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VIRTUAL REALITY (VR), AUGMENTED REALITY (AR) AND MIXED REALITY (MR), A NECESSITY OF THE MODERN DIVING TECHNOLOGY

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ABSTRACT

The paper looks at three emerging technologies, namely virtual reality (VR), augmented reality (AR) and mixed media (MX), and explains how they are transforming the way we interact with the digital and real worlds. Each technology is defined and the main features are highlighted for comparison. VR gives us a complete and immersive experience in the virtual world, AR adds digital elements to the real world, and MX integrates both media to create an interactive experience where virtual and real elements interact and coexist. Within the work a number of equipment or applications incorporating these emerging technologies were reviewed to highlight how they could assist divers to train under controlled conditions and simulate real diving conditions in hazardous or complex environments. The implementation of technologies such as virtual reality (VR), augmented reality (AR) and mixed media (MX) within the Diving Center of the Romanian Naval Forces would bring many advantages and significant improvements in terms of the training capacity, operational efficiency and safety of military divers. These technologies would not only modernize training and operations, but also strengthen the ability to intervene and react in critical situations.

KEYWORDS: virtual reality (VR), augmented reality (AR), mixed reality (MR), technology, diving

1. Introduction

Recent advances in high-speed communications and miniature mobile computing platforms have escalated a strong demand for deeper human-digital interactions beyond traditional flat-screen displays. Augmented reality (AR) and virtual reality (VR) headsets appear as state-of-the-art interactive displays with the ability to provide vivid three-dimensional visual experiences. VR embraces a total immersive experience, while AR promotes

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interaction between the user, digital content, and the real world, thereby displaying virtual images while remaining viewable. MR is a combination of VR and AR, managing to perfectly merge real and virtual elements.

2. Virtual Reality (VR)

Virtual reality (VR) is a fully simulated environment that allows users to feel present and interact in a virtual world. This environment is created with the help of computer technology. It involves the use of VR headsets to create an artificial and immersive environment, completely or largely blocking out the real world. Thus, users can interact completely absorbed in the virtual environment that gives them the impression that they are in the real world. Moreover, Virtual Reality has the ability to recreate environments or circumstances that may be different or even impossible to create in the real world.

The fields of applicability are vast, from video games, training simulators in different environments, domains (medical, aviation, hyperbarism, military, etc.) to learning and entertainment applications.

3. Augmented Reality (AR)

Augmented reality (AR) connects physical objects with digital information. This is done through mobile devices, tablets or special glasses, which are tools that allow virtual elements to overlap with physical reality. Digital overlay includes and integrates virtual elements into physical reality, and users have the ability to interact with virtual objects and manipulate digital information in a real way.

We find this technology in applications for location and object recognition on mobile devices, in games, but also in assistance in medical or engineering fields.

4. Mixed Reality (MR)

Mixed reality (MR) is an interface that enables real-time interactions between virtual and physical objects by integrating virtual and augmented reality components at the same time and in the same environment thus creating unique experiences that can bridge the real and virtual worlds.

The interaction between the environments of research, observation, surveillance, execution, information – correct and complete in practically instantaneous time – the classification of the received information, then the decision-making by the factors in the surface team and their command to the team in the working environment, design applications and engineering to test prototypes in simulated and real environments or conducting trainings and simulations involving the integration of virtual and real environments are just a few examples where this innovative technology can be applied with great success.

5. Comparison of VR, AR and MR

Table no. 1

Comparison of VR, AR and MR

Factor	Virtual Reality (VR)	Augmented Reality(AR)	Mixed Reality (MR)
Interaction	Completely virtual, not directly related to the real world	Superimposition of virtual elements on top of physical reality	Simultaneous interaction with virtual and real elements
Presence	Intense sense of presence in a fully virtual environment	Interface between physical and virtual world	Concurrent experience of real and virtual environments
Use	Simulations, immersive games, specialized training	Mobile applications, support in various fields	Interactive training, design and engineering

In conclusion, VR gives us a complete and immersive experience in the virtual world, AR adds digital elements to the real world, and MR integrates both media to create an interactive experience where virtual and real elements interact and coexist. Each technology has its own uses and can be used in different fields, from entertainment to medicine, education and engineering, bringing innovation and change to the way we interact with the world around us.

6. The Use of VR, AR and MR in the Field of Diving

Divers can use VR simulations to train under controlled conditions and simulate real diving conditions in dangerous or complex environments. By using VR and AR technologies, divers can make virtual 3D reconstructions of discovered or explored underwater sites, in order to further analyze and study these locations.

They can use AR technology to view essential data in real time, such as distance to an object, specific data about that object, depth, water temperature, or any other information that can be transmitted by the surface team. All of this data can be viewed by the diver on lenses or screens integrated into their diving helmets.

During a dive, divers must pay attention to various safety factors, including depth, dive time, and remaining time. For many inexperienced divers, it is easy to lose track of time underwater, especially when observing marine life. This can lead to very dangerous consequences and even their death.

While diving, divers must pay attention to various safety factors such as depth, dive time and remaining time. Many inexperienced divers tend to lose track of their time underwater, especially when observing marine life. This has very dangerous consequences and can even lead to death.

AR could help change this by making diving information more accessible to divers. With an AR-controlled diving mask, divers will never lose track of depth or air intake when "taking in the view" underwater. If successful, AR could transform even technical diving, which is much riskier than recreational diving.

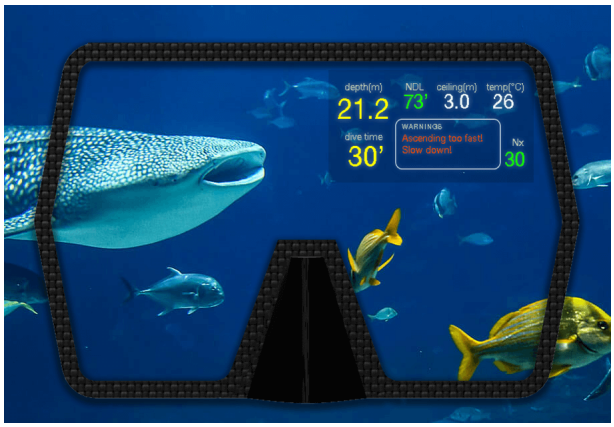

Figure no. 1: *Smart diving mask Mirage prototype*
(Source: https://www.immersivelearning.news/2021/08/20/how-ar-diving-masks-can-improve-underwater-operations/)

Divers can also take advantage of AR technology to identify and obtain information about marine species encountered during dives through a system that automatically recognizes underwater fauna and flora. They can also use AR to access detailed information and instructions for maintaining their equipment during dives, reducing the time needed for repairs or maintenance.

The use of MR allows divers to interact with 3D underwater maps, providing detailed information about terrain and current location during dives. Through MR technologies they can access holograms or real-time visual information to receive guidance instructions during their underwater missions.

Another area where divers can use MR communication technologies is medical. Through this innovation, doctors can provide medical assistance to divers on underwater missions by providing real-time consultation and instructions.

Vr-One Diving is a VR application that gives users the experience of exploring underwater reefs and sites. This app is available for several VR platforms, including Oculus Rift and HTC Vive, and offers an immersive experience in the underwater world.

Figure no. 2: *MeDryDive – free mobile app for Android and Apple devices that allows people to explore dive sites virtually (Currently, the app offers the possibility to visit four dive sites in the Mediterranean Sea, as follows: Ancient Peristera Shipwreck in Alonissos, Greece; Baiae Underwater Archaeological Park in Naples, Italy; Gnalić Wreck on Gnalić Island near Pašman, in Croatia and the modern shipwreck Oreste in Budva, Montenegro)*
(Source: https://pros-blog.padi.com/padi-dive-center-virtual-reality-vr-scuba-diving-experience/)

Sublue Navatics Mito is an underwater remote controlled drone with the possibility to use with VR glasses. It can be used for underwater filming, and users can view the footage captured by the drone in real time through a VR experience.

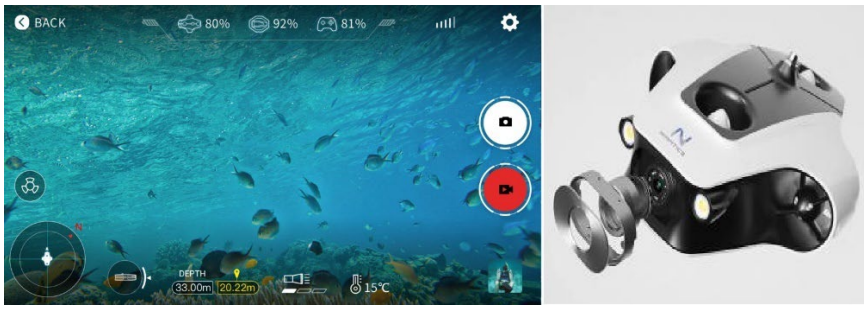

Figure no. 3: *Underwater drone NAVATICS MITO*
(Source: https://www.digitaltrends.com/cool-tech/navatics-mito-kickstarter/)

AquaComms has developed an AR-integrated diving mask for divers that displays useful information on the helmet screen while diving. This AR system is designed to provide divers with essential real-time information about depth,

temperature, orientation and other necessary data. The Amphi AR by Navatics helmet does the same. The helmet is equipped with a system that displays data such as depth, water temperature and sailing direction directly on the visor of the diving helmet.

Figure no. 4: *Divin*g mask with AR integration for divers
(Source: https://www.diverightinscuba.com/ffmscoms-c-36.html)

The Diveroid offers a compact device that attaches to a diver's oxygen tank and provides essential information such as dive depth and time through an AR app connected to a smartphone. Users can thus access real-time information via the smartphone screen, which connects to the device mounted on the bottle.

MR technology is used by Virtual Divers in the Ocean Explorer MR mixed reality system that combines VR and AR to provide divers with an experience of underwater exploration and interaction with real-time data. This system allows divers to access vital information during dives, such as interactive underwater maps, fauna and flora information and environmental data, providing a complete experience during underwater exploration.

HoloSea by VOXELGRID is an MR system that provides divers with an interactive experience for viewing and manipulating underwater maps and real-time data. The system integrates information such as depth, underwater topography and environmental data, allowing divers to interact with this data during dives.

These examples represent some of the VR, AR and MR technologies used in diving, providing essential information, providing immersive experiences and facilitating underwater exploration for divers.

The implementation of technologies such as virtual reality (VR), augmented reality (AR) and mixed reality (MR) within the Diving Center of the Romanian Naval Forces would bring numerous advantages and significant improvements in terms of the training capacity, operational efficiency and safety of military divers. These technologies would not only modernize training and operations, but also strengthen the ability to intervene and react in critical situations.

The development and implementation of these technologies in the Romanian Army would allow realistic simulations of real diving situations, including dangerous conditions or various emergency scenarios, providing a safe and controlled training environment. The use of MR would facilitate real-time communication and collaboration between divers and the surface team, improving the coordination and efficiency of underwater operations/missions.

The implementation of advanced technologies would allow divers quick access to crucial information such as detailed underwater maps or real-time

environmental data, helping them to react more quickly in emergency situations or rescue missions. VR training can reduce exposure to risk during training by allowing repeated training without endangering divers' lives or equipment damage, which can lead to reduced costs associated with equipment training and maintenance.

7. Conclusion

Military divers could be trained in virtual environments to gain experience and essential skills in a simulated and safe environment, preparing them for real situations. AR technologies could provide divers with essential real-time information such as depth, temperature and direction, contributing to more accurate navigation and more effective intervention in emergency situations or complex underwater operations.

Access to real-time data and information through MR technologies would reduce the time needed for decision-making and allow divers to act more quickly in rescue missions or underwater interventions. The use of advanced technologies would improve the safety and precision of underwater operations, minimizing risks to divers and optimizing the use of available resources.

The implementation of these technologies within the Diving Center of the Romanian Naval Forces would contribute to the modernization and significant improvement of its ability to respond to the increasingly complex and varied requirements of national security. These innovations would help strengthen operational readiness and capabilities, ensuring a more efficient and rapid response in underwater missions and emergency situations.

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