# Virtual Reality:
# Past, Present, and Future

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http://www.crs4.it/vic/data/papers/vr-report98.pdf

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# Note

- This is a paper about VR, but many of the points are valid and it provides a good intro to what is needed for such systems. These base requirements remains the same for AR, which is why I chose this paper. Also, I wanted to keep it short.

- If you want to read 48 pages of EVERYTHING about AR, please refer to "A Survey of Augmented Reality" by Ronald T. Azuma http://www.cs.unc.edu/~azuma/ARpresence.pdf (with ~10 pages of references)

# Perspectives on AR: Evolutionary

- Build a better UI
  - Desktop is the primary interface mode right now
  - Good for documents and flat stuff
  - Not so good for 3D input or output
  - Humans are well designed for a 3D world
  - Taking the interface into 3D will benefit certain classes of applications

# Perspective on AR: Revolutionary

- Presence simulation itself is an interface metaphor
- Build a new reality, providing a new way to work
    - Virtual prototyping and walkthroughs
    - Simulation based training
    - Telepresence and teleoperation
    - Generalized augmentation of everyday reality
- Change the way the work is done at a very low level

# Short History

- 60's-70's: Origin with teleoperation systems
- 1980's: MIT creates first limited 3D workspace
- 1980's: NASA picks up work, with focus on teleoperation
- 1989: Autodesk and VPL Research demo VR in trade shows
- VPL founder Jaron Lanier coins "Virtual Reality"
- … and the rest is history

# Necessities of AR/VR

- Multiple/integrated input and output modalities
- Functional fidelity: sensory cues must match task
- Responsiveness
- Affordances: maintain affordance needed to create illusion of presence in the perceived reality
- Appeals to mental representation: recognizable by users through real-world metaphors

# Requirements of VR/AR: Input

- Simulated presence requires allowance for all normal modes of interaction with reality
- Full body gesture/position/locomotion sensing is the holy grail
- In reality, only a few of the possible channels are captured
  - Gesture and voice come in second to position
  - Guesture/locomotion is sampled at critical points and rest of data is interpolated

# Output: Visual

- Human eyes have a horizontal FoV of ~180 degrees without motion
  - The sensitivity drops greatly, but peripheral view is needed for sense of realism
- Maximum accuracy id defined by size of fovea, with resolution of 0.5 arc minutes (0.008°)
- Minimum motion update rate is ~15 Hz, below which the brain no longer interpolates motion
- For high motion content simulations, >60Hz is often necessary

# Output: Aural

- Hearing is not as privileged as vision, but necessary for situational awareness
- Dynamic sensitivity is max between 1 and 4 kHz
- Azimuth (left vs. right) perception is generally good to one degree
- Monaural levels are used for amplitude detection, which is often mapped to distance using rate of change

# Output: Haptic

- Haptic senses are combined sensory and motor systems
- Basic idea is force feedback
- Generally, there is a lack of techniques for simulating the haptic output without having a real object
- In absense of this, stylized gestures are often used to replace fine haptic interaction
- Update rates > 1kHz is needed to maintain realism

# Key Issues: Synchronization

- VR/AR often causes motion sickness
- Key to this is the fact that one or more sensory subsystem is producing data which is not in synchronization with either the other sensory systems, or not matching previous experience with the same conditions
- Each sense has its own detection threshold
- Overall tolerance of variation is generally very low

# Hardware issues

- Covered in other presentation

# Guidelines/Comments

- Iterative/user-centric design is key when using a new methodology
  - There are no toolkits to abstract away the UI issues
- Synchronization of this sort requires parallel programming techniques
  - Latency is especially jarring and should be carefully considered
- There are new problems such as occlusions
  - 2D display techniques often do not apply
- This is still a lot about technology and basis
  - Set reasonable goals for the points to be made today