Interpupillary Distance Mismatch in Enterprise AR – Impact on Depth Perception and Task Performance

Category:

Software or Hardware Issues

Problems this Research Would Address

Fixed-camera IPD mismatch distorts depth cues for most users outside a device's target IPD range

The technical problem

Video passthrough AR headsets use fixed front-facing cameras set at one interpupillary distance (IPD) that will not match many users — causing subtly but measurably incorrect depth cues

Unlike optical see-through devices (e.g., HoloLens 2), many current video-passthrough devices use fixed camera positions that may not match an individual user's IPD, potentially affecting binocular depth cues.

In industrial settings — assembly, maintenance, inspection, hazard detection — **even small depth errors carry real safety and accuracy consequences.**

Why enterprises can't ignore it

54–74 mm

human IPD range — workers at both extremes are affected by every video passthrough device on the market today

Enterprise buyers have no data to assess IPD mismatch risk when selecting video passthrough headsets for their workforce.

Device manufacturers lack neutral benchmark data to drive adjustable-IPD camera system development.

How would this research be conducted?

1. **Conduct a literature review** - survey optometric and human-factors research on IPD mismatch, vergence-accommodation conflict and stereoscopic depth perception to set the scientific foundation and define measurable outcomes.
2. **Develop a standardised IPD mismatch test protocol** - define scenarios, measurable outcomes (depth error in mm, task accuracy %) and IPD-spanning participant criteria. Reviewed and approved by the AREA Research Committee before participant testing begins.
3. **Recruit a stratified participant group -** a minimum of 30 participants across at least 3 IPD groups (narrow, average, wide) representing the full range of enterprise workforce IPD variability.
4. **Execute on at least 2 commercial video passthrough devices -** Execute the validated protocol on at least two commercially available video-passthrough XR devices, selected using transparent criteria including enterprise relevance, market availability, and camera configuration

Project Deliverables

1. **Report of research findings** describing the relationship between IPD mismatch, depth-perception error, task performance, and workforce safety considerations across tested video-passthrough devices.
2. **Validated IPD Mismatch Test Protocol** that AREA members, researchers, and device manufacturers can reuse to evaluate present and future video-passthrough XR devices.
3. **Workforce-Fit Device Assessment Tool** for enterprise buyers to assess IPD-related deployment risk for a target workforce, compare device suitability, and identify when testing, mitigations, or alternative hardware should be considered.
4. **Enterprise Device Selection Guide** with practical guidance for procurement, IT, health-and-safety, and operational teams when selecting video-passthrough headsets.
5. **Manufacturer Recommendations** identifying design and software improvements that could reduce IPD mismatch risk, including adjustable camera positioning and software compensation approaches.
6. **Executive summary of findings for public release and member exclusive webinar**

Project Deliverables

Four reusable outputs — a method, evidence, buyer guidance and a manufacturer roadmap

Validated IPD mismatch test protocol

A reproducible, peer-reviewed methodology AREA members and **manufacturers can reuse to evaluate** new video passthrough devices as they reach market.

Enterprise device selection guidance

Practical recommendations for buyers on assessing IPD mismatch **risk when selecting video passthrough headsets** for a given workforce population

Quantified depth perception findings

Statistical analysis linking IPD mismatch magnitude to depth **estimation error across device types** - with significance testing and confidence intervals.

Manufacturer recommendations

A formal document identifying performance improvements needed - e.g., **adjustable-IPD camera systems, software compensation** - to reduce mismatch impact.

How would findings be analysed and validated?

1. **Analyse collected data -** apply statistical methods to quantify the relationship between IPD mismatch magnitude and depth perception error per device, establishing significance and effect size for enterprise-relevant task scenarios.
2. **Cross-reference findings across devices -** compare results between tested passthrough devices to determine whether mismatch impact is device-specific or a category-level issue, and document contributing hardware factors.
3. **Develop enterprise guidance -** translate statistical findings into practical, non-technical guidance for buyers and HR / health-and-safety teams responsible for headset selection and workforce fit assessments.
4. **Validate and publish -** present draft findings to the AREA Research Committee and a panel of human-factors experts for review before final publication, ensuring findings are scientifically defensible and practically actionable.

Project Deliverables — Summary & Impact?

Deliverable	Who it serves	Value delivered
Validated IPD mismatch test protocol	AREA members & device manufacturers	A reproducible, reusable evaluation standard for new devices
Quantified depth perception findings	Researchers & enterprises	Statistical evidence linking IPD mismatch to depth estimation error
Enterprise device selection guidance	Enterprise buyers & health-and-safety teams	Confident, workforce-fit headset selection decisions
Manufacturer recommendations	Device manufacturers	A roadmap to adjustable-IPD cameras & software compensation

Why This Research Matters

- **Protects workforce safety and task quality:** IPD mismatch may affect depth judgement in assembly, maintenance, inspection, and other spatial tasks.
- **Enables evidence-based device selection:** Buyers need a way to assess workforce-fit risk before committing to video-passthrough hardware.
- **Creates a reusable industry standard:** The protocol and assessment tool support consistent evaluation of future devices.
- **Improves manufacturer accountability:** Neutral benchmark data can guide camera design and software-compensation improvements.
- **Supports responsible enterprise adoption:** Members can make more defensible procurement and deployment decisions.