

Apple Vision Pro Restores True 4K Resolution at Typical Operating Room Viewing Distances

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Introduction

Why is this a problem?

- Modern operating rooms use 4K cameras and 4K monitors
- Human visual acuity is limited by angular resolution (~1 arc-minute)
- A 32-inch 4K monitor must be viewed at ~25 inches to perceive full 4K detail
- In real OR settings, monitors are typically viewed from 3–4 feet

Key point:

- At standard operating room distances, surgeons cannot perceive true 4K resolution despite using 4K imaging systems.

Purpose

- To compare perceivable visual resolution between a standard 32-inch 4K surgical monitor at typical OR viewing distance and a virtual 4K monitor displayed using the Apple Vision Pro.

Method

Design

- Quantitative, comparative study

Participants

- Adults ≥18 years
- Normal vision or corrected with contacts / LASIK

Key Methodological Simplification:

- Same participants
- Same 4K source
- Same test pattern
- Only variable changed: viewing geometry

Outcome Measure / Definition:

- Highest resolvable spatial frequency using a standardized black-and-white line-pair test pattern (4K, 1080p, 720p, 540p).

Statistical analysis

- Descriptive statistics were reported as median (IQR) and frequency (%).
- A one-sample binomial test was used to assess whether 4K identification with Apple Vision Pro was greater than chance.

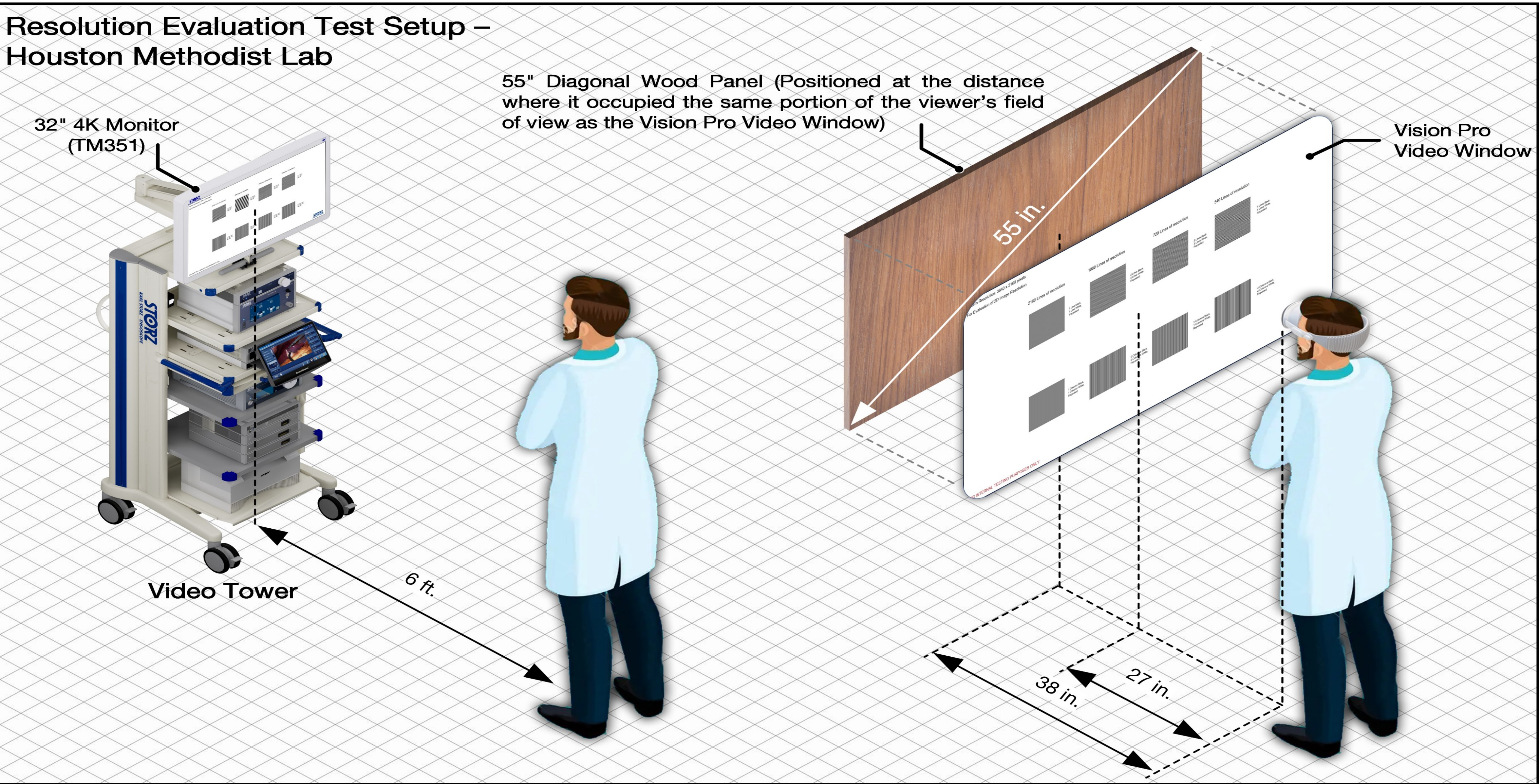
Simulated Scenario

Participants viewed a standardized 4K Line-pair resolution test pattern under two viewing conditions:

- 32-inch 4K monitor at typical OR distance (3-4 feet) using a floor marker for consistent positioning (*F1,Left*)
- Apple Vision Pro virtual monitor fixed in the same location within the room, maintaining a consistent viewing distance (*F1,Right*)

* Participants reported the highest resolvable resolution level (4K-540p)

Figure 1



Key Findings:

At Standard OR viewing distances (3-4ft), Surgeons could not perceive true 4K resolution using a 32-inch monitor. Apple Vision Pro restored full perceivable 4K resolution and was strongly preferred for image clarity.

What Surgeons Could Actually See

True 4K perception

- 32" 4K monitor – 0%
- Apple Vision Pro – **100%**

Effective monitor resolution at OR distance

- 720p – **71%**
- 540p – **19%**
- 1080p – **10%**

Preference

- Image clarity – **AVP 93.5%**
- Comfort – **Monitor 54.8%**

Main Findings

Summary Results

- Standard 4K surgical monitors do not deliver perceivable 4K resolution at OR distances
- Apple Vision Pro restores full perceivable 4K resolution

Significance / Implications

- This represents a human-factors limitation, not a camera limitation
- Increasing camera resolution alone does not improve visualization if viewing distance is suboptimal

Future Direction

- Evaluate impact on dynamic surgical video and procedural performance
- Assess surgeon fatigue, ergonomics, and workflow integration
- Explore implications for precision-dependent minimally invasive procedures

Limitations

- Small sample size (31 participants)
- Simulated viewing environment rather than operative conditions
- Outcome measured perceived resolution rather than surgical performance

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