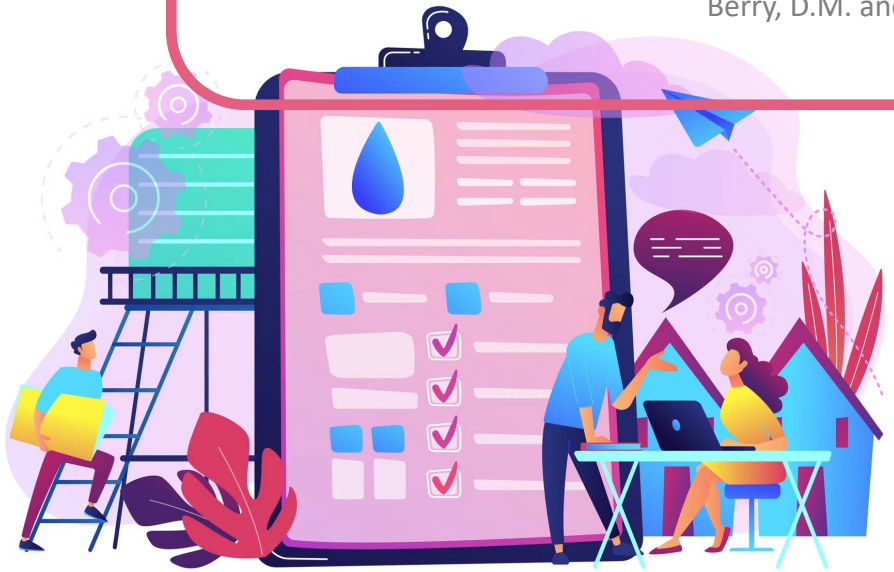
Requirements Specification for Virtual Reality and Augmented Reality Applications

Presented By: Muhammad Arsalan Khan

Requirements Specification

A requirements specification is a document that describes the expected capabilities, characteristics, and qualities of a system in enough detail that a design for the system can be derived from it.

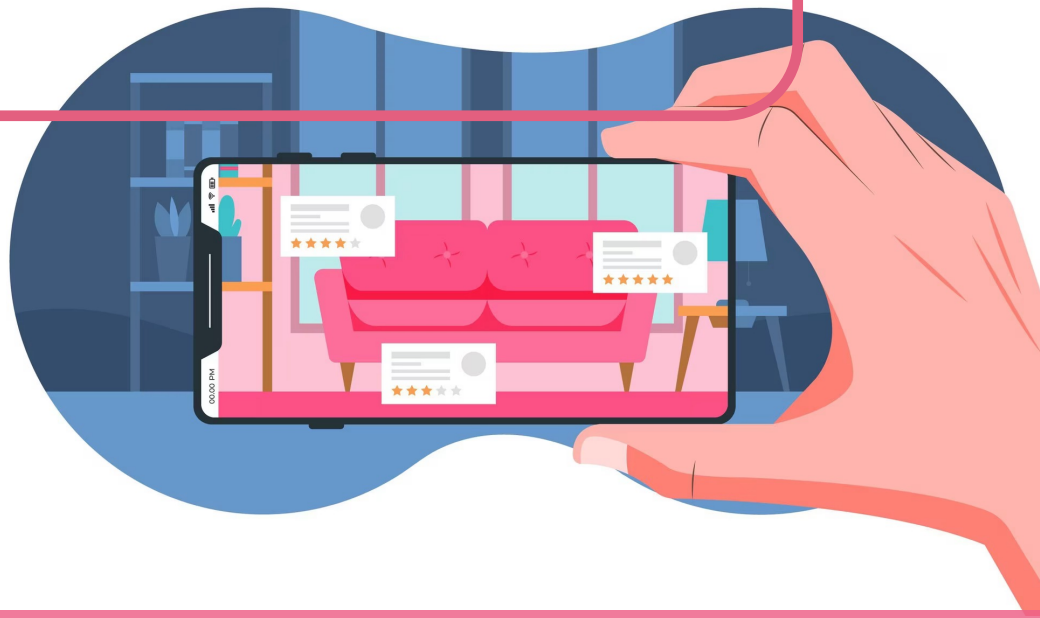
Berry, D.M. and Kamsties, E. (2004). Ambiguity in Requirements Specification.



Augmented Reality

Augmented Reality (AR) is a technology that overlays digital information, such as virtual objects or contextual data, onto the real-world environment in real-time.

Azuma, R. T. (1997). A Survey of Augmented Reality.



Virtual Reality

Virtual Reality (VR) is a computer-generated simulation of an immersive and interactive environment that can be explored and experienced by users through sensory stimuli, such as visuals, sounds, and haptic feedback.

Sherman, W. R., & Craig, A. B. (2003). Understanding Virtual Reality: Interface, Application, and Design.

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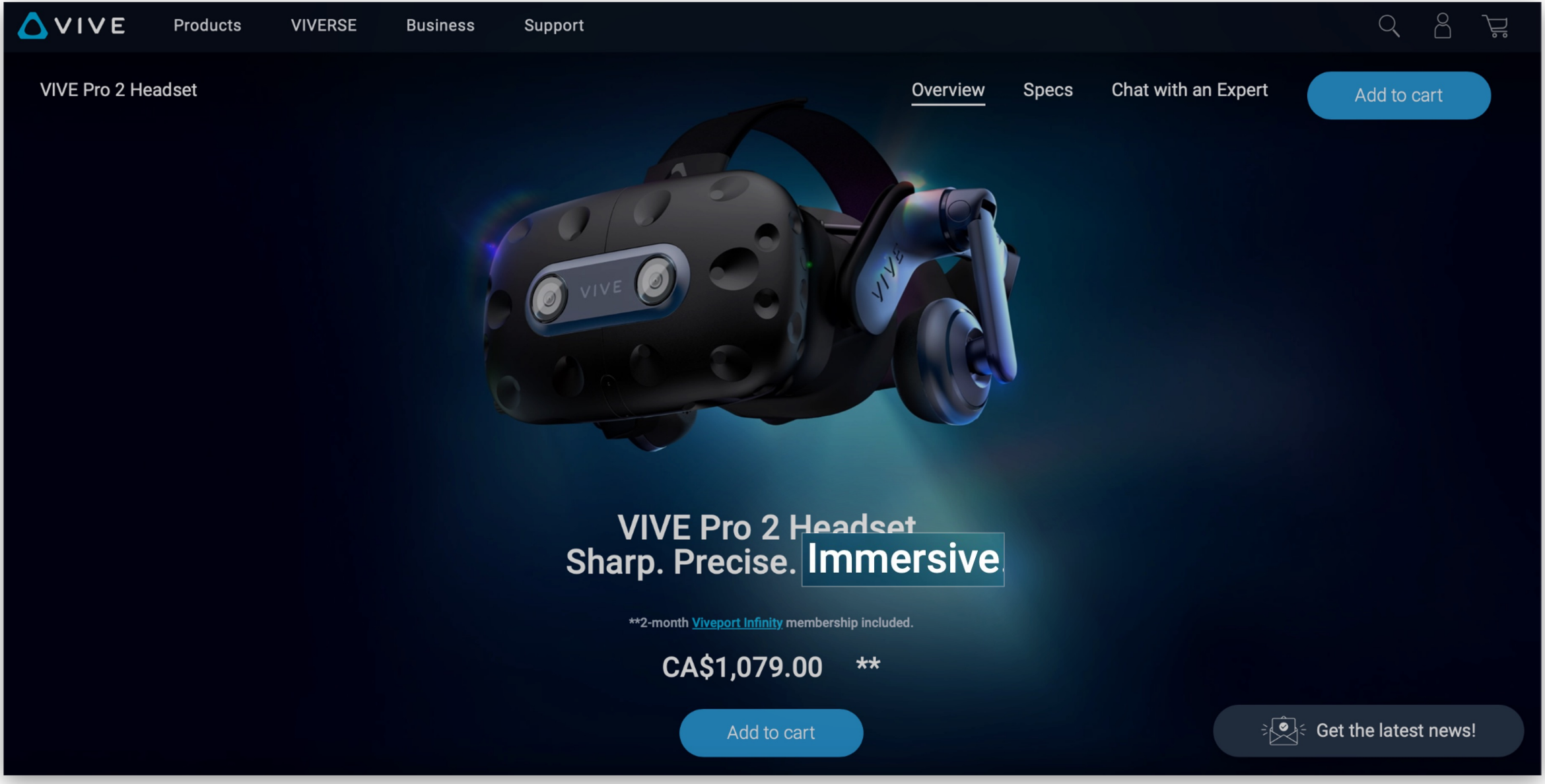
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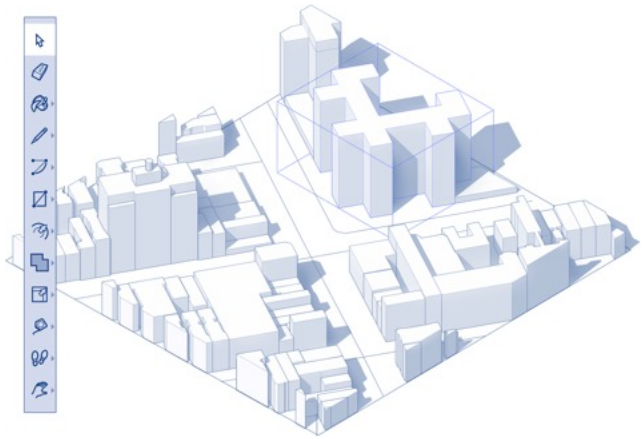
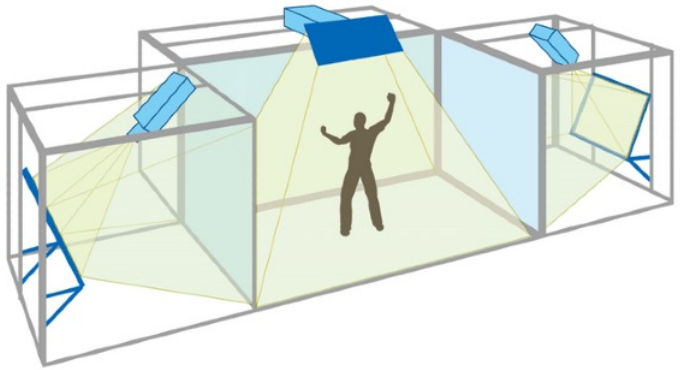
Virtuality-Reality Continuum

The term was first introduced by Paul Milgram and Fumio Kishino in 1994. It is a scale that measures the different levels of immersion or degree of digital augmentation. It ranges from reality, which is the completely real environment, to virtuality, which is the completely digital environment.

Type of Virtual Reality Systems

- Non-Immersive
  - CAD
    Computer-Aided Design
- Immersive
  - Semi Immersive
    - CAVE
  - Fully Immersive
    - HMDs
      Head-mounted Display

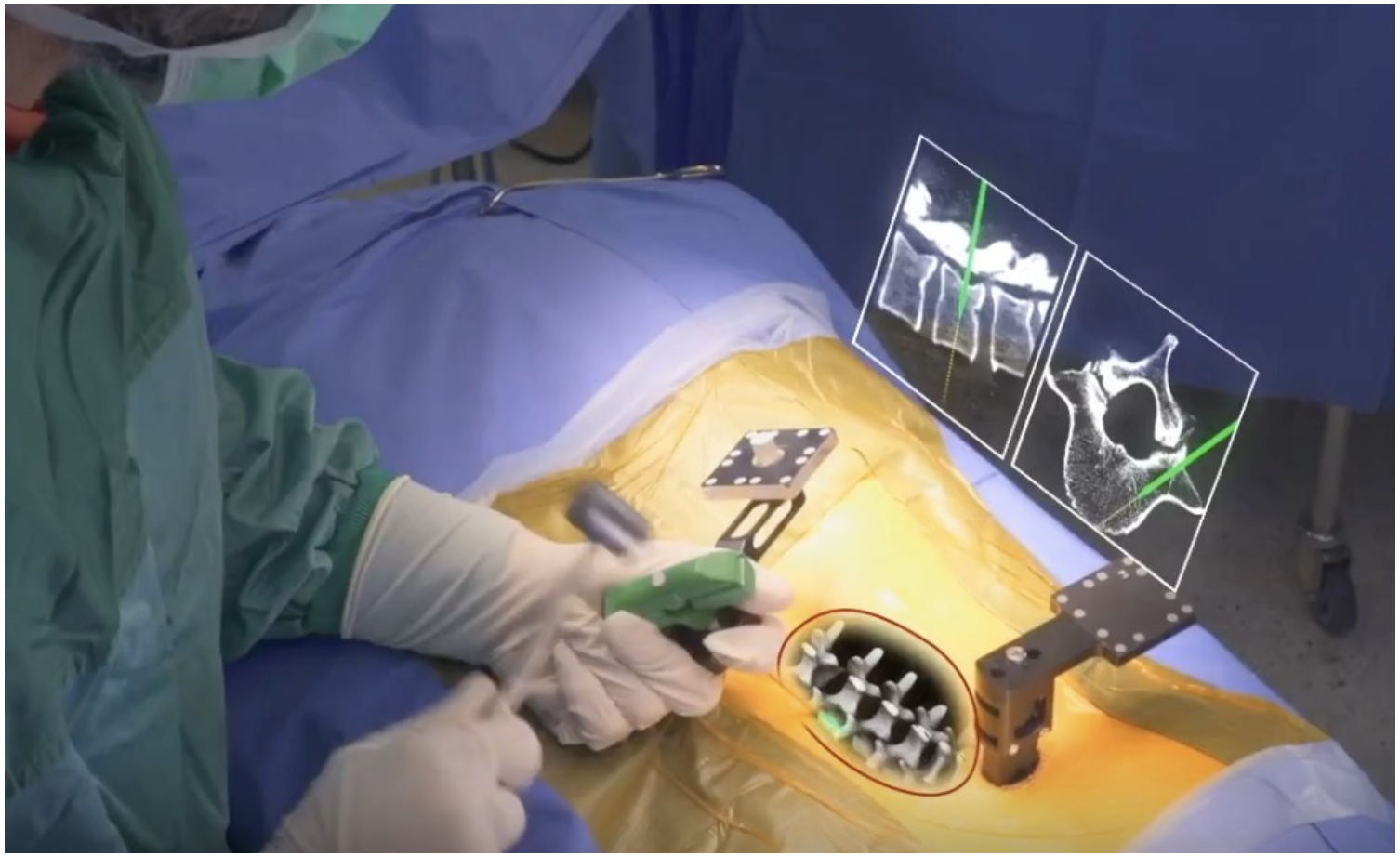




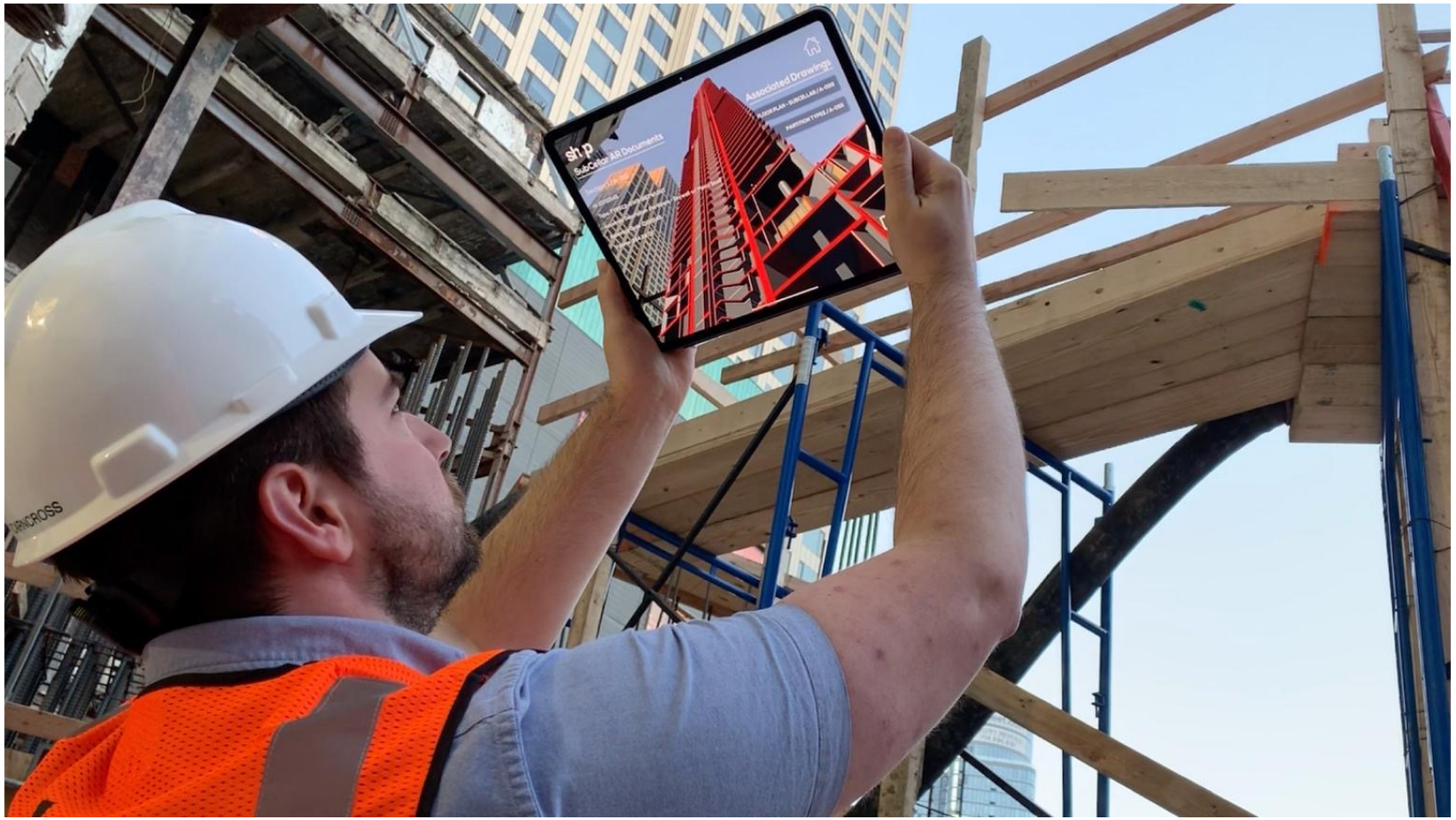
Applications

Gaming

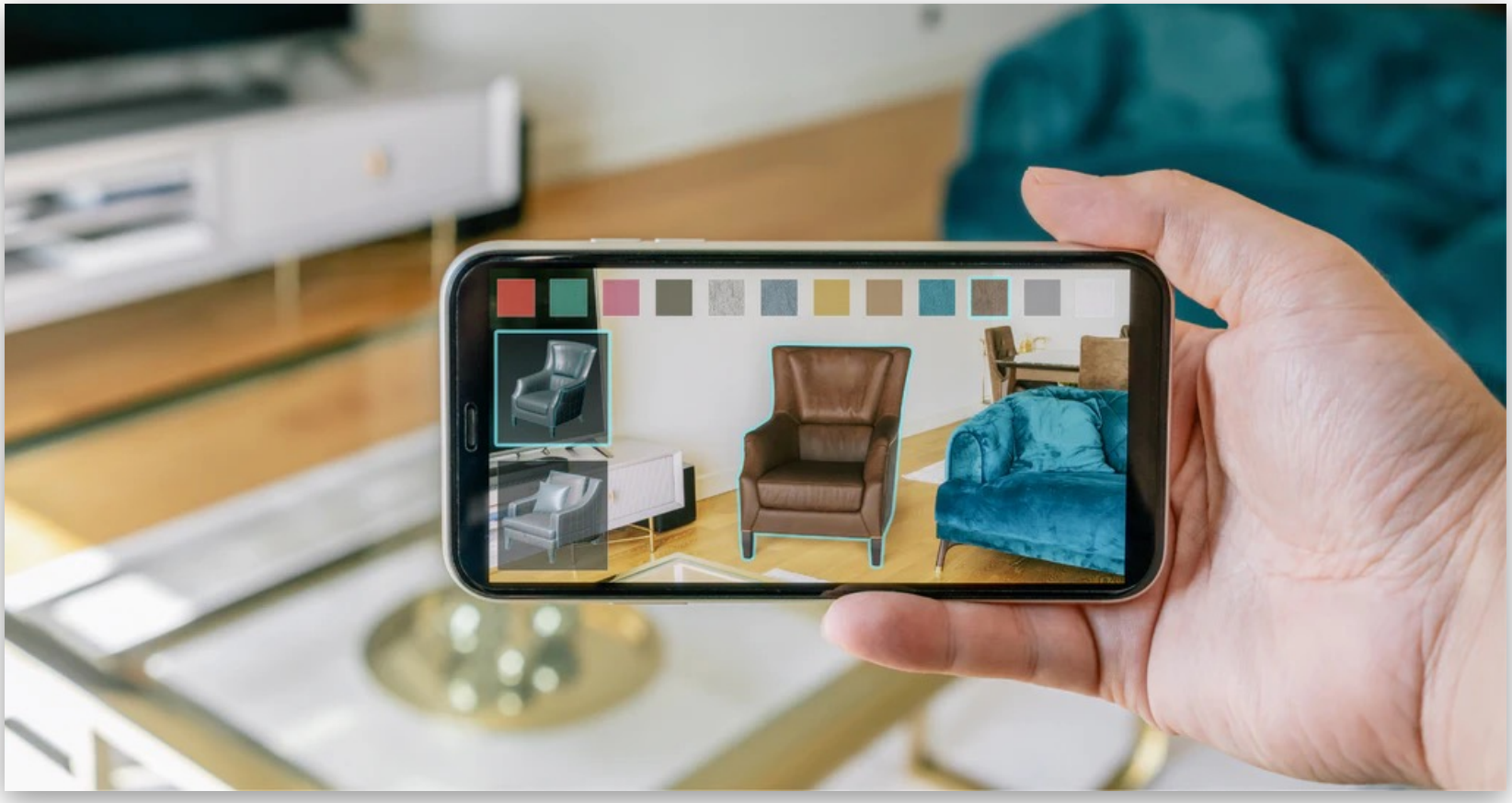
Healthcare



Construction



E-commerce



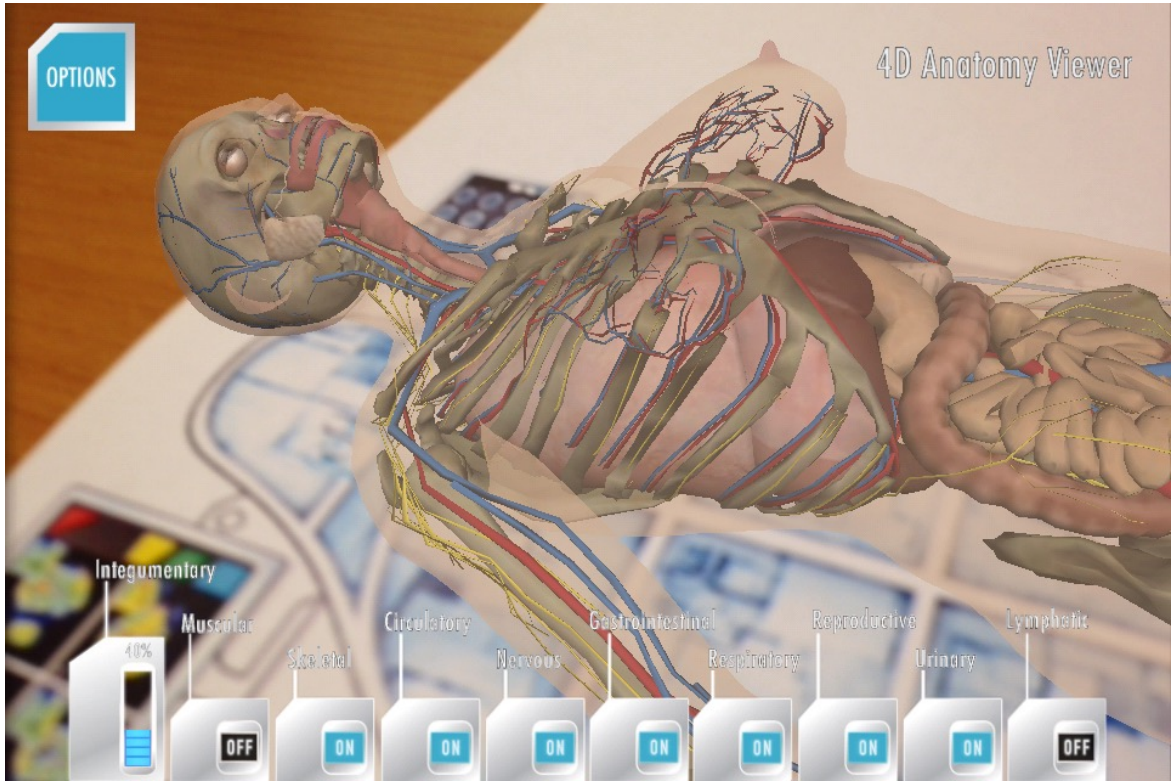
Navigation

In-car Navigation

In-car Navigation

Real Estate

Education


OPTIONS
4D Anatomy Viewer
Integumentary
Muscular
Skeletal
Circulatory
Nervous
Gastrointestinal
Respiratory
Reproductive
Urinary
Lymphatic
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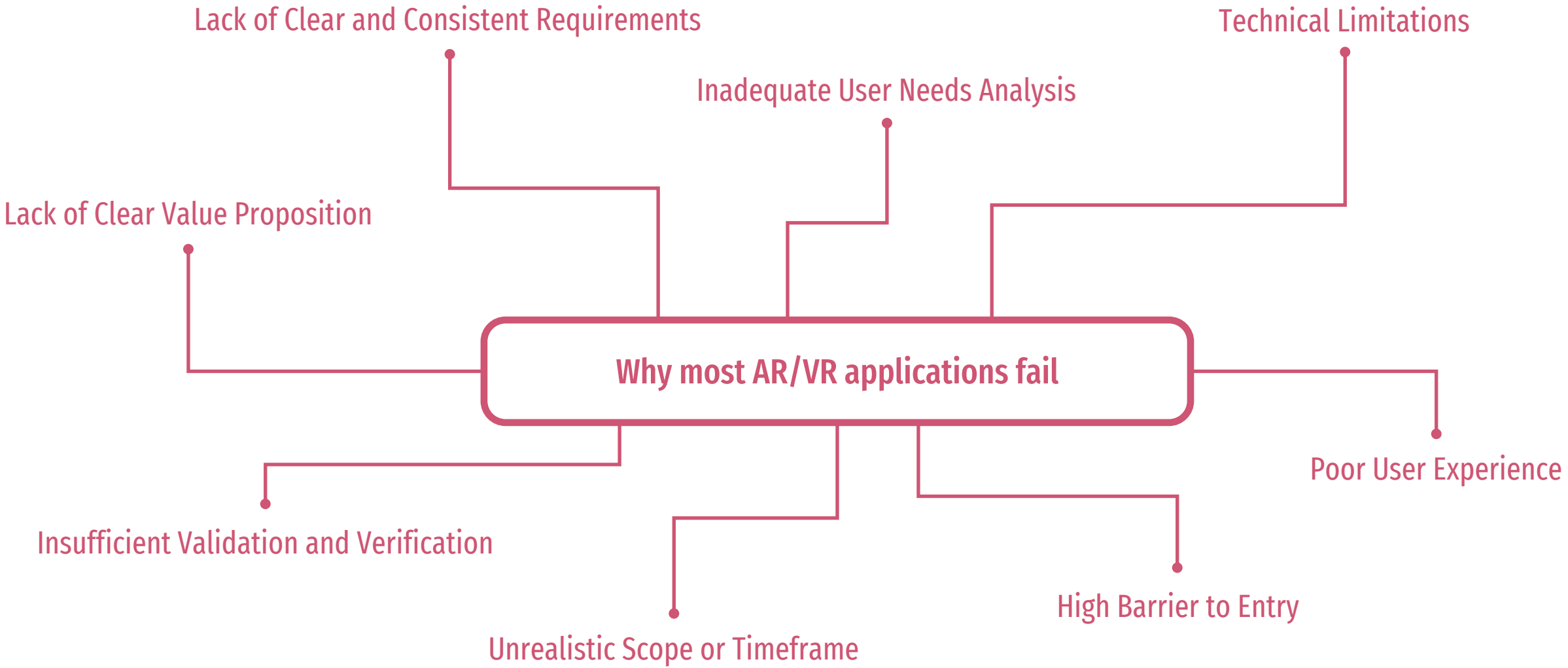
Why most AR/VR applications fail


Lack of Clear and Consistent Requirements
Technical Limitations
Inadequate User Needs Analysis
Lack of Clear Value Proposition
Why most AR/VR applications fail
Poor User Experience
Insufficient Validation and Verification
High Barrier to Entry
Unrealistic Scope or Timeframe

Lack of Clear Value Proposition

AR and VR applications that lack a clear value proposition fail to attract and retain users. Users need a compelling reason to adopt the technology and continue using the application.

- **Nguyen et al. (2020)**

  highlights the importance of defining a clear value proposition to enhance user engagement and satisfaction in AR-based mobile applications.

- **Kressler et al. (2019)**

  talks about why Google Glass failed to gain widespread adoption, due to a lack of clear use cases and value propositions beyond novelty and limited functionality.

- **Sweeney et al. (2017)**

  explores the factors influencing the adoption and impact of VR in the retail industry. One of the key findings is that the lack of a clear value proposition and uncertainty about the return on investment hinder the adoption of VR technology in retail settings.

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- **Heikkilä et al. (2018)**

  emphasizes the importance of a clear value proposition in terms of solving real business problems and enhancing productivity for successful adoption.

Lack of Clear and Consistent Requirements

Poorly defined or ambiguous requirements can result in misunderstandings and misinterpretations during the development process, leading to an application that does not meet user expectations.

- **Billinghurst et al. (2015)**

  emphasizes that when requirements for interaction and immersion are not clearly specified, the resulting application may lack intuitive controls or realistic virtual environments, leading to user frustration.

- **Roy et al. (2019)**

  discusses the impact of unclear requirements in the development of AR applications, emphasizing the need for precise and unambiguous requirement specifications.

- **Azuma et al. (2001)**

  provides an overview of AR technology and emphasizes the importance of clear requirements and precise specifications to achieve successful AR applications.

Lack of Clear and Consistent Requirements

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- **Martín-Gutiérrez et al. (2013)**

  explores the use of VR in education and highlights the significance of well-defined requirements and specifications to ensure educational effectiveness and alignment with learning goals

Inadequate User Needs Analysis

Failure to conduct thorough user needs analysis can lead to a mismatch between the application's functionalities and user expectations.

- **Choung et al. (2019)**

  emphasizes the importance of understanding user needs and preferences for the successful design and development of VR applications in the tourism domain.

- **Kocielnik et al. (2018)**

  stresses the importance of conducting thorough user needs analysis in VR applications to ensure that it meets the specific requirements and goals of the intended users.

- **Spano et al. (2019)**

  highlights the significance of understanding user needs and preferences in haptic interactions within VR and AR environments to design effective and engaging experiences.

Inadequate User Needs Analysis

Failure to conduct thorough user needs analysis can lead to a mismatch between the application's functionalities and user expectations.

- **Manresa-Yee et al. (2017)**

  focuses on the analysis of user requirements for augmented reality (AR) applications in the context of cultural heritage, emphasizing the need for **comprehensive user needs analysis** to align AR technology with user expectations and objectives.

- **Teixeira et al. (2018)**

  discusses the importance of **user-centered design** and **user needs analysis** in the development of virtual reality-based training systems, emphasizing the need to identify and understand user requirements and preferences.

Unrealistic Scope or Timeframe

Setting unrealistic project scopes or timeframes can result in rushed development, compromising the quality and completeness of requirement specifications.

- **Juric et al. (2019)**

  discusses the challenges of managing project scope and time constraints in the development of VR applications, emphasizing the importance of **realistic planning and prioritization**.

- **Borba et al. (2017)**

  discusses the challenges of managing scope and timeframes in AR/VR application development, highlighting the importance of **setting realistic goals and managing expectations**..

- **Caudell et al. (1992)**

  discusses the application of augmented reality in manual manufacturing processes. While it may not explicitly address unrealistic scope or timeframes, it highlights the importance of aligning AR technology development with **practical and achievable goals** in industrial settings.

Insufficient Validation and Verification

Inadequate validation and verification of requirements can lead to undetected errors or mismatches between the specified requirements and the implemented application.

- **Ahmed et al. (2021)**

  explores the importance of validation and verification techniques in ensuring the correctness and completeness of requirements in AR applications.

- **Pereira et al. (2020)**

  highlights the importance of testing and validating VR environments. It emphasizes the need to ensure that VR applications meet the intended requirements and provide the desired user experience through effective validation and verification processes.

High Barrier to Entry

High barriers to entry, such as cost, technical requirements, expertise, and infrastructure, can contribute to the failure of AR/VR applications in various domains.

- **Baraković et al. (2013)**

  discusses how **costs** and **technical requirements** associated with deploying and maintaining VR systems, lead to potential failures in adopting VR for educational purposes.

- **Gomes et al. (2018)**

  explores immersive virtual reality learning environments in higher education. It highlights the high barrier to entry in terms of cost, technical requirements, and **expertise** needed to develop and deploy AR/VR applications, limits their adoption and leads to failures in implementation.

- **Schaller et al. (2019)**

  focuses on the potential of virtual reality applications in physical rehabilitation. It mentions the need for **specialized equipment**, **technical support**, and **user training** can limit the widespread implementation and success of VR in rehabilitation settings.

Poor User Experience

AR and VR applications that provide a subpar user experience, including clunky interfaces, unintuitive controls, or uncomfortable experiences, are likely to fail.

- **Pascoal et al. (2020)**

  discusses why AR/VR applications need **intuitive and user-friendly interfaces** to ensure ease of use and engagement. Complicated or cumbersome interfaces can deter users.

- **Pertaub et al. (2002)**

  some AR/VR experiences may lack social elements, leading to a sense of isolation. Enabling social interaction and collaboration can enhance user engagement.

- **Hamilton et al. (2019)**

  talks about the VR game “No Man’s Sky VR”, which faced criticism for its cumbersome controls and limited interactivity, resulting in negative user reviews and reduced interest in the VR version of the game.

Technical Limitations

Technical limitations can significantly contribute to the failure of AR/VR applications. These limitations can involve hardware, software, or a combination of both, affecting factors such as performance, compatibility, and user experience.

- **Melero et al. (2019)**

  discusses the hardware required for AR/VR experiences, such as headsets or devices, can be **expensive**, **bulky**, or have **limited processing power**, which hinders mass adoption.

- **Sodhi et al. (2021)**

  discusses the impact of **insufficient processing power** on the performance and usability of VR applications in the healthcare sector.

- **Faisal et al. (2019)**

  discusses how AR/VR applications can be high resource-demanding, leading to high power consumption and reduced battery life. **Limited battery life** can affect the duration of AR/VR experiences and user convenience, requiring users to recharge or replace batteries frequently.

Technical Limitations

Technical limitations can significantly contribute to the failure of AR/VR applications. These limitations can involve hardware, software, or a combination of both, affecting factors such as performance, compatibility, and user experience.

- **Brade et al. (2020)**

  focuses on the usability and user experience of optical see-through AR devices. It discusses the impact of a **limited field of view** on user experience and the challenges it poses for creating effective AR applications.

- **Rebenitsch et al. (2016)**

  talks about cybersickness in applications and visual displays, and how users may experience **visual discomfort or motion sickness** due to limited field of view, resolution, or latency issues.

Requirements Specification

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Environment

Device

Application

User

Application

- *What does your application do?*
- *What do you want to show on the screen?*
- *What degree of immersion is required?*
- *What is the content and functionality?*
- *What types of content needs to be displayed (3D models, videos, animations, interactive element)?*
- *Where on screen is this content displayed?*
- *How accurate does the content needs to be?*
- *What tools are to be used to create this content?*
- *How are the contents managed?*
- *Are the contents fixed, or are they continuously updated?*
- *How are they updated?*

Application

- *Who is the target audience?*
- *Has the application been thoroughly tested?*
- *What kind of performance is expected (framerate, latency and response time)?* *Chen et al. (2017)*
- *What kind of graphics are expected?*
- *What is the desired field of view?* *Brade et al. (2020)*
- *Is there any input required from the user?*
- *What are the supported user input methods?*
- *Does the application require network connectivity or can it be used offline?*
- *How will the application handle user input errors or invalid interactions?*
- *What is the expected duration of user engagement with the application?*

Device

- *What type of device is needed?*
- *How many devices are required?*
- *Is there any additional hardware required, like motion controllers, haptic feedback devices, or positional tracking sensors?*
- *What are the limitations of the device's processing power or memory?* Melero et al. (2019)
- *Are there any specific considerations for the device's weight or comfort?*
- *What is the desired level of portability for the device?*
- *What should be the display resolution?*
- *How much battery life is needed?* *Faisal et al. (2019)*
- *What's the maximum field of view?*

User

- *Are there any accessibility requirements to ensure the application can be used by individuals with disabilities?* Mahmud et al. (2019)
- *Are the user experience factors such as comfort, ergonomics, and minimizing motion sickness in VR applications considered?* Rebenitsch et al. (2016)
- *Does the system incorporate user preferences and customization options, like adjustable settings for visual comfort (e.g. brightness, contrast)* Lernia et al. (2020)
- *Does the UI design prioritize simplicity, clarity, and ease of use?* Marquardt et al. (2016)
- *What user positions can the applications be used in (standing, walking, sitting)?* Slater et al. (2008)
- *Are there any specific user training or onboarding requirements?* Oriola et al. (2017)

Environment

- *In which environmental setting would it be most used?*
- *Are occlusion and collision handling considered?* Ruddle et al (2000)
- *How will the application handle varying physical spaces or room configurations?*
- *Are the potential safety risks considered for the application's environment?* Seo et al. (2021)
- *Does the application provide clear guidelines and warnings to users about potential environmental hazards or limitations?*
- *Does the application adapt to different environmental conditions, such as indoor versus outdoor settings or varying ambient noiselevels?*
- *Will the application require calibration or setup for different environmental settings?*

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Thank You