

PriXR: Protecting Extended Reality (XR) User and Bystander Privacy

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Funded by REPHRAIN [runs until November 22]

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University
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VIRTUALITY CONTINUUM

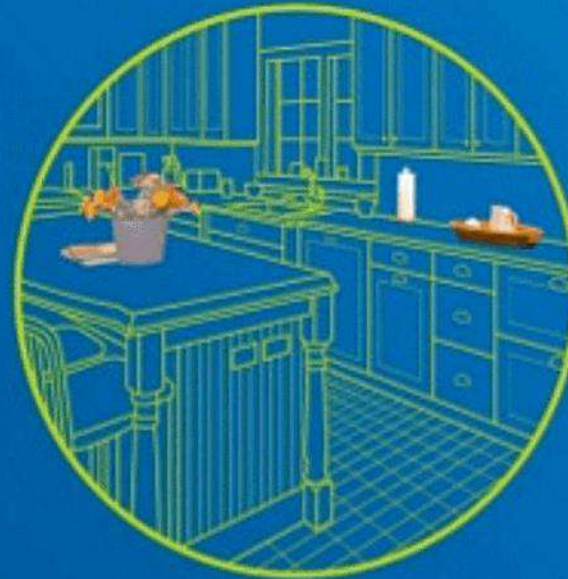
MIXED REALITY



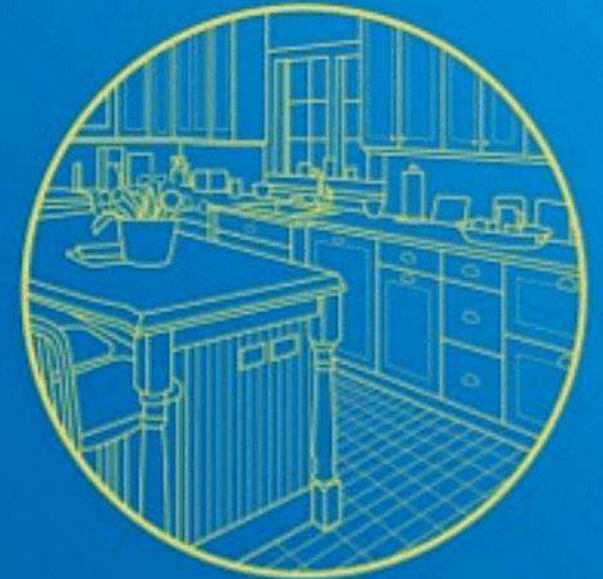
REALITY



AUGMENTED
REALITY (AR)



AUGMENTED
VIRTUALITY (AV)



VIRTUAL REALITY

Milgram's Reality-Virtuality / Mixed Reality Continuum http://etclab.mie.utoronto.ca/publication/1994/Milgram_Takemura_SPIE1994.pdf

Also referred to as eXtended Reality (XR)

Image from https://medium.com/@Maria_Nova/4rs-or-get-your-head-around-virtuality-continuum-625e256ddd1d

COMBO

13

45 007

x4

74

100

STEAMVR beta 1.5.15

Now Playing
Beat Saber





HoloLens 2 AR Headset: On Stage Live Demonstration - <https://www.youtube.com/watch?v=uIHPPtPBgHk>



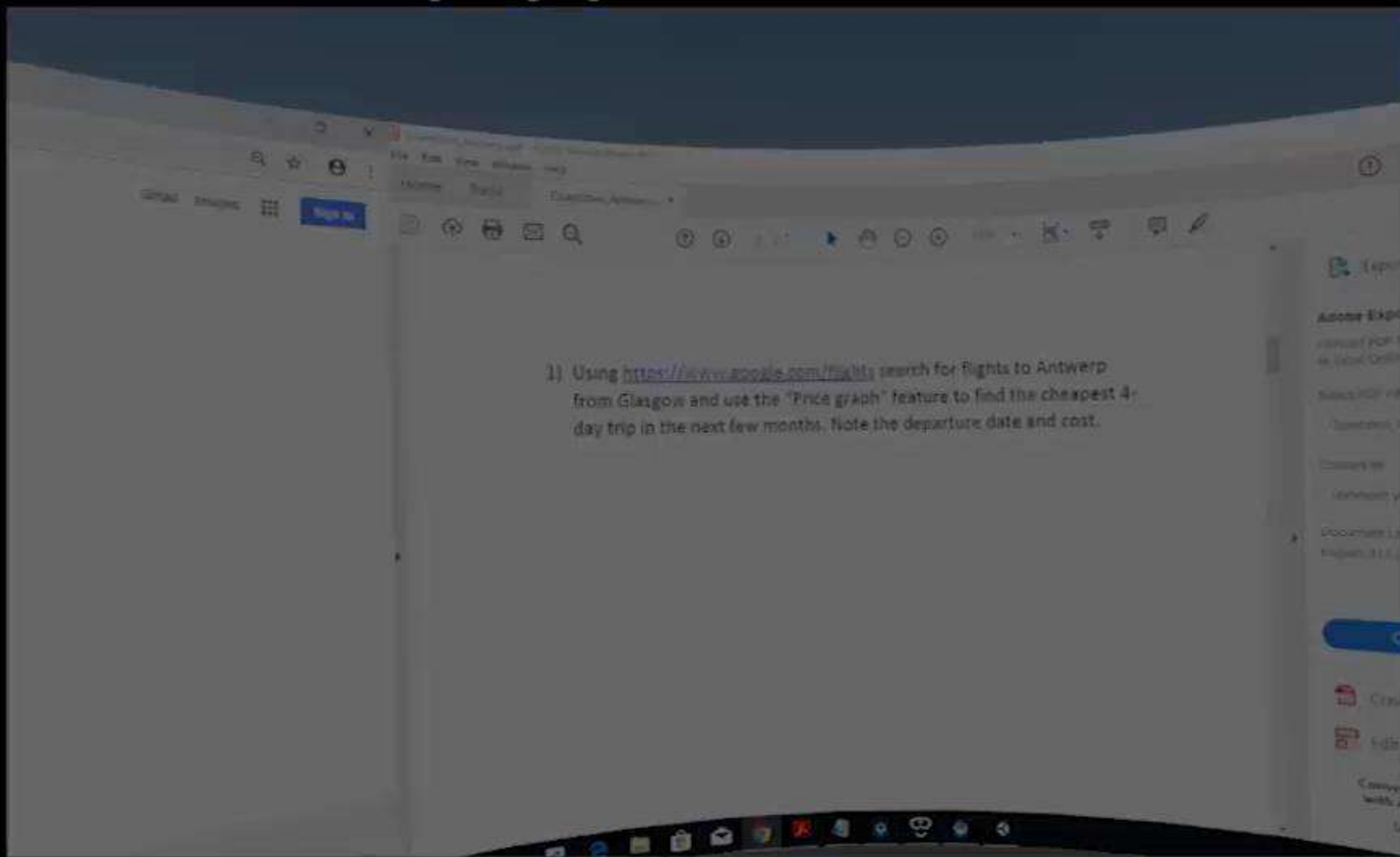


“We won’t be able to opt out from wearing AR glasses in 2035 any more than we can opt out of owning smartphones today...”

<https://mssv.net/2020/08/16/digital-sight-management-and-the-mystery-of-the-missing-amazon-receipts/>

HYPER-REALITY

<https://www.youtube.com/watch?v=YJg02ivYzSs>





Game Night Squad

Ready!

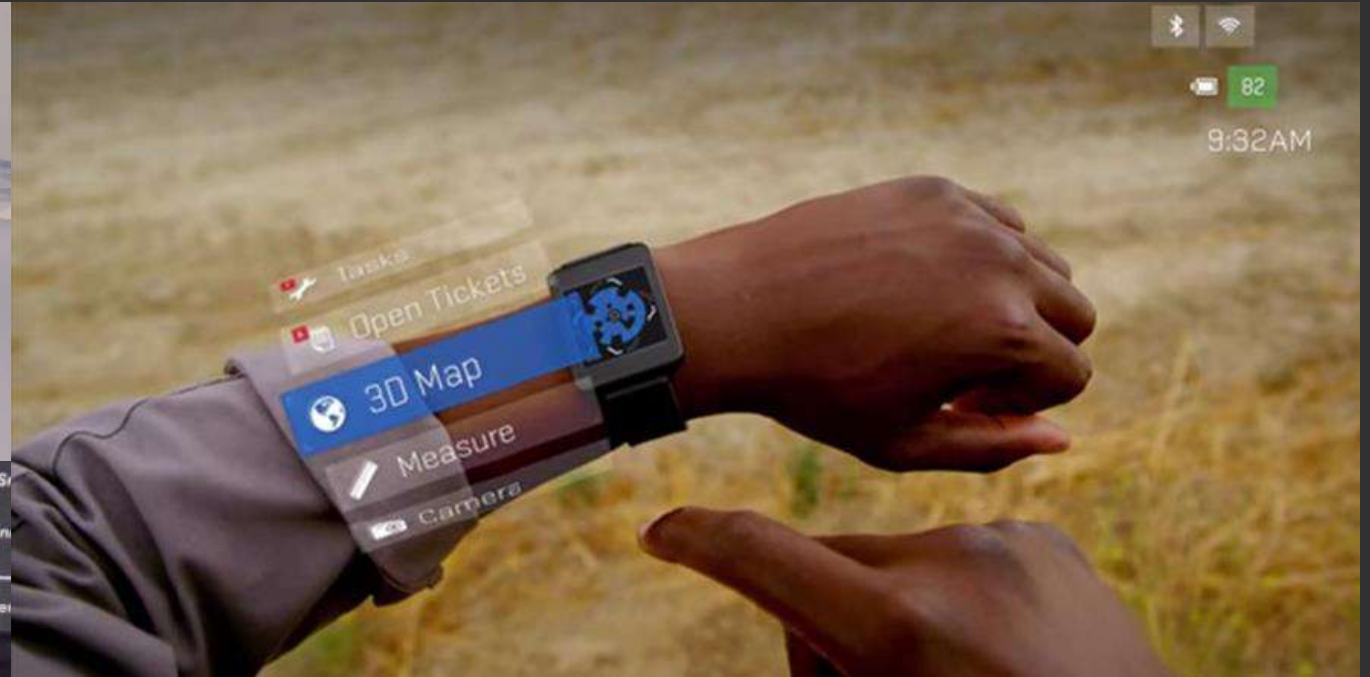
Pablo wants to play!

JOIN

Simulation footage



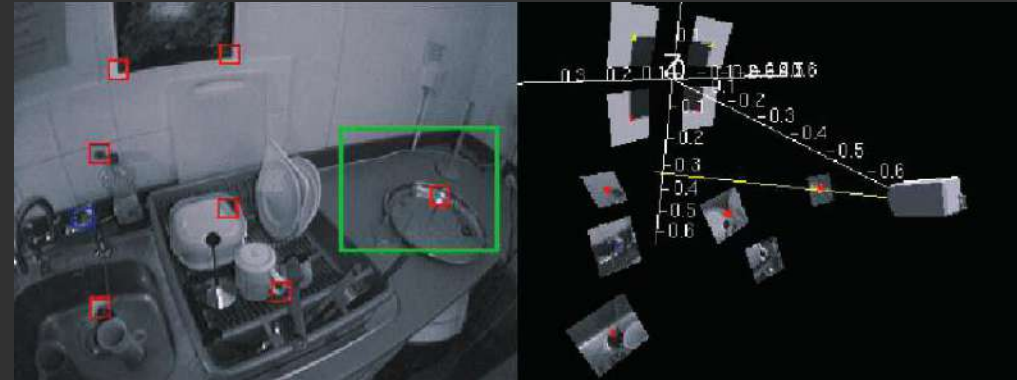
Exocentric, grounded, world-fixed



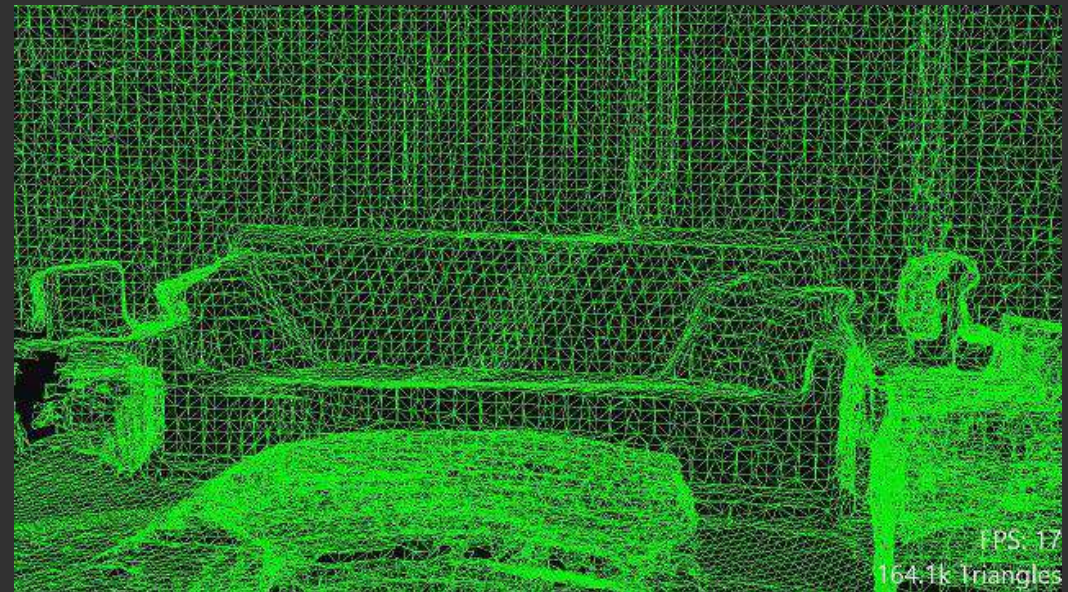
Exocentric: describes an object's location independently of the perceiver's perspective or location.

XR “Requisite” Sensing

Inside-Out (e.g. Oculus Quest, AR headsets/smartphones) utilize **Simultaneous Localization and Mapping (SLAM)** cameras / sensing on the headset/device to track the environment, enabling 6DoF tracking



Tracked landmarks <https://www.andreasjaki.com/basics-of-ar-slam-simultaneous-localization-and-mapping/>



Hololens Spatial Mapping





Scale	1
Resolution	+
Outdoors	++++
Indoors	-
Dynamics	+



1K
++
+++
-
++

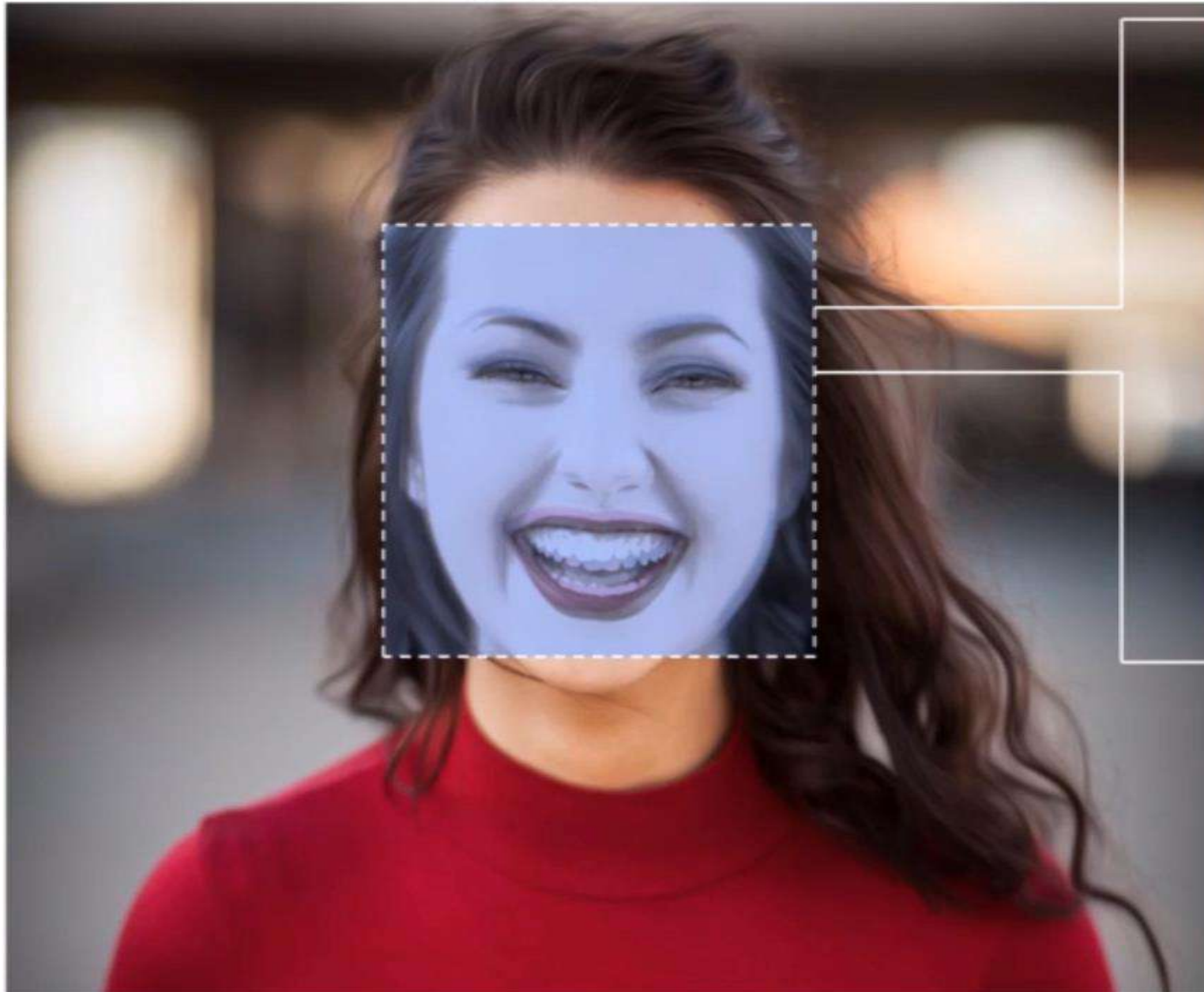


10K
+++
+++
++
+++



1M+
+++++
+++
++++
+++++

Scenario or activity: **Identifying or inferring personal characteristics of other people such as gender identity, age, race, sexuality etc.**



The image shows a woman with long, dark, wavy hair, smiling broadly. She is wearing a red turtleneck sweater. A dashed white rectangular box is drawn around her face, indicating the region of interest for the face model.

General Model

Quickly understand objects, actions, scenes, and colors within an image.

alizarine red color	0.83
person	0.81
female	0.71
woman	0.70
television reporter	0.64
girl	0.62
young lady (heroine)	0.53
young girl	0.50

Face Model

Locate faces within an image and assess gender and age.

Face 1

age 21-24	0.80
FEMALE	1.00

Risks of Requisite XR Sensing...

XR technology will unlock spatial computing and better context-aware computing and support – enhancing entertainment, productivity, communication etc.

Consumers and business will be likely to adopt this technology for these obvious benefits – perhaps without considering, or understanding, the privacy risks this brings.

Consequently, XR technology risks...

- a (seemingly) consensual erosion of privacy from the perspective of the XR User
 - *The price you pay for access to the metaverse?*
- and a non-consensual erosion of privacy from the perspective of the bystander

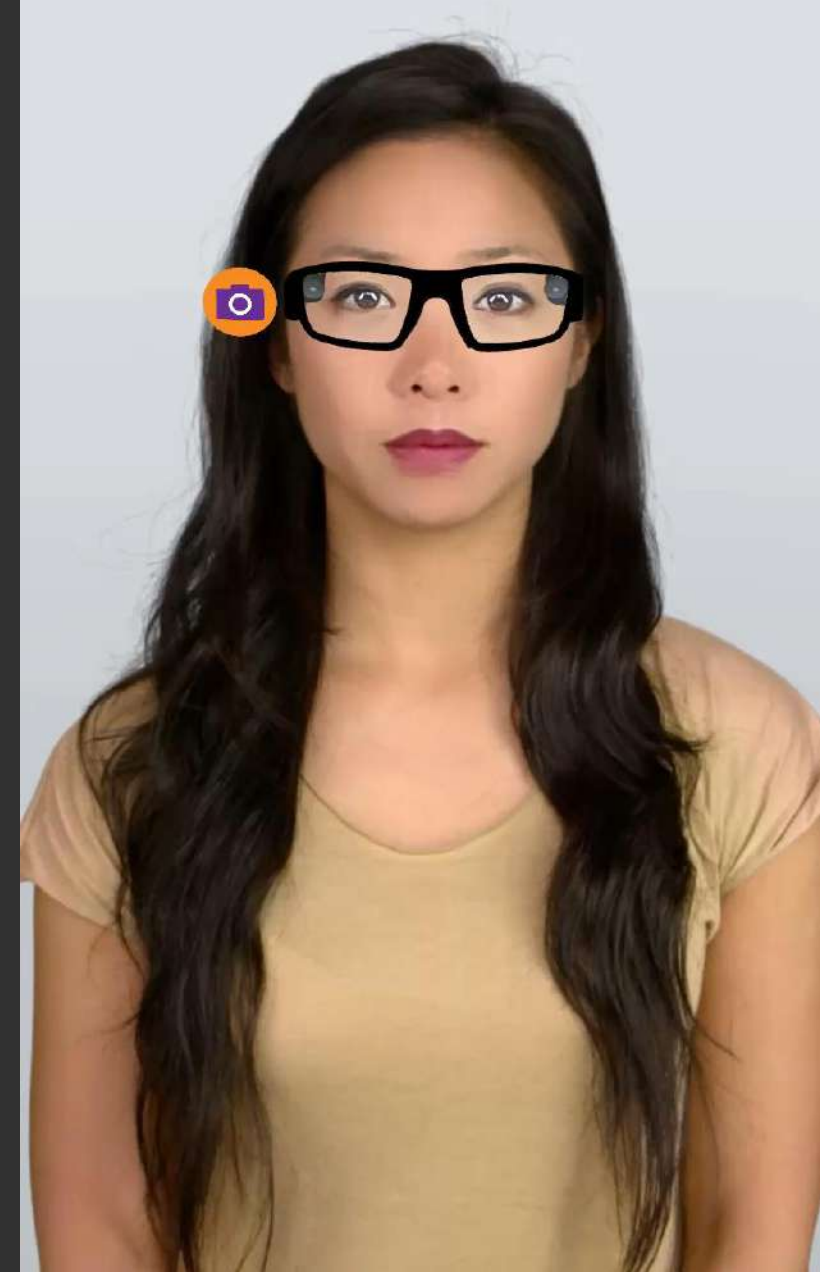
PriXR aims to...

Support resistance against surveillance and misuse – e.g. enhanced data access protections, increased user awareness and control over how, when, and to what purpose their personal sensing / XR device is being used

Facilitate bystander awareness and agency – where XR activity may pertain to the bystander, there are clear issues regarding how they are made aware of this activity, how it pertains to their privacy, and what level of control they can exert over this (e.g. consenting to, or denying, said activity)

[addressing REPHRAIN mission 1 – privacy at scale, trade-offs of PETs]

End result: Bring some degree of transparency and accountability to the use of personal XR activity



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