

Mixed Reality In-Situ Welding

Integrating AR, tinyML, and generative AI to train skilled workers for future opportunities in creative arts and manufacturing

Background

Metal welding is a craft manufacturing skill that can be unusually difficult to externalize and represent to novices. Building competency requires an apprentice to iteratively practice embodied skills and sensitize themselves to a sensorially complex practice.



To explore these challenges, we organized a series of co-design workshops with a youth program in welding and fabrication. We identified opportunities for mixed reality, sensing, and tinyML processes to augment welding training and practice.

System Design

An extended reality (XR) welding helmet and torch enhances the embodied learning of welding in three key ways

1 Visual XR Guides and Integrated Motion Sensing

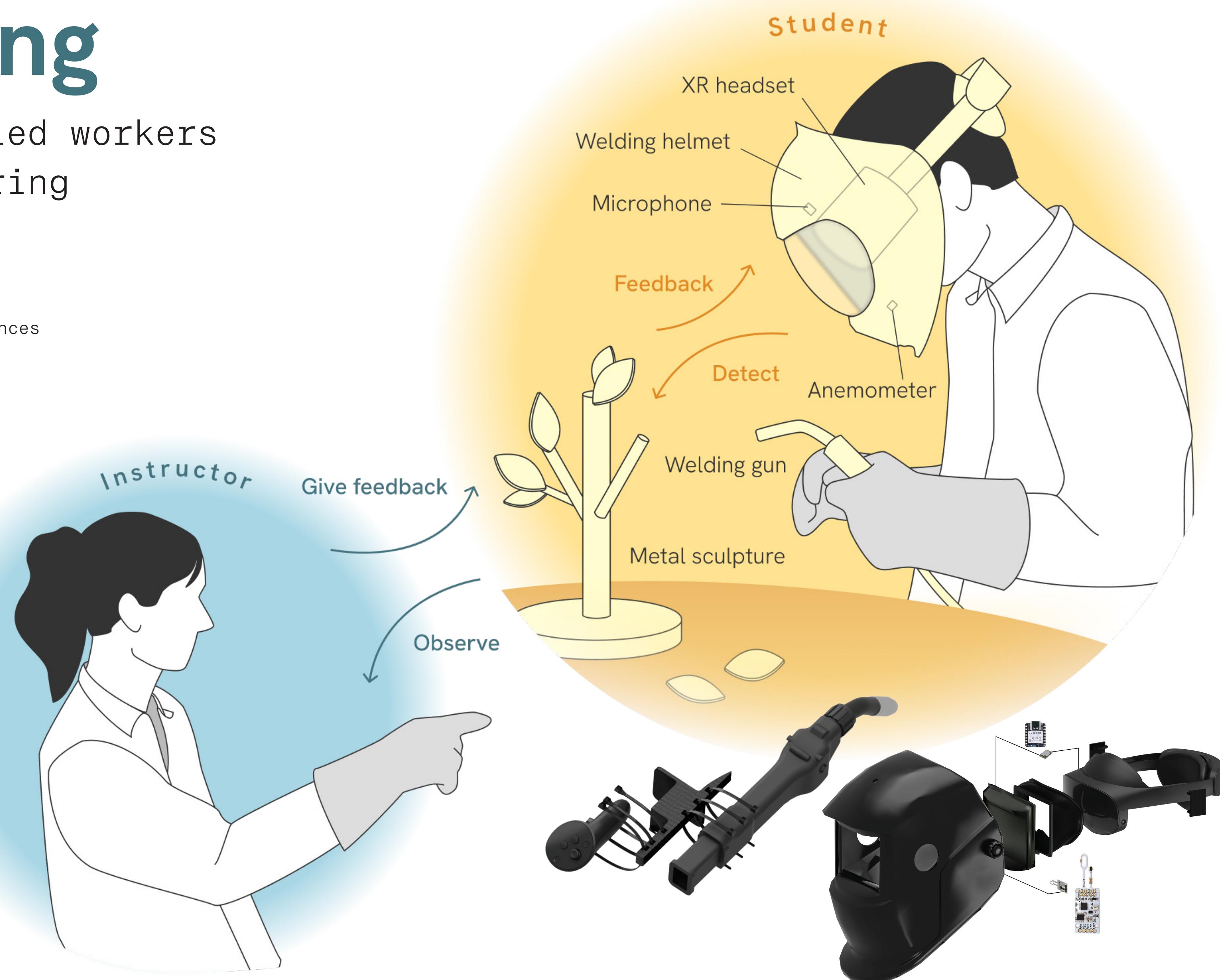
Combined motion-sensing and visual XR feedback helps improve proprioceptive and embodied learning

2 Sensing Sonic Cues During Welding Practice

Acoustic sensing focuses learner attention on non-visual cues of weld performance

3 Mediated Meditation and Regulation

Biometric sensing enhances mindfulness and stress management in sensorially challenging environments



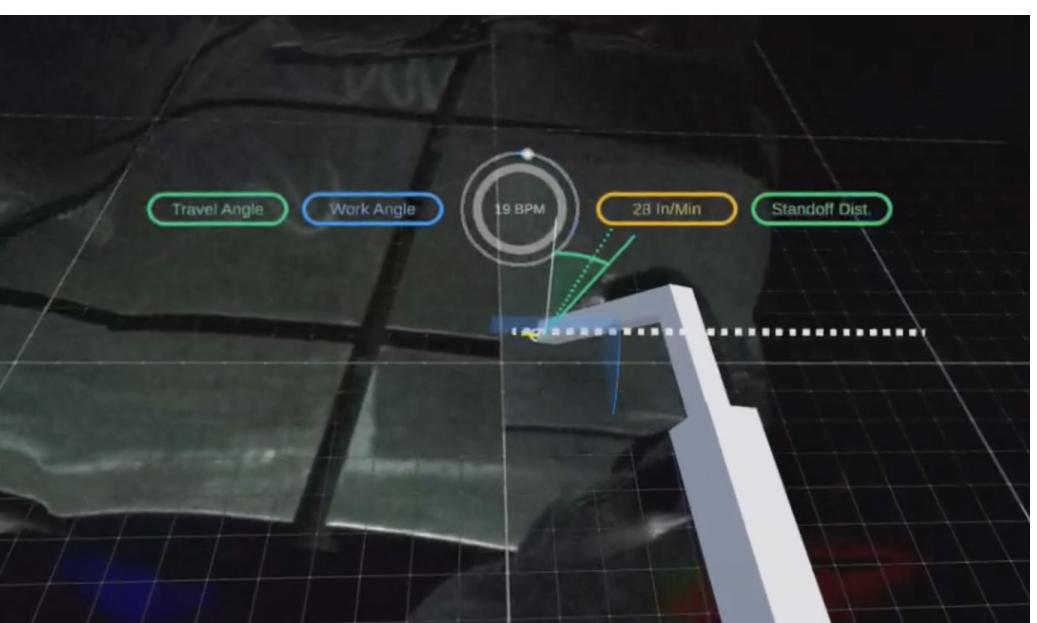
Initialization

When the welder initially wears the helmet, they must adjust the Quest optics, headband fit settings, and ensure that the proper welding safety equipment is worn.



Calibration

The welder uses the gun to place coordinate locations for the start and end of the weld, linking the real world weld line to a graphic representation in the XR display.



Pre-weld feedback and meditation

Before welding, the welder can use the breath-controlled meditation program and gun angle monitoring to focus and prepare for a successful weld.



Active weld feedback

During welding, the display dims automatically, allowing the welder to see the molten weld bead and XR display elements, providing responsive feedback on the welder's performance.



Reflection and evaluation

Automatically generated 3D weld lines can be reviewed post-weld inside the headset, allowing the welder to monitor variance from an ideal weld and reflect on overall performance and behavior.



Realtime instructor view

At any time, an instructor or student can review realtime or recorded point of view (POV) footage to monitor behaviors or analyze difficult scenarios.