information layering it out for us. Mixed Reality is the most advanced concept of the Augmented Reality that combines and integrates digital 3D computer-generated objects and the real-world environment as one. Mixed Reality does

21 T. Rhodes, S. Allen, *Through the looking glass: how Google Glass will change the performing arts*, Arts Management and Technology Laboratory, pp. 1–12, (2014)

22 T. Aitamurto, J. B. Boin, K. Chen, A. Cherif and S. Shridhar: "The Impact of Augmented Reality on Art Engagement: Liking, Impression of Learning, and Distractiome", in: J. Y. C. Chen and G. Fragomeni (eds.) *Virtual, Augmented and Mixed Reality: Applications in Health, Cultural Heritage, and Industry*, 2018, pp. 153–171, DOI:10.1007/978-3-319-91584-5_13

not exclusively take place in either the physical or virtual world, but is a hybrid of our reality and virtual reality generated digitally. The Mixed Reality technology in industrial practice provides a more natural way of interacting in the immersive environment in which virtual and physical objects can merge and coexist. MR includes both 2D augmented reality objects and 3D augmented virtuality elements combined with the digital twin technology; therefore, this hybrid reality is increasingly utilized for information visualization, remote collaboration, human-machine interfaces, design tools, as well as in education and training.

All of these new industrial tools have the grand possibility to be implemented in other spheres of life, especially for designers in all creative industries, for education and for presentation as an advanced intuitive tool, as well as in helping people to work and collaborate at a distance.

The Design Collaboration Process (DCP) can be described as a design action on the digital twin model in a field of industrial engineering, supported by AR and assisted by synchronous collaboration of several people at the same location or worldwide. The objective of DCP is to reduce costs and errors, shorten the product development cycle times during design or redesign of products and enhance understanding during the development process. The design review is a cognitive process where communication has a substantial role. Instead of going vocally and textually through the developers, engineers and users, the incorporation of MR in DCP offers an effective tool for applying contextual information directly to the actual industrial product and to technical drawings.

A typical software solution that covers the area like DCP (Design Collaboration Process) with all features described earlier is Hololight AR 3S (former name ARES – Augmented Reality Engineering Space). This software solution uses the Hololens 2 platform to give multiple users the possibility of viewing, presenting and reconfiguring CAD made solutions in real time without the need to have them all in the same place. Hololight AR 3S software is a great example of collaboration software that is primarily built for engineers who create and design in teams. While working in the team, all members need to interact and visualize the solution to help each other understand how their parts interact and interconnect without mistakes or problems. In this way they can avoid costly errors, enhance speed of the design process and overcome misunderstandings.

The large fluctuation of work force has created the need for fast, efficient and low-cost training and education of frontline workers. Companies all over the world need to have workers who are able to do very complex tasks and operations with no or very limited previous knowledge, training and experience. Augmented Reality offers solutions in step-by-step instructions on both concepts: in the Assisted Reality and in the Mixed Reality. For frontline workers who are novice and have just started working, without experience and technical knowledge, Mixed Reality step-by-step tools have proved to be more effective. The main advantage of MR is that human minds are created to work with and understand easily 3D environment, and workers accept 3D presented instructions in a more natural way. One of the most used step-by-step instruction tools in Mixed Reality is Microsoft Dynamics 365 Guides (MS D365 Guides), and this application uses Hololens Mixed Reality glasses as the hardware platform. MS D365 Guides consists of three modules: PC application, Hololens application and a cloud-based analytics application to get feedback from MS D365 Guides usage. Easy-to-use software is made to help workers go through the production process following step-by-step instructions one task at a time. Structured instructions

are divided in tasks and each task is divided into steps. By following steps, frontline workers can fulfill their tasks explained in detail by using 3D objects, gestures and animations, images and videos and PDF documents with schematics and diagrams.

The MS D365 Guide has a great potential to be used not just in the production environment but also as an advanced presentation tool. It could be used for educational purposes, as well as a tool to do jobs from a distance.

Nowadays, especially during the pandemic, the need for remote help and assistance has become a necessity. The number of specialized and highly trained servicemen has reduced in the last decade due to changes in the job market and educational systems all over the world. Training of new servicemen is becoming a real problem. To overcome this challenge, one solution that is becoming popular, is remote expert assistance. This solution helps new servicemen start working immediately with backup knowledge and help from experts that are connected from a remote location. In this way experts view exactly what servicemen see and guide them to a solution while they work in difficult conditions.

Depending on the smart glasses platform, two different software solutions have become dominant. Using AR assisted reality glasses TeamViewer has brought a great solution for remote expert assistance. This kind of smart glasses is more suitable for frontline workers and servicemen working outside buildings and factories in very difficult conditions. The TeamViewer Frontline software pack provides a high communication throughput, encrypted connection, HD video and 3D pointers giving a secure link between expert and frontline workers. The TeamViewer Frontline allows the possibility of having a conference call (one or more experts talk with one or more frontline workers at the same time) in order to provide a faster response and to overcome problems in the field.

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AR art is digital art that augments the physical world in a creative way. As a novel creative medium, it brings a new type of artwork into the physical world. AR artwork can be anywhere, of any size and of any structural and functional complexity because any part of physical world can be used as an artistic canvas, either a computer screen or a gallery. The emerging field of AR art is the potential of AR as a new artistic medium for effective and adequate visualization indoors and out-of-doors. AR utilization is explained as an auxiliary tool in the management of tourists' museum experiences. It manifests itself in two ways. The first way offers a new level of virtual presence by augmenting immersive scenes, such as a historical, natural, or cultural virtual environment that reflects the contents of the exhibits. The second way offers augmenting digital assets of exhibits that include verbal descriptions of exhibits, 2D or 3D visual appearances, or visual animation that conveys an exhibit's transformation.

AR has the potential to bridge the existing gap between live art performances and the second screen experience. By using AR during a live performance, the audience

could have an immersive experience on display with extra information making art more alive and interactive.

For future work we are planning to extend our research towards configuration software for creating an agile robotic system for traceable unified manipulation that is engaged in the logistical flow of items in the process of palletizing/depalletizing and automatic vision inspection during packaging. Configuration software will automatically generate a 3D model that would be imported in the Hologlight AR 3S environment to show how an agile robotic cell could be incorporated in the current manufacturing process and organization in factories.

ILLUSTRATIONS

1. Mixed Reality implements 3D models in hybrid digital/real world space
Мешовита Реалност имплементира 3Д моделе у хибридном дигиталном/реалном простору
Autor: Tipteh d.o.o.
2. Hologlight ARES software in action
Softver Hologlight ARES у акцији
Autor: Tipteh d.o.o.
3. Microsoft Dynamics 365 Guides – Operation Mode
Microsoft Dynamics 365 Guide – Мод оператора
Autor: Tipteh d.o.o.
4. Microsoft Dynamics 365 Guides – Imported animated 3D models
Microsoft Dynamics 365 Guide – Унети анимирани 3Д модели
Autor: Tipteh d.o.o.
5. Microsoft Dynamics 365 Guides – Image gives detail instruction
Microsoft Dynamics 365 Guide – Додата слика даје детаљно упутство
Autor: Tipteh d.o.o.
6. Microsoft Dynamics 365 Remote Assist – Asking expert for help in real situation
Microsoft Dynamics 365 Remote Assist – Захтев за даљинску асистенцију и помоћ експерта
Autor: Tipteh d.o.o.
7. Augmented Reality gives endless possibilities in creative technologies and art
Додата Реалност пружа бескрајне могућности за креативне технологије и уметност
Autor: Tipteh d.o.o.

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Иван Р. ДАНИЛОВ, Ђорђе П. ШАПОЊИЋ, Божица А. БОЈОВИЋ
ПРИМЕНА АЛАТА ЗА МЕШОВИТУ РЕАЛНОСТ ПРИ НАПРЕДНОМ ПРОЈЕКТОВАЊУ

Нови алати у Мешовитој Реалности, који су саставни део технологије проширене реалности, пружају свеж приступ пројектовању, образовању, презентацији и сарадњи у свим аспектима савременог живота. Индустриска револуција 4.0 пружа нове могућности проширења и унапређења примене мешовите реалности током свих фаза пројектовања и развоја производа и процеса. Интеграцијом дигиталног окружења у реални свет остварује се бољи увид током процеса пројектовања и олакшава се сарадња међу пројектантима широм света у реалном времену. Коришћењем *Hololight ARES* софтвера за сарадњу омогућен је преглед и интеракција 3Д модела у реалном окружењу са освртом на испуњење ергономских и функционалних захтева. *ARES* софтвер помаже разумевање веома комплексних решења са високим нивоом детаља. Коришћење on-line састанака са потпуном интеракцијом у мешовитој реалности свих учесника омогућује боље међусобно разумевање и сарадњу. Упутства корак по корак у мешовитој реалности дају значајне могућности за презентацију и едукацију омогућавајући корисницима да виде холограме (стационарне или анимиране), слике и видео записе. Мешовита стварност у *Microsoft Dynamics 365 Guides* даје свеобухватне податке и документа са светске мреже који су доступни у реалном времену и са могућношћу да корисници активно учествују у раду са презентованим материјалом. Сви материјали који се користе у *Microsoft Dynamics 365 Guides* базирани су на *Cloud* технологијама, омогућавајући истовремени рад великом броју корисника. Као едукциони алат, *Microsoft Dynamics 365 Guides* бележи начин, количину и разумевање презентованог материјала ради анализа и са циљем даљег унапређења. Корисници софтвера *Microsoft Dynamics 365 Remote Assist* могу да деле изузетно искуство мешовите реалности са другим корисницима током презентовања широком аудиторијуму. Сви нови алати у мешовитој реалности у будућности биће саставни део едукације и презентације пројеката и решења.

Кључне речи: мешовита реалност, алати за колаборацију, упутства корак по корак