

# THE CREATIVE USE OF ARTIFICIAL INTELLIGENCE IN XR APPLICATIONS

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## ABSTRACT

In this study, the conceptual relationships between Artificial Intelligence (AI) and Extended Reality (AR) are examined from the perspective of design and creativity. The article raises three main questions. What outcomes are obtained when AI and XR concepts are combined? Today, how and to what applications are these findings applied? How can the combination of Artificial Intelligence and Extended Reality technologies transform the design and art of the future? The results of the content analysis were classified according to "Conceptual Innovations" "Technical Innovations" and "User Experience". Artificial Intelligence and Extended Reality have been shown to benefit people in the fields of creativity and design, based on current examples.

**Keywords:** *Extended Reality, Artificial Intelligence, Immersive Applications, Creativity.*

## GENİŞLETİLMİŞ GERÇEKLIK UYGULAMALARINDA YAPAY ZEKANIN YARATICI KULLANIMI

### ÖZ

Bu çalışmada Yapay Zekâ (YZ) ve Genişletilmiş Gerçeklik (GG) konuları arasındaki kavramsal ilişkiler, tasarım ve yaratıcılık perspektifinde incelenmiştir. Makale üç ana soruyu gündeme getirmektedir. Yapay Zekâ ve Genişletilmiş Gerçeklik kavramlarının birleşiminden hangi sonuçlar elde edilmektedir? Bu sonuçlar bugün hangi uygulamalara nasıl çevrilmektedir? Yapay Zekâ ve Genişletilmiş Gerçeklik teknolojilerinin birleşimi geleceğin tasarımını ve sanatını nasıl dönüştürebilir? İçerik analizinin sonuçları "Kavramsal Yenilikler", "Teknolojik Yenilikler" ve "Kullanıcı Deneyimi" başlıklarına göre sınıflandırılmıştır. Yapay Zekâ ve Genişletilmiş Gerçekliğin birlikte yaratıcılık ve tasarım alanında insanlara çok şey katacağı güncel örnekler üzerinden değerlendirilmiştir.

**Anahtar Kelimeler:** *Genişletilmiş Gerçeklik, Yapay Zekâ, Sürükleyici Uygulamalar, Yaratıcılık.*

### INTRODUCTION

While the exponential progress of technology accelerates sociological, cultural, and economic changes with long processes, it also paves the way for a transition to a period in which different companies on a global scale push the limits in terms of both technology and creativity. First, all processes of the products until they reach the end user are now more individual and independent than fabrication. Known as the "Industrial Revolution 4.0", this era is a phase where the rules of human-machine interaction are reinvented like never before.

It is seen that the concept of "creativity" emerged in the 19th century to cover various innovation concepts accepted in art and science (Weiner, 2000: 8). Legrenzi (2005: 5) uses a very simple logic

when distinguishing between scientific and artistic creativity. Scientific discovery only accepts affirmations, not repetitions, while artistic creativity is inspired by imitation. Today, artificial intelligence has turned into a point where the extremes of technological and artistic creativity collide.

The concept of "artificial intelligence" has been discussed long before computers were invented, and it determines the boundaries of human-machine interaction. For this reason, the concept of artificial intelligence includes a multi-layered structure inspired by human intelligence. Perception, understanding, learning, deduction, decision making, thinking, and making suggestions are the features of human intelligence that are included in this structure.

For AI systems, learning is crucial. Grossi and Buscema (2008) define an Artificial Neural Network (ANN) as an information processing technology inspired by the human brain's information processing mechanisms. Deep learning, which includes machine learning, is built on artificial neural networks. An artificial neural network is modeled after a simple biological nervous system. The nerve cells studied contain neurons, which are connected in a variety of ways to form a network. These networks are said to be able to learn, memorize, and reveal data relationships. In other words, an artificial neural network produces solutions to problems based on a person's natural abilities such as perception, learning, thinking, inference, reasoning, and observation.

The effects of industrialization on the production-consumption cycle can be seen as a shift in human power from muscle power to mental power. Within the scope of automation, handling repetitive processes first by machines and then by robots aided the worker's transition from physical to mental activity. However, at this point, the lines between the human mind and machines began to blur, and a sort of Augmented Human definition emerged with the help of computers. With the introduction of computers into everyday life, these boundaries have gradually eroded and become habits that we are no longer aware of.

Artificial intelligence is a popular science topic as well as a relatively uncommon design and art concept. Perhaps the most important reason for this is the widespread belief that computers lack human-like emotions and comprehension. However, the recent development of computers, which produce works that will cause judgments in the fields of art and design to be re-evaluated within the scope of creativity, shows the potential to revolutionize not only the works produced, but also the definitions of art and design and the context of innovative ideas.

## **AI AND XR PARTNERSHIP**

Virtual and augmented reality studies, which have a 60-year history, have always attracted a lot of attention as a way to look at perceived reality differently, but they've mostly been used for military and medical applications due to the high costs and technical requirements.

New products and technologies that have become more affordable as a result of the widespread use of portable computers (mobile phones, tablets, laptops, etc.) have made significant advances in the field of alternative reality sought by today's consumers. Alongside Augmented and Virtual Reality, this emerging field also uses the term "Mixed Reality" (MR) to describe technology's ability to accurately map and place objects in a user's environment (deSouza et al., 2009). Extended Reality (XR), which includes definitions such as VR, AR, MR, begins with the formation of extraordinary new relationships between the physical and digital worlds. In addition, Extended Reality simulates spatial environments under controlled conditions, allowing time and cost efficient interaction, manipulation, and isolation of certain variables, objects, and scenes (Marn-Morales et al., 2018).

One of the most important revolutionary changes in Artificial Intelligence is the collaboration with Extended Reality. What are the implications of combining the concepts of Artificial Intelligence and Extended Reality? What are the current applications of these concepts? How can the combination of

Artificial Intelligence and Augmented Reality technologies change the design and art of the future? The answers to these questions are already found in applications that are still in the prototype stage but have the potential to transform these technologies in a relatively short period of time. These three questions require addressing a large number of elements that appear unrelated from various angles. These elements are classified as "conceptual innovations," "technical innovations," and "new user experiences."

### Conceptual Innovations

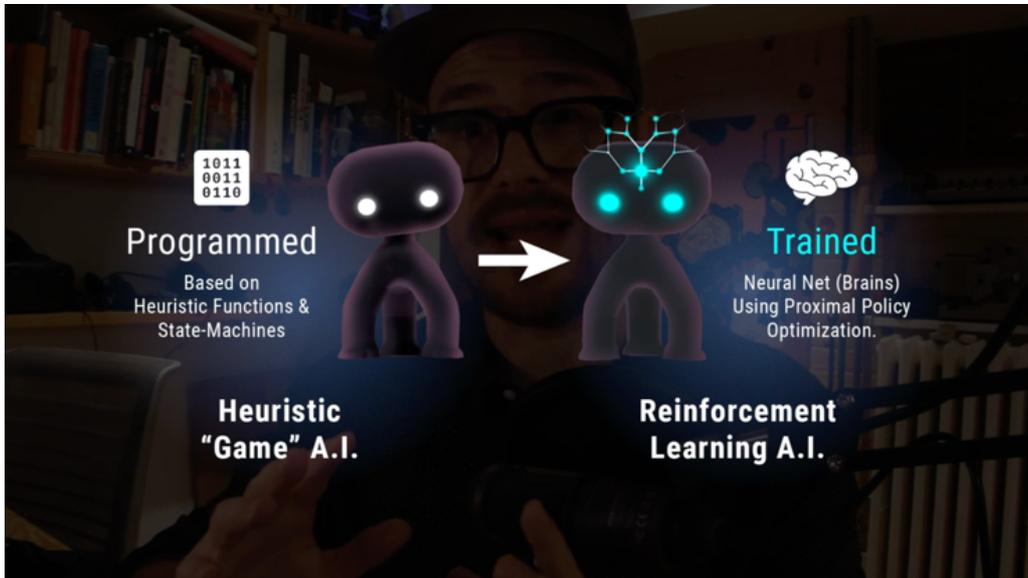
In response to the first question, "conceptual innovations" includes examples of how existing concepts are affected by Artificial Intelligence and Extended Reality. It is the primary proof that these two technologies, which seem to be independent from each other, are actually fed by the same essence.

### Learning

The learning action emerges as AI transforms the ability to analyze and comprehend. So artificial intelligence can grow in proportion to its cognitive capacity day by day. While each of the ideas generated thus far is unique, they have the potential to collide in a 'deep' learning pool and become a new idea.

Humanity is both excited and concerned about the future of information because of AI and deep learning's ability to access data sources. The act of thinking includes the acts of consciously understanding, learning, and choosing. One of the main goals of new technologies is for Artificial Intelligence to be able to control itself in these actions and produce sensory solutions as a result.

With the help of Augmented Reality technology, learning can be accomplished in a timely, comprehensive, and engaging manner. Many training simulations can generate never-before-seen images based on the user's reactions, personalizing the simulation experience. Similarly, when artists working in the field of Extended Reality use the tools available here, they can leave certain parameters to the control of Artificial Intelligence and tend to seek a random aesthetic.

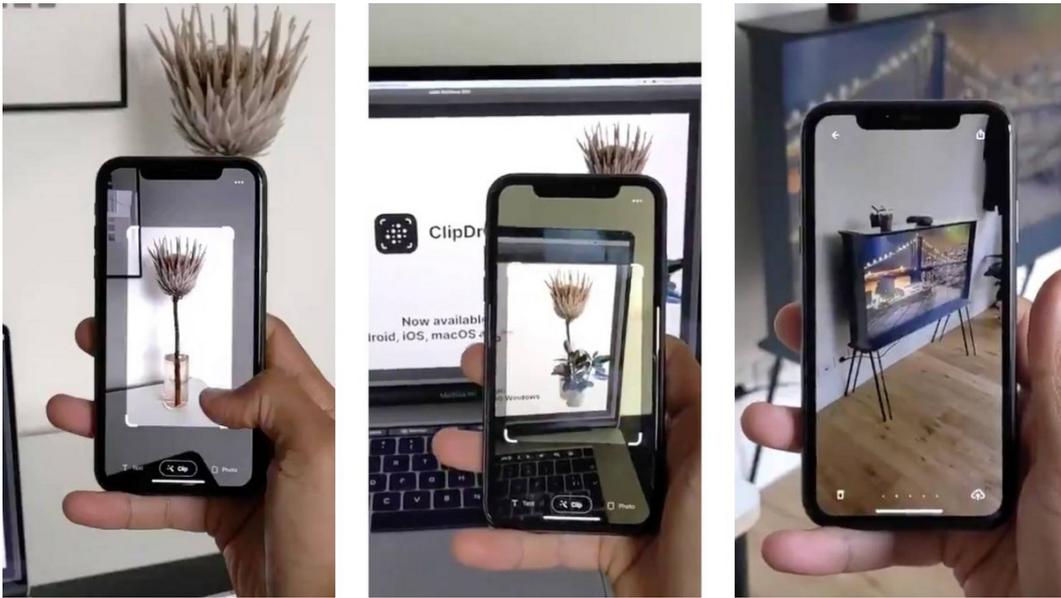


**Figure 1.** Agence VR Game with Reinforcement Learning AI. **Source:**URL-1

Agence VR is an inclusive game with AI and user-controlled cute creatures on both virtual and mobile platforms (Figure 1). The characters in this game can tell a different story in every way by displaying the behaviors they learned using a technique called Reinforcement Learning AI rather than the behaviors that were programmed into them. Reinforced Learning enables Artificial Intelligence to decide its actions through rewards and punishments (Sutton and Barto, 2018:3)

The ability of an app to write its own story based on a user's behavior can be seen as a fundamentally creative act. Because every story should have a logical flow in itself. The system, which has more than one dynamic element that provides this flow, makes instant decisions according to external factors such as the user, and this is perceived as logical, opening the door to the next generation of human-computer interaction and communication.

In current Extended Reality studies, Artificial Intelligence is said to be aimed at assisting the user and working in accordance with his or her actions. In this context, it is reasonable to anticipate that in the future, Artificial Intelligence will be used more intensively and extensively in content and design, without the need for human intervention or a workforce. Certain repetitive processes and tasks are not creative but are part of the design profession. During the design process, it should undoubtedly benefit from the speed and efficiency provided by Artificial Intelligence in repetitive actions.



**Figure 2.** ClipDrop AR Application. **Source:** URL-2.

ClipDrop (Fig. 2) is an Augmented Reality app that masks the outlines of real-world objects before digitizing them. Regardless of how complex the contours of a real-world object are, artificial intelligence distinguishes it from its surroundings using computer vision and deep learning technologies. ClipDrop automates the decoupage process, which designers find tedious.

### ***Language and Communication***

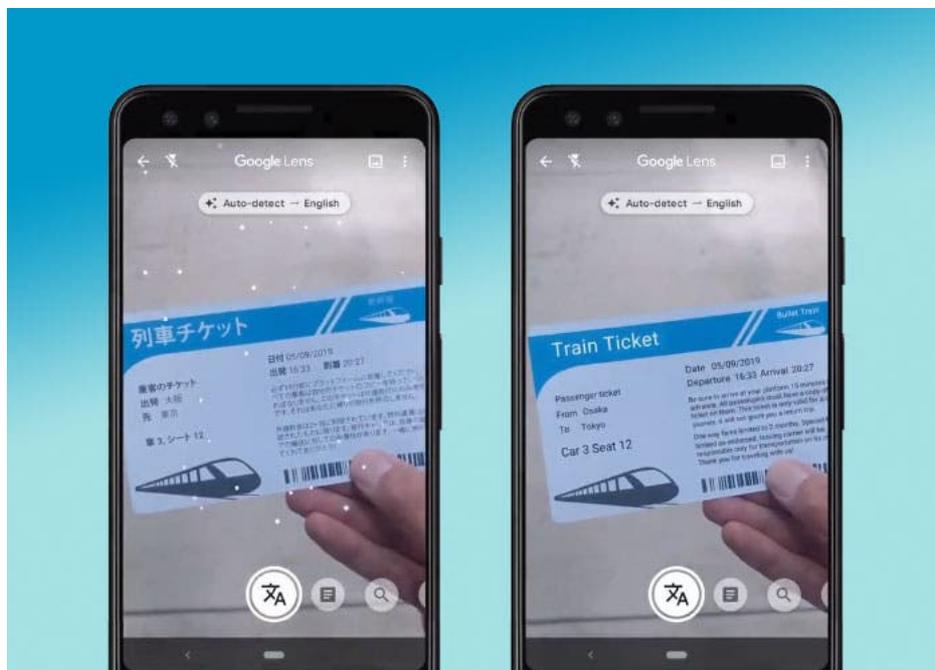
Language and communication are undeniably important intelligence indicators that distinguish humans from other living things. The Turing test, which questioned the concept of AI when it first appeared, is no longer valid today. The primary reason for this is that the language and communication algorithms of Artificial Intelligence are so advanced that they are indistinguishable from humans.

Natural Language Processing (NLP), attempts to recognize not only word equivalents, but also how a language works, including its grammar, word sequence, sentence structures, and everything else that makes these words meaningful (Liddy, 2001). Furthermore, Point Mutual Information (PMI) is a system that attempts to understand that different phrases (e.g., Social Media) can have new meanings in addition to their word meanings (Cover and Thomas, 2006).

Today, AI's ability to understand and communicate language is embraced by auditory applications such as Siri, and with Google Translation, both written and visually accurate language translations are provided. In addition, Skype Translator is a good example of using AI for both text and voice translation in one-on-one communication.

Simultaneous translation is extremely important in the Augmented Reality environment. People from different countries and cultures can only communicate and interact on the same virtual platforms if they understand each other at the same time. Simultaneous translations can also be used in language learning applications to adapt to the user's learning speed and abilities, as well as to evolve in response to the user's behavior.

Visual communication is recognized as a universal language in the field of design. Visual communication is one of the most effective communication structures because it allows written and verbal communication to be visually transmitted. These are the most obvious points of convergence between AI and XR applications. The ability to translate an image into text or audio while it is being translated can be viewed as the new key to universal design.



**Figure 3.** Google Lens app. Source: URL-3.

Google Lens (Figure 3) employs deep machine learning-based Artificial Intelligence technology to provide scanning, translation, shopping, and other services while not only detecting but also recognizing the object in front of the camera lens.

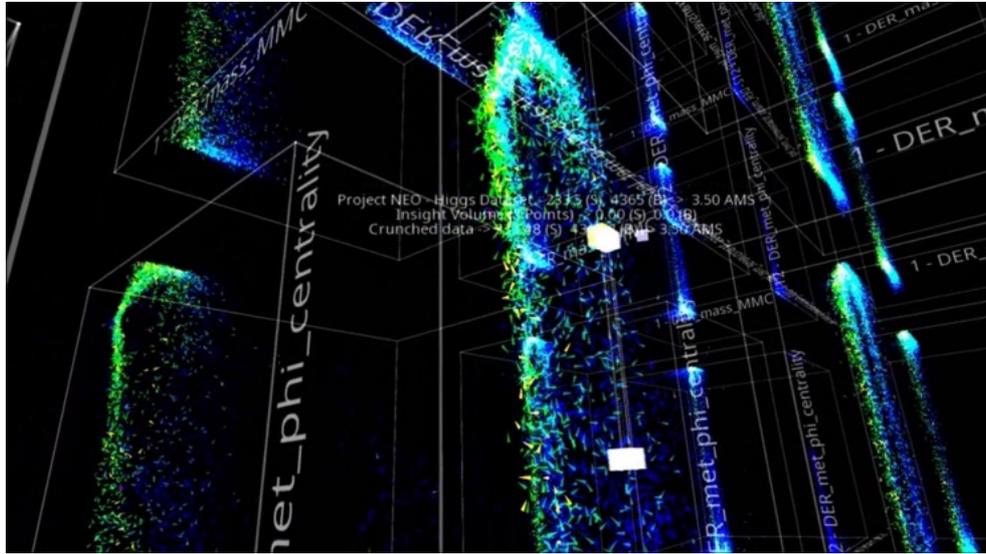
### **Visualization**

Art and design are the first things that come to mind when it comes to visualizing ideas. This is primarily due to the fact that these disciplines contain all of the tools required to embody the concept, from the most basic line tools to complex 3D structures.

When data, the smallest unit of information, is properly organized, it becomes meaningful. Although these arrangements have long been thought to be an aesthetic and artistic element in theory, they have only recently begun to be realized in practice. The instant and dynamic visualization of data combined with one of the most common artistic conceptions enables abstract expressions. Making this statement

in an Extended Reality environment has the potential to take the user on an entirely new journey that they were previously unaware of.

In almost every field, visualizing data makes it easier to understand and control information. The fact that data analyzed with AI becomes sensory at the same time, that is, it can be heard, touched, and even smelled, accelerates the blending of virtual and real-world experiences. Of course, vision is the inseparable combination of virtual images superimposed on or in the real world as Extended Reality, and it is the sense that transfers the most data among our senses.

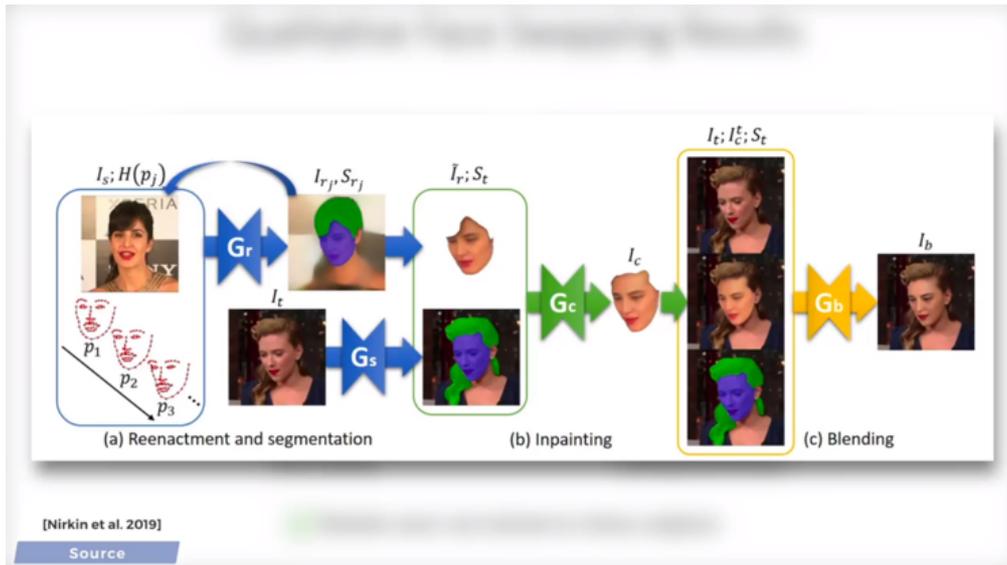


**Figure 4.** ProjectNeo VR Interface with ML data visualization. **Source:**URL-4.

ProjectNeo is an application that visualizes data for Virtual Reality environments using machine learning (Figure 4). One of the most important features of this application is that it can visualize data simultaneously. Artists, designers, and computer programmers are all interested in the functional and aesthetic effects of data visualization. Data aesthetics emerge as new experiences that lead the viewer away from motion graphics that are not only beautiful but also meaningful (Manovich, 2002).

The first deep learning model that can generate images was proposed by Goodfellow (2014). In this productive model, also known as the GAN, two networks, one productive and one discriminatory, compete in a contentious manner, and the learning process occurs, unlike in traditional deep network architectures. A discriminatory network is a network that distinguishes between synthetically generated images and real images in a database. The deep web generator uses a noise signal as input to generate fake images that look like real images and attempts to fool the discriminator network into thinking these images are real. Both networks are competitively trained at the same time. After a certain iteration of the process, the producer network finally succeeds in producing new images similar to the real ones.

Deepfake is a sophisticated visualization term that is becoming increasingly popular, particularly because celebrities' faces are frequently altered using AI. Deepfake videos, which were initially released solely by changing facial expressions, have gained credibility over time by covering the perspective, color, texture, and light characteristics of the image. Nirkin's FSGAN (Face Swapping GAN) study, for example, is a subject-independent face swapping and animation application that employs four different meshes to adjust both pose and expression variations in a single image or video sequence (Figure 5). The system (Nirkin et al., 2019) also serves as the foundation for today's augmented reality filters on social media.



**Figure 5.** Nirkin's FSGAN overview. **Source:** URL-5.

AI's realistic rendering capability has the potential to reduce the cost and time required to create convincing simulation environments and characters which game studios devote more than half of their resources to create them. Artificial Intelligence is now widely used in joint simulations for XR technologies. Users can choose between dynamic and interactive characters for Extended Reality thanks to artificial intelligence. This system enables realistic-moving virtual avatars to interact with the outside world.



**Figure 6.** Ready Player Me Avatar creation tool by Wolf3D. **Source:** URL-6

The Ready Player Me application (Figure 6), created by Wolf3D, employs Artificial Intelligence technologies to create personalized avatars, particularly for XR environments. While avatars created on this platform are now available in over 200 games and apps, players can now create custom avatars that they can use to switch between video games, virtual reality experiences, and other apps using a single virtual identity.

The concept of immersion is defined as "sensory-spatial perception, dissolution of distance, and participation in experiences" (Schranz, 2013: 84). Artificial intelligence allows users to interact with immersive simulations while enhancing their perception of reality with character enhancements. While character actions used to have to be programmed to respond to user behavior, now systems and characters with behaviors that learn from user actions can be developed with artificial neural networks inspired by the structures and functions of the human brain. Such characters provide higher levels of immersion effects in the Extended Reality experiences of the users.

The use of artificial intelligence systems in the field of health is an important step toward predicting deadly diseases and determining disease stage. Deep learning methods, which are successful in data analysis with various network architectures and learning algorithms, provide images to health professionals that traditional methods cannot, assisting in both early disease diagnosis and early disease treatment.

In addition, the use of XR technologies for medical education has received a lot of attention recently, especially in high-risk tasks such as surgery. It can provide rich information in terms of evaluating users' technical performance and training during simulated tasks. (Bissonnette et al., 2019:2).



**Figure 7.** CAE AresAR with HoloLens 2. **Source:** URL-7.

CAE AresAR (Fig. 7) is an AI-based system that allows students to freely interact and move in a holographic clinical environment using Microsoft HoloLens 2. It includes AI systems that can track people's hand and eye movements to enable intuitive interactions. The user can detect, reach, resize, and position the hologram that is floating in front of them. Artificial Intelligence enables instinctive interaction for better learning by integrating holograms into the real world without eye-tracking.

### **Technical Innovations**

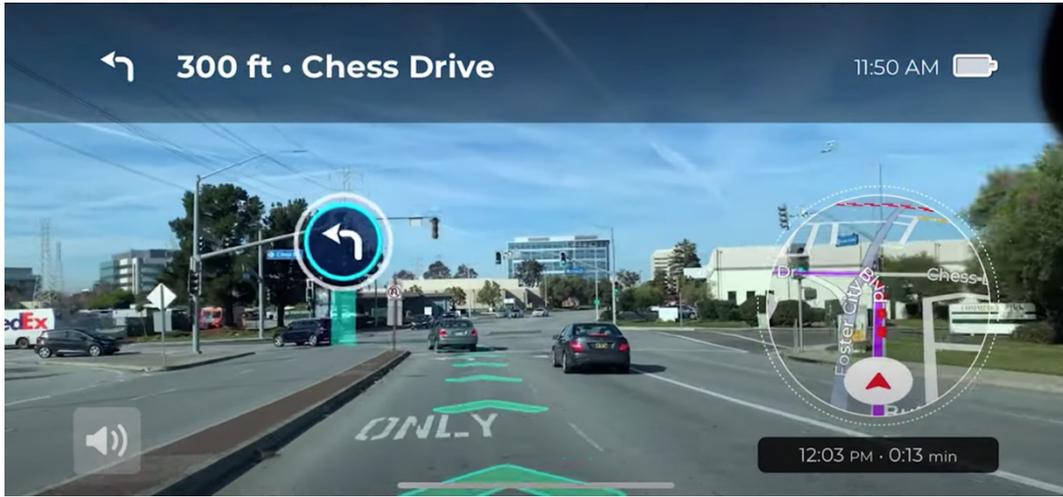
Technical innovations cover the application of new technologies in different areas, resulting from the combination of Artificial Intelligence and Extended Reality technologies.

### **Computer Vision**

Computer Vision is the most fundamental and complicated method for Artificial Intelligence to comprehend the user. At the micro and macro levels, computer vision can manifest as a single or multiple

systems. Artificial intelligence can detect invisible details to make a virtual character's blink more realistic and believable, or it can interpret the movements of people and vehicles on a busy street at the same time.

Object detection is a finer-scale implementation of Computer Vision and is closely related to image classification. Object detection detects and categorizes entities in images. Navigation apps developed by combining machine learning-based deep learning technology and augmented reality benefit drivers in a variety of ways, including object detection, tracking, and guidance; real-time road tracking; safe driving; and detection of all movements.



**Figure 8.** PhiAR Application real-time road assistance. **Source:** URL-8.

The PhiAR application (Figure 8) prioritizes safety by alerting the driver when the following distance is exceeded. The application analyzes the surrounding environment efficiently, taking into account lights, weather conditions, and existing objects while eliminating the need for 2D map reading. Concurrently, improved motion tracking allows computer interfaces to transition from touch to gesture expressions.

Although not directly related to the connection between design and creativity, new generation navigation applications are important in terms of changing the interface design. Virtual images superimposed on real images are essential design elements that must function without being noticed by the user, from typography to colors, composition to animation.

### ***Compositing***

Composition in cinema, which is also defined as bringing different layers of images together in the same frame, is the foundation of Extended Reality. Superimposed and even nested images react precisely and instantly to the user's movements.

Occlusion is a technique for AI-assisted imaging that has recently been used in XR environments. Virtual images are projected onto a three-dimensional plane and interact with the user's movements as well as real-world objects in the environment. As a result, if there is a real object between the virtual image and the user, the virtual image appears behind the real object.



**Figure 9.** Niantic AR with Occlusion Technology **Source:** URL-9

In Niantic AR's Pokémon Go application (Fig. 9), the Pikachu character is masked simultaneously as the user moves, resulting in a much more realistic spatial interaction with other objects.

Seamless overlapping of computer-generated images with real-world images is an essential requirement in a variety of applications, including entertainment, cinematography, design visualization and medical simulations. At the same time, although it is challenging to obtain photorealistic scans in AR applications, successful applications have emerged. For reliability, it is critical to use basic photographic information such as illumination, reflection, and depth of field, as well as surface and material properties, in the photorealistic representation of detailed geometric 3D models. This factor influences not only the visual complexity of virtual objects, but also the consistency of real-world objects in the scene.

Traditional computations like Raytracing and Radiosity, which are used in well-known 3D rendering methods, heavily rely on AI for a wide range of equations like illumination, light transmittance, and reflection. It's extremely difficult to calculate how the virtual object will appear from various angles depending on environmental factors and its location. This necessitates high computational performance, particularly in scenarios where the user is on the move.



**Figure 10.** Virtual Production Set for Mandalorian **Source:** URL-10

Virtual production sets are one of the most recent advancements in filmmaking technology (Figure 10). High-resolution LED panels are used for background image projection instead of chroma keying (greenscreen) techniques, which require a significant amount of time and effort in digital image composition. Unlike the traditional approach, the background image can be calculated and projected within the position of the real camera, resulting in a perfect overlap of the real and digital images at the same time.

Another issue in the XR environment is distinguishing between real and virtual objects. Using parsing, objects can be copied and moved to a different size or location in the real world. With Lidar scanning technology and the 3DScanner App on iPad tablets, this parsing is a breeze. In addition, for reverse engineering purposes, the user can print approximate 3D models of the objects he decomposes. Because images are the most important part of a design, AI can quickly, efficiently, and realistically separate or combine digital and real images. This proper separation and merging of digital images gives the impression that the design is in good working order, which is especially important in Extended Reality experiences.

### ***Simultaneity and 5G***

Simultaneity is the immediate response of an event to the phenomenon that caused it. As a reflex, it is based on a simple but basic physical rule such as action-reaction. Any delay between the perceptible transmission of this response to the user, such as the speed at which AI analyzes, thinks, interprets, and reacts, disrupts the flow of experience.

As the distance between the system and the user increases due to limited data transfer capacities, the above-mentioned technical features are interrupted. Many standalone XR tools have recently gained the ability to work without the aid of a computer. Thanks to the fact that the 5G technology almost 100 times faster and uninterrupted experiences will be possible in XR soon.

Each XR experience is interpreted in the context of its physical environment (Biocca, 2002). Augmented Reality can improve perception of the surrounding real world by introducing new sensations and perceptions that are required for a better understanding of the physical world (Kesim & Ozarslan, 2012). Art and design applications for co-production activities always require highly efficient platforms. Due to their limited use and access possibilities, such Augmented Reality platforms with human creativity at

their core have been inadequate until recently. In addition to network systems that reach much higher speeds with 5G technology, the processing capacity of portable devices will increase in line with the development and prevalence of Extended Reality experiences to serve more social creativity in the near future.



**Figure 11.** Snapchat London AR Experiment. **Source:** URL-11

Users who used the City Painter app (Figure 11), which was created for Snapchat's Local Lens feature in 2020, numerically painted London's Carnaby Street red and blue. This is a multi-user Augmented Reality experience that allows you to create a digital copy of any city in the world and color it in a virtual environment.

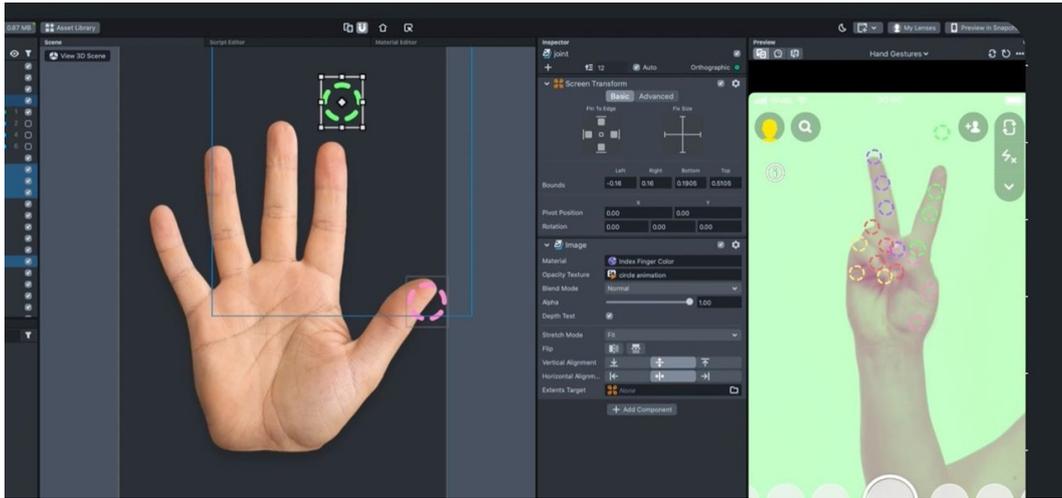
### **User Experience**

It includes examples of how future products combining Artificial Intelligence and Augmented Reality technologies may differ in terms of user experience.

### **GUI**

Interfaces have been used as a means of understanding each other since the dawn of time, and they have always been at the heart of human-computer interaction. The user does not need to understand how the computer works, especially in complex systems, and the system simply waits for the command requested by the user from the interface. GUI (General User Interface) should be simple, understandable, and functional in this regard. Being in charge and in control of an experience not only makes users feel better about Augmented Reality content, but it also encourages them to dig deeper into it (Collier & Sherrell 2010)

Because of AI's dynamic features that are personalized and instantly updated, new XR experiences have begun to shift toward gesture-based options rather than traditional fixed touch structures. Snap Lens Studio (Fig. 12) enables gesture-based selections by allowing interfaces to track finger and hand gestures.



**Figure 12.** Snap Lens Studio. **Source:** URL-12.

Interfaces that interpret body movements and gestures as commands can reflect not only visual and auditory information, but also tactile information. While these multi-mode interfaces provide two-sided data transfer, they are classified differently, according to Reeves and Nass (2000).

Perceptive User Interfaces (PUI) are the first of these, and they can track a user's actions while also capturing a developing phenomenon. These interfaces are focused on identifying and distinguishing objects in their environment while also taking screen size and media content into account.

The second type is the Attentive User Interface (AUI), which adapts to the user's actions. According to Maglio (2000), these interfaces monitor a user's behavior, model their interests, understand user needs, and predict their wants and actions without the user having to say anything.

According to Bergamasco (2005), the third type is Enactive User Interfaces (EUI), which deals with an interaction concept that is not possible in traditional Human Computer Interaction (HCI) technologies. Interactive systems that enable the organization and communication of information obtained through action are known as active user interfaces.

Rather than authoritative information, traditional computer-mediated information interaction relies heavily on symbolic or iconic data. Visual images, such as diagrams and pictures, are used to store symbolically learned information that can be combined with verbal information. Multiple elements, such as the user's body language, voice, and hand movements, are evaluated simultaneously during active learning.

Artificial intelligence has made it possible to create human interfaces based on speech and typing that do not require the use of a keyboard or mouse. The most difficult part here is getting the system to recognize the user and connect them to the resources they need to help them improve.

Human behavior's paradoxical aspects will be a major challenge, requiring AI to work not only on a process, but also on an action basis. Furthermore, in XR environments where the user is caught between the real and the virtual worlds, how Artificial Intelligence manifests itself as an interface raises both functional and aesthetic concerns. "The deepest technologies are those that disappear" writes Weiser (1991). They become indistinguishable from the fabric of everyday life as they blend in.



**Figure 13.** Samsung Project Neon Interface. **Source:** URL-13.

With Project Neon (Fig. 13), which debuted in 2020, Samsung introduced the concept of humanoid interface. Different AI-created characters are already altering how the next generation views the concept of interaction.

### ***Personalization***

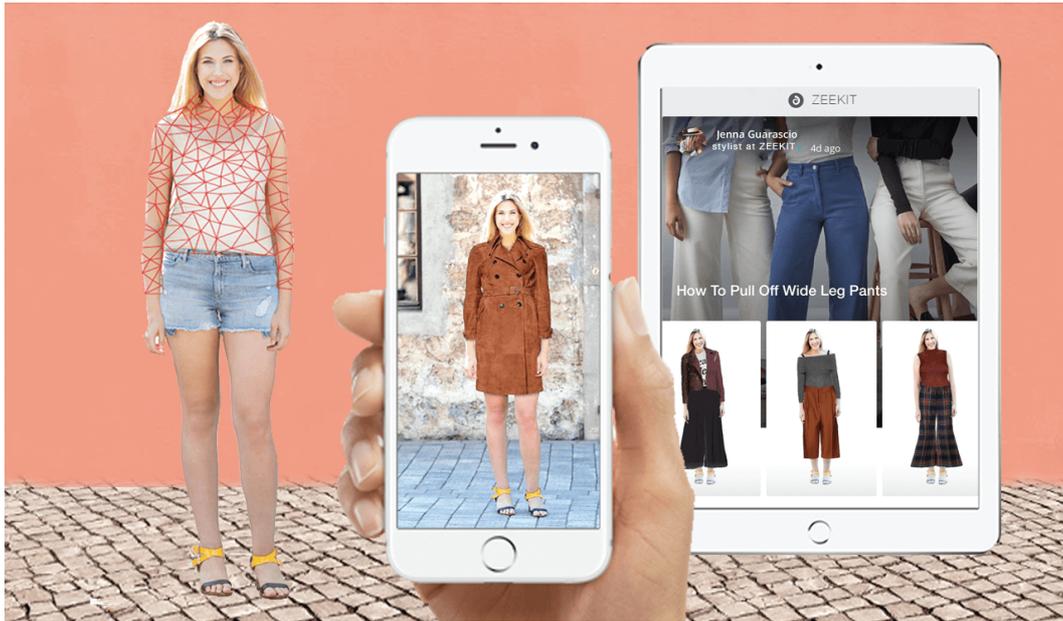
Given the ability of AI to analyze the user and create personalized solutions by extracting data it collects, there are many potential for personalization to be both unique and express individual creativity.

How much personalization will change the interfaces of next-generation shopping and marketing sites is directly related to the ability of AI to convince decision-making. Image interactive technologies (IIT) allow online shoppers to (a) view products from various angles; (b) modify design features; and (c) see how clothes fit and appear on their body/avatar (Fiore and Jin, 2003).

Personalization is the most daring marketing strategy for reaching a product's target audience. Creating a structure among different characters that appeals to one's own private life is a difficult and complex process. At this point, Artificial Intelligence offers a plethora of opportunities for personalized experiences with interfaces that change depending on the user.

Personalization with AI necessitates categorizing and extracting valuable insights from various customer datasets. This data is sent to an automation engine, which can act without the need for human intervention. Custom playlists based on a customer's listening and watching habits, such as those created by Spotify or Netflix, are excellent examples of AI-powered customization.

The design process is made easier by artificial intelligence's ability to analyze user behavior and provide personalized solutions. Personalized shopping experiences, also known as next-generation marketing, are gaining popularity as a result of Extended Reality applications that allow users to test products before purchasing them.



**Figure 14.** Zeekit Fashion App. **Source:** URL-14

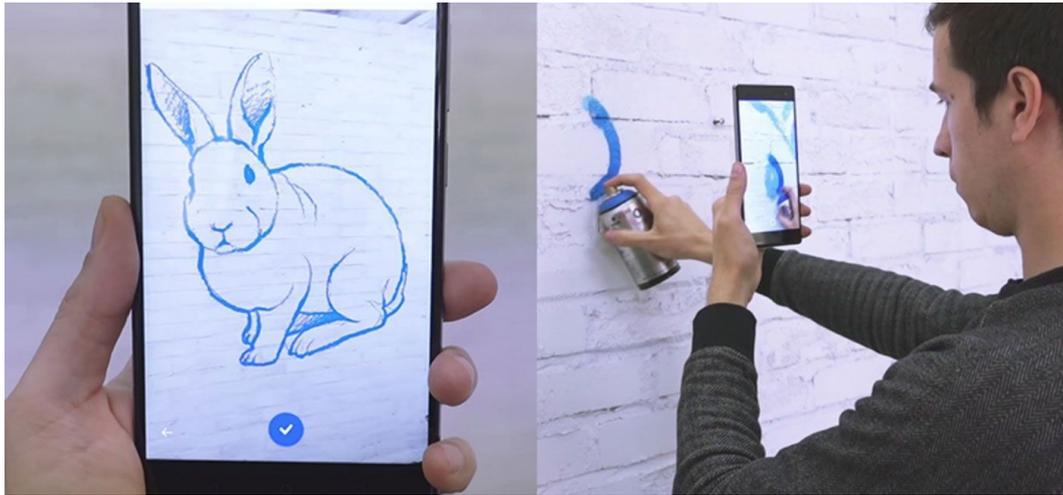
Zeekit, an application that uses Artificial Intelligence, Computer Vision, and Deep Learning algorithms to customize customers' purchasing experiences, has set an example in the fashion industry. Customers use their own photos and body measurements, which distinguishes Zeekit technology from other virtual test apps and experiences. Customers can also mix and match products from various retailers in their virtual closets to share with friends and purchase clothes through an app link.

### ***Gamification***

Gamification is the process of improving user interaction by applying game mechanics to non-game processes (Deterding et al., 2011). This appeals to a person's natural competitive and cooperative instincts, frequently by instituting a reward system for completing a series of tasks.

People are exposed to a conscious or unconscious flow of data as Extended Reality enters every aspect of human life. It is possible to compare data obtained from daily activities with others and even turn it into a competition, especially when interacting with different people on the same interfaces.

Gamification, also known as Unified Collaboration and Communication (C&C), is a new method of collaboration and communication that serves as a valuable data source not only for users but also for AI. C&C is optimized using expert systems that use linguistic (verbal, musical, etc.) tools. This includes global management, mind mapping, artificial intelligence-assisted contextual communication, and body language analysis.



**Figure 15.** SketchAR App for drawing graffiti **Source:** URL-15.

Children learn most effectively through play, and game-based learning techniques can be easily adapted to Artificial Intelligence and Augmented Reality. SketchAR (Figure 15) is an Extended Reality drawing app that teaches users how to draw on paper or walls with a smartphone or HoloLens. It employs non-marking computer vision tracking to 'stick' the virtual object to the real world, allowing the user to see the virtual object on screen even at extreme zoom levels while drawing on real-world surfaces. Neural networks can instantly convert photos into linear drawings. It also tracks users' drawing habits in order to provide a personalized learning path to assist them in reaching their drawing objectives.

## CONCLUSION

In this study, the relationship between AI and Extended Reality practices was assessed through concrete examples, especially in terms of design and creativity relationship, and it was deemed that this union would grow exponentially. Based on the fact that every technological advance is immediately echoing in art and design, it is clear that these technologies will redefine human creative capacity and change the way we look back and forth. Hybrid technologies also bring the concept of design to new horizons in terms of the products they uncover. While the relationship between technology and creativity is constantly being renewed through design and art, it also introduces a new challenge. Artificial Intelligence, which emerges as a new actor in terms of design and creativity in this unprecedented era of human-computer interaction, creates a world of limitless possibilities, especially when combined with Extended Reality.

"Learning," "Language and Communication," and "Visualization" are topics covered under conceptual changes in the study, which evaluates artificial intelligence approaches to embodying abstract ideas based on the human brain. As artificial intelligence's ability to understand and interpret language improves, it produces astounding creative results. The technical innovation topics of "Computer Vision," "Composition," and "Simultaneity" exemplify developments in real world and digital image matching, which is the foundation of artificial intelligence, particularly in Extended Reality applications. Although this match is still not at the desired level in terms of technical and ergonomics, it is clear that existing obstacles will be overcome in a short period of time due to the introduction of 5G and cloud systems. The topics of "General User Interface," "Personalization," and "Gamification" discussed under the heading of User Experience, on the other hand, express users' attitudes toward applications that combine artificial intelligence and augmented reality technologies. The fact that applications recognize the user, in particular, makes personal and user-oriented design solutions indispensable.

It will be clear only in the future whether computers will be a competitive factor, particularly in a complex issue like creativity. The examples in this study produce successful results as creative outputs.

The potential of Artificial Intelligence to increase human creativity in all dimensions can be assessed from a dualist perspective. Artificial intelligence is no longer a pipe dream, as it can think faster than humans in embodying abstract ideas, transforming them into expressions, and producing meanings that everyone can comprehend. Looking at the future of artificial intelligence and augmented reality technologies, it is first seen that intensive computing applications will work much faster, more efficiently and more user-focused. Wearable technologies will soon become part of the human body, affecting sensory organs without the need for any agent (glasses, gloves, etc.). As a result, while new technologies are constantly being developed to reduce human workload and save time, multibillion-dollar industries are now focusing on personalized manufacturing, self-design, and limitless customization options.

However, both technologies have human-related challenges in front of them. First of all, critical approaches to issues such as the creativity of artificial intelligence, the value and acceptance of its works, and the sustainability of human-machine interaction remain in the background. In addition, the biggest challenge posed by this combination is that not enough content has yet been produced to do justice to these technologies. At this point, a great burden and responsibility falls on all designers working in the field of artificial intelligence and augmented reality. The meaning and aesthetic quality of 3D and interactive content, which is needed in thousands of different sectors from education to finance, from transportation to health, from security to planning, has already begun to change the design and creativity of tomorrow.

The collaboration of AI and XR will open up new horizons and frontiers in our creativity in perceiving not only the world around us, but also completely different mindsets that we have never encountered before. These new horizons and boundaries concern how we will be as individuals in the future, as well as how our work and life habits will be redefined. Most importantly, we have now consciously relinquished our ability to 'control' machines. We predict that Artificial Intelligence will act like us by imitating our thinking, learning, and decision-making processes in order to produce more creative solutions, in the hope that human and computer cooperation in terms of design and creativity will lead us to a better world.

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