

Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR) and eXtended Reality (XR) Integration in Artificial Intelligence (AI) Software Systems

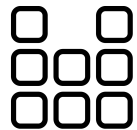
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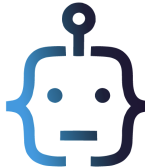
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XR5.0



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Motivation: Why XR Matters

Extended Reality (XR) technologies are transforming the way people interact with digital content:

- XR combines AR, VR and MR experiences.
- Adoption is rapidly increasing across multiple industries.
- AI is enabling more intelligent and personalized immersive environments.
- XR is evolving from experimentation to practical real-world deployment.

Extended Reality (XR) technologies are transforming the way people interact with digital content:

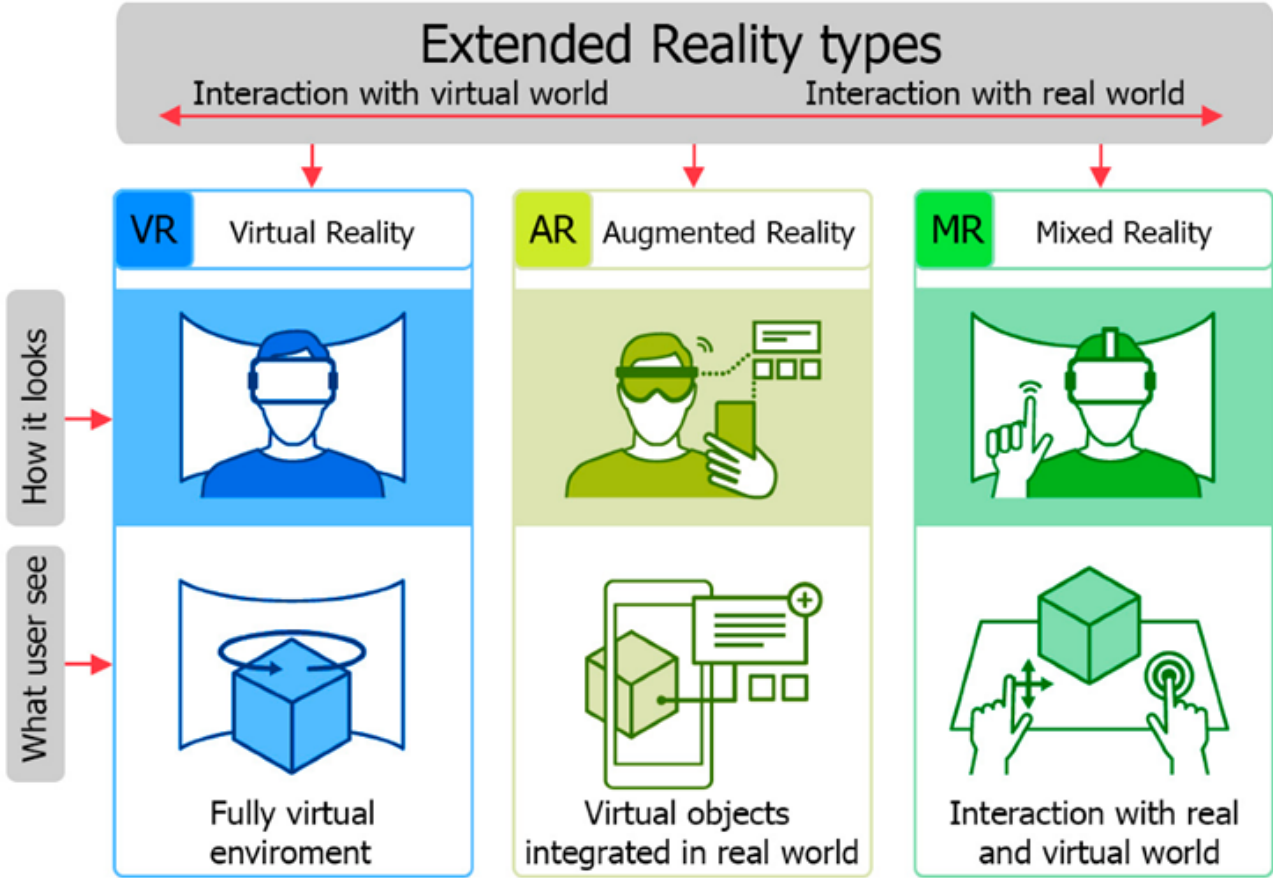
- 🎓 Education and Training
- 🏭 Industry and Manufacturing
- 🛒 Retail
- 🎮 Entertainment & Gaming



The XR Ecosystem

Technology	Description
AR (Augmented Reality)	Digital content is overlaid onto the real world
VR (Virtual Reality)	Users are fully immersed in a virtual environment
MR (Mixed Reality)	Physical and digital objects interact in real time
XR (Extended Reality)	Umbrella term that includes AR, VR and MR

- XR adds digital content to the real world
- VR replaces the real world
- MR combines both and allows interaction
- XR includes all of them



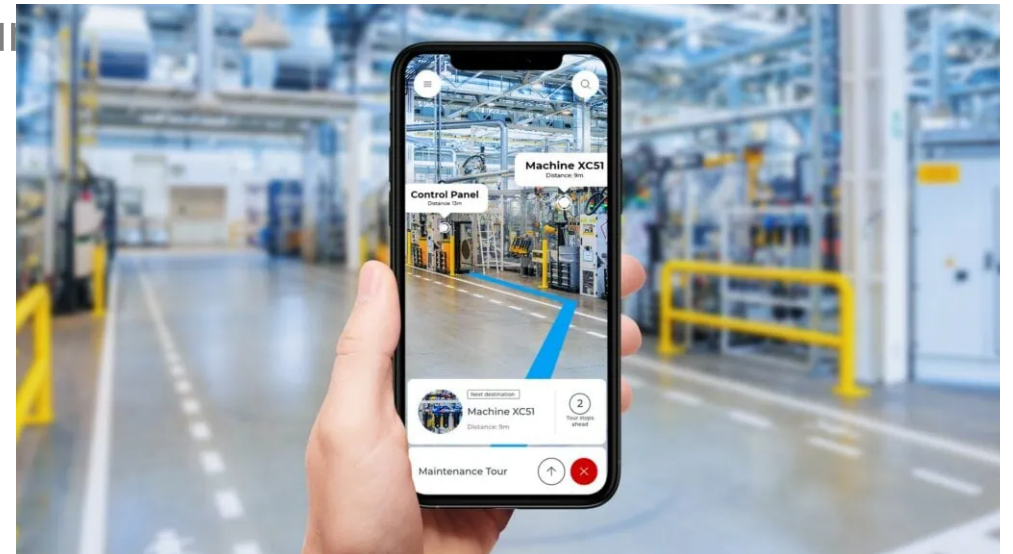
Augmented Reality (AR)

Enhancing the real world with digital information

- Overlays digital content onto physical environment
- Operates in real time.
- Uses smartphones, tablets, AR glasses, or headsets
- Enhances user interaction without replacing real world

Example Applications:

- 🛒 Retail (IKEA Place)
- 🏥 Healthcare (AccuVein, HoloLens-assisted procedures)
- 🎓 Education
- 🛠️ Industrial maintenance and support
- 🎮 Entertainment & Gaming



Virtual Reality (VR)

Immersing users in a fully digital environment

Key Characteristics:

- Creates a completely virtual world
- Users are isolated from their physical surroundings
- Uses head-mounted displays (HMDs) and controllers
- Provides highly immersive and interactive experiences

Example Applications:

- 🎮 Gaming & Entertainment
- 🏥 Medical Training & Therapy
- 🚀 Astronaut Training & Simulations
- 🏭 Industrial Workforce Training
- 🎓 Virtual Learning Environments



Mixed Reality (MR)

Building the physical and digital worlds

Key Characteristics:

- Combines real and virtual environments
- Physical and digital objects interact in real-time
- Uses spatial awareness and AI-driven environment understanding
- Enables highly interactive immersive experiences

Example Applications:

- 🏥 Surgical planning and medical visualization
- 🏭 Manufacturing and maintenance assistance
- 🚗 Vehicle design and prototyping
- 🎓 Interactive education and training
- 🎮 Immersive storytelling and gaming



XR Applications Across Industries

XR is not just a technology, it solves real

Sector	Example Use Cases
 Healthcare	Surgical planning, medical training, patient therapy
 Education and Training	Virtual classrooms, interactive learning, simulations
 Industry and Manufacturing	Maintenance support, assembly guidance, digital twins
 Retail	Virtual try-on, product visualization
 Entertainment and Gaming	Immersive experiences and interactive environments

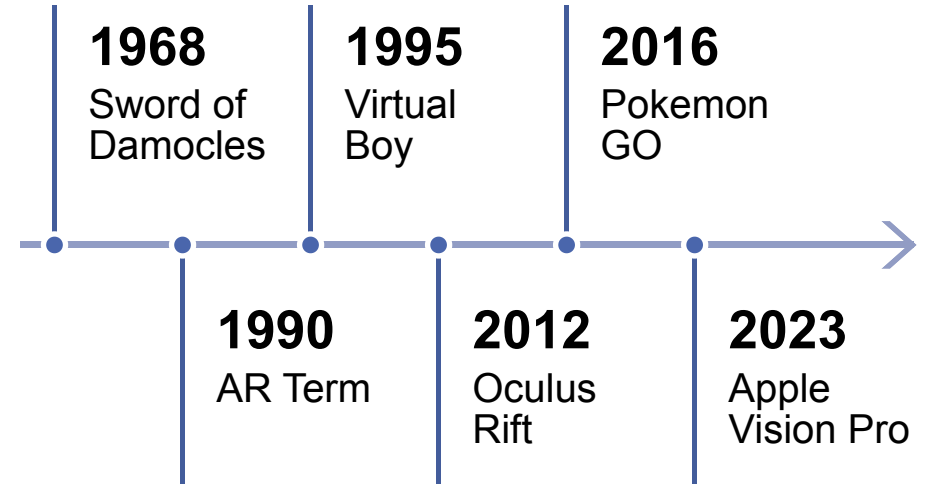
XR technologies are moving from experimentation to practical deployment across multiple sectors



Evolution of Immersive Technologies

Key Milestones:

- **1968:** First Head-Mounted Display (Sword of Damocles)
- **1990:** Introduction of the term Augmented Reality
- **1995:** Nintendo Virtual Boy
- **2012:** Oculus Rift revitalizes VR
- **2016:** Pokemon GO demonstrates mass-market AR adoption
- **2023:** Apple Vision Pro accelerates spatial computing



XR evolved from experimental prototypes to mainstream consumer and enterprise platforms

Current Challenges and Barriers

If XR is so promising, why isn't everyone using it yet?

Technical Challenges:

- High Hardware costs
- Significant computing requirements
- Limited battery life and device comfort

Ethical and Privacy Challenges:

- Collection of sensitive user data
- Security concerns
- Digital identity and misinformation risks

User Experience Challenges:

- Motion sickness (cybersickness)
- Latency and Performance Issues
- Interface Design Limitations

Interoperability Challenges:

- Lack of common standards
- Cross-platform compatibility issues
- Interface Design Limitations

Wider XR adoption depends not only from technological advances, but also on usability, accessibility, security and trust.

AI Integration in XR Software Systems

How AI enhances XR

Intelligent User Interaction:

- Natural language interaction
- Gesture recognition
- Eye tracking

Adaptive and Personalized Experiences:

- User-specific content adaptation
- AI-driven recommendations
- Personalized learning and training

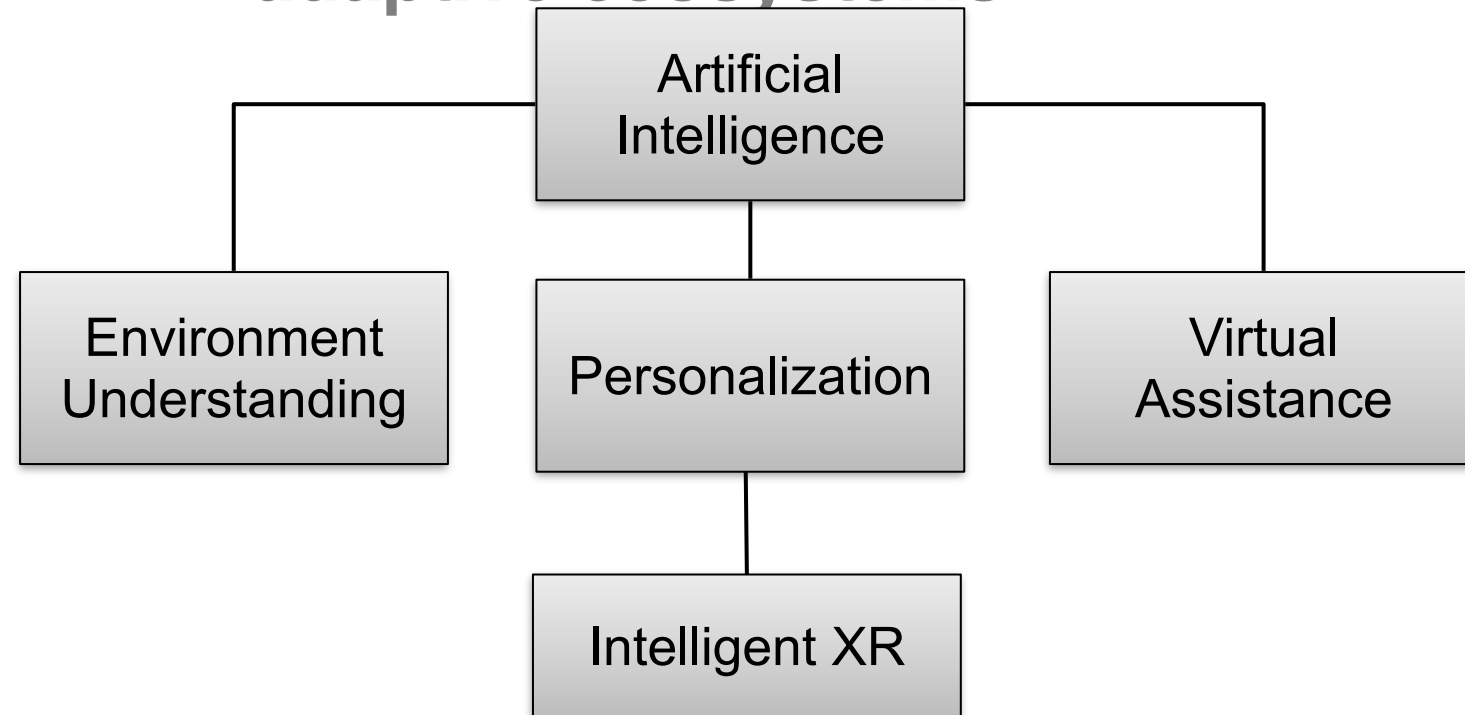
Environment Understanding:

- Object recognition
- Spatial mapping
- Scene understanding

Intelligent Virtual Agents:

- AI assistants
- Digital humans
- Conversational avatars

AI transforms XR from immersive environments into intelligent and adaptive ecosystems



Future of XR and the XR5.0 Vision

Future of XR:

- Increasing adoption across industry, education and healthcare
- Integration with AI, cloud computing and 5G/6G networks
- More immersive and personalized experiences
- Growth of virtual collaboration and intelligent assistants.

How XR5.0 contributes:

- Better human-machine interaction.
- Accessibility and inclusivity
- Privacy, security and ethics
- AI-driven training and learning
- Intelligent connected XR ecosystems

XR5.0 represents a practical framework for building the next generation of intelligent, accessible, and human-centric XR systems

Conclusions

- XR encompasses AR, VR, and MR technologies, creating immersive experiences that combine physical and digital worlds
- XR adoption is rapidly expanding across, health, education, manufacturing, retail and entertainment.
- AI is becoming a key enabler of intelligent, adaptive and personalized software systems.
- Several limitations remain, including hardware limitations, acceptability, interoperability, privacy, and ethical concerns.
- Future progress will depend on responsible innovation, interdisciplinary collaboration, and human-centric approaches such as those promoted by **XR5.0**

XR is evolving from an emerging technology into a foundational platform for future human-computer interaction.

XR5.0

Human-Centric AI-Enabled
Extended Reality Applications
for the Industry 5.0 Era

Thank you for your
attention!!!

