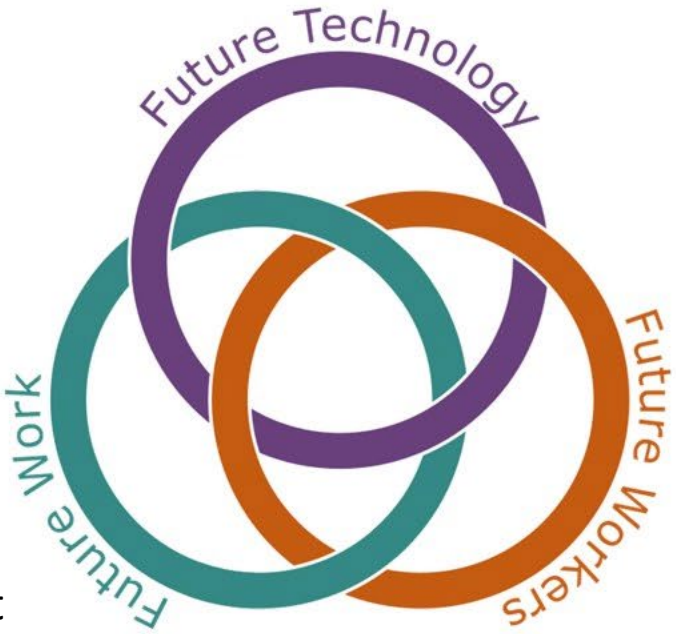
Panel 5:
Skill Enhancement, Reskilling, and Collaboration



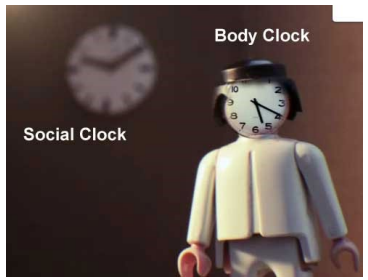
- An Embodied Intelligent Cognitive Assistant to Enhance Cognitive Performance of Shift Workers
- Human-Robot Collaboration for Enhancing Work Capabilities
- Augmenting Spatial Cognition Capabilities of Future Workforce to Enhance Work Performance in Altered Environments Using Virtual Reality
- Enhancing Human Capabilities through Virtual Personal Embodied Assistants in Self-Contained Eyeglasses-Based Augmented Reality (AR) Systems
- Intelligent Facilitation for Teams of the Future via Longitudinal Sensing in Context
- Optimizing Long-term Human Performance in Future Work
- Wearable Adaptive Cognitive Assistance to Auditory Situational Awareness for Workers Exposed to Complex and Dynamic Noises

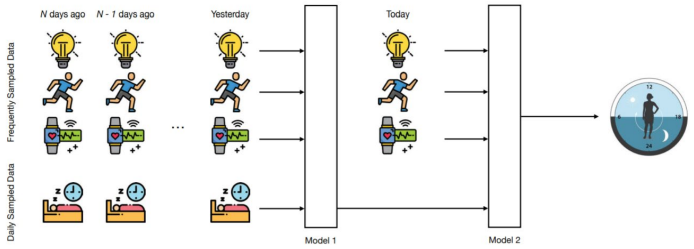
#1840167: An Embodied Intelligent Cognitive Assistant to Enhance Cognitive Performance of Shift Workers

Akane Sano, Rice University
akane.sano@rice.edu, https://compwell.rice.edu/

Project goals: To develop a closed-loop Intelligent Cognitive Assistant (1) to infer circadian rhythm, alertness, and stress levels and (2) to provide personalized feedback to enhance users' cognitive ability and wellbeing in an unobtrusive manner.

Sensor-Based Estimation of Dim Light Melatonin Onset (DLMO) Using Features of Two Time Scales





Wan et al., under review (arxiv)

Personalized Wellbeing Prediction and Doctor-in-the-loop Sleep Advice System for Medical Professionals

- Wellbeing Prediction
- Burnout Prediction
- Automatic CBT Selection

Li & Sano, IMWUT 2020
Yu et al., MobiHealth 2020

Frequency-Dependent Light Stimulation for Regulating Alertness

- Minimally-obtrusive and highly accessible visual sensory biofeedback through laptop screen

Victor & Sano, IEEE EMBC 2020

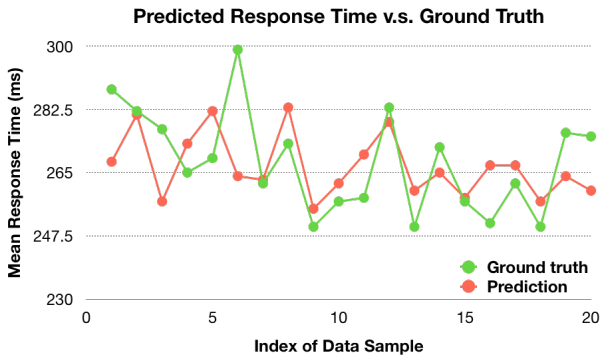
Collaborative Research: An Embodied Intelligent Cognitive Assistant to Enhance Cognitive Performance of Shift Workers (#1840025)

PI: Tanzeem Choudhury, Cornell Tech
Presenter: Vincent Tseng, Cornell Tech, vincent@infosci.cornell.edu

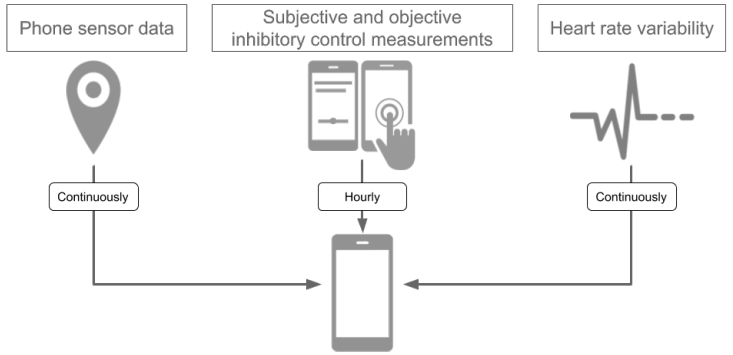
Place Presenter's Zoom Image/Video Here

- Goal: Assist workers in managing their cognitive performance
- Unobtrusive performance monitoring and identifying the digital biomarkers
- In-the-moment interventions to improve workers' cognitive performance

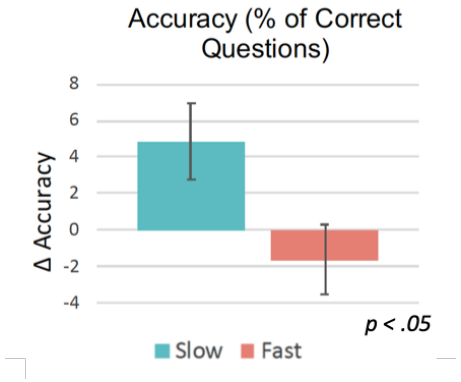
- Developed **AlertnessScanner**, a smartphone app that tracks eye markers using frontal cameras.
- Conducted 2 studies to examine the feasibility of assessing cognitive performance (alertness) using **phone-based eye markers.**



- Conducted a 4-week in-the-wild user study with 12 participants.
- Collected cognitive performance (inhibitory control) **in-situ** and **continuous** sensor and heart rate data to identify the digital biomarkers.



- Developed **BoostMeUp**, a smartwatch app that provides **haptic feedback**.
- Study with 72 users showed unobtrusive intervention can **boost cognitive performance** (working memory).



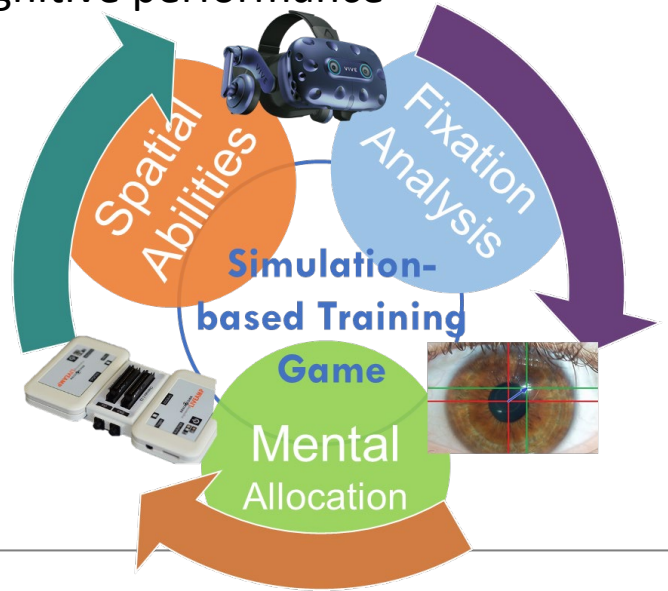
CNS1928695: FW-HTF-RM: Augmenting Spatial Cognition Capabilities of Future Workforce to Enhance Work Performance in Altered Environments Using Virtual Reality

PI(s): Manish Dixit, Texas A&M University, mdixit@tamu.edu

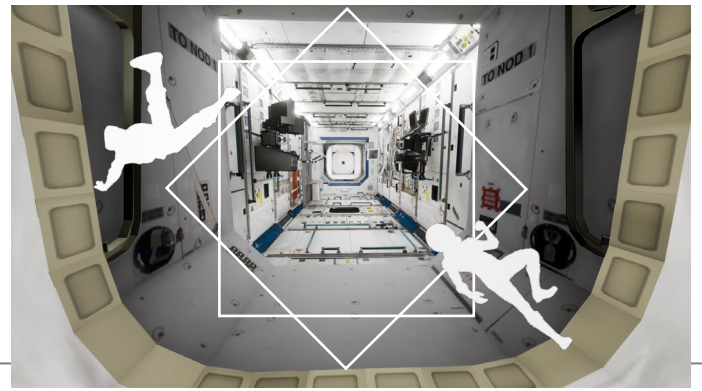
Place Presenter's Zoom Image/Video Here

Overview: Understand spatial performance degradation in **altered environments**: (1) measure the impact of static and dynamic misalignment of idiotropic and visual frame of reference & a lack of spatial cues on spatial abilities; (2) examine mental allocation & spatial strategies to inform design principles for a training method.

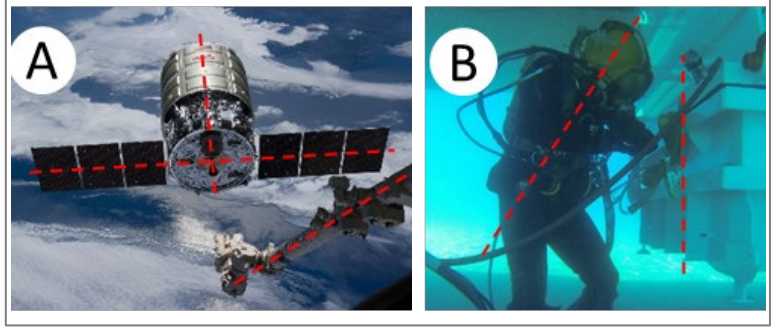
Future Technology: Integrated Virtual Reality, eye-tracking & electroencephalography (EEG) simulation to augment spatial cognitive performance



Future Work: Scientific/military explorations of Poles, Moon/Mars, deep oceans, low earth & lunar orbits: inspection, maintenance & repair with tele-operated robots/in-person; Operate polar/lunar rovers; Aerial reconnaissance using UAVs; Spacecraft rendezvous & docking



Future Workers: High risk workers from a wide array of STEM fields : Polar & marine researchers; Astronauts; Divers; Oil rig workers; Flight engineers/fighter pilots (e.g. Space Force); a broad logistics workforce in extreme conditions (e.g. Moon base/space station)



Project Award 1840131: Enhancing Human Capabilities through Virtual Personal Embodied Assistants in Self-Contained Eyeglasses-Based Augmented Reality (AR) Systems

PI: Henry Fuchs, UNC Chapel Hill, fuchs@cs.unc.edu

Research on an eyeglass-based 3D mobile telepresence system with integrated, situationally aware, virtual personal assistant. 3D reconstruction of the wearer of eyeglasses is done solely from cameras on the eyeglass frames and from ordinary motion sensors on arms and legs -- in future: watch, wristband, shoes. Application scenarios: 1) Physical Therapy exercises 2) Early return to work of burn survivors.

Future Technology:

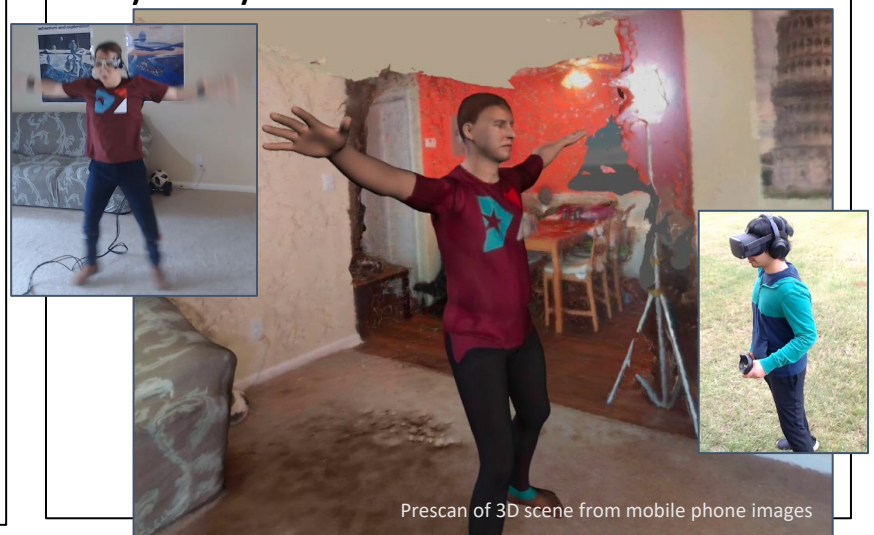
AR glasses with many cameras

UNC 2020
3 cameras

XIMMERSE & UNC 2021
6 (or 10) cameras

2025?
20? cameras

Future Work: Remote Physical Therapy
Next: Virtual Assistant will coach between sessions. No room cameras, only body-worn cameras & IMUs.



Prescan of 3D scene from mobile phone images

Future Workers: Early return to work from accident, illness, quarantine, and other remote workers.

#1839974 FW-HTF: Collaborative Research: Enhancing Human Capabilities through Virtual Personal Embodied Assistants in Self-Contained Eyeglasses-Based Augmented Reality (AR) Systems

PI(s): Gordon Wetzstein & Jeremy Bailenson, Stanford,
gordon.wetzstein@stanford.edu

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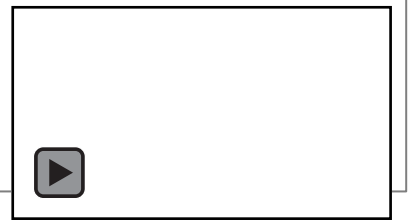
- Idea: to develop and evaluate new AR display and systems technology to enhance remote work and collaboration
- Goals: improve visual comfort and perceptual realism in AR systems; enhance collaborative work

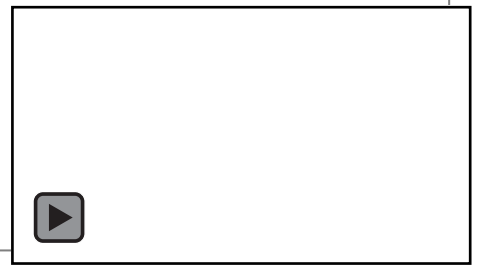
Progress on Future Technology:

- Gaze-contingent stereo rendering for enhanced depth perception (SIGGRAPH & SIGGRAPH Asia 2020)
- Event-based eye tracking beyond 10,000 Hz (arxiv)
- Occlusion-capable See-through AR Display (IEEE TVCG 2020)
- State-of-the-art holographic near-eye display technology (SIGGRAPH Asia 2020)



Progress on Future Work:

- Developed easy-to-use pipeline for 3D telepresence (Bailenson/Fuchs/Wetzstein, PRESENCE 2020)



Progress addressing Future Workers:

- Started to evaluate these systems with real users!
- ~20 users tested in the lab with eye tracking and gaze-contingent rendering systems; many statistically significant results
- Spun out startup (SBIR funded) developing 2019 AutoFocals project – system development and user testing in progress
- COVID challenge

2026478 FW-HTF-RM: Human-Robot Collaboration for Manual Work

Robert Radwin, Bilge Mutlu, Jingshan Li, Lindsay Jacobs, & Timothy Smeeding, University of Wisconsin-Madison, rradwin@wisc.edu

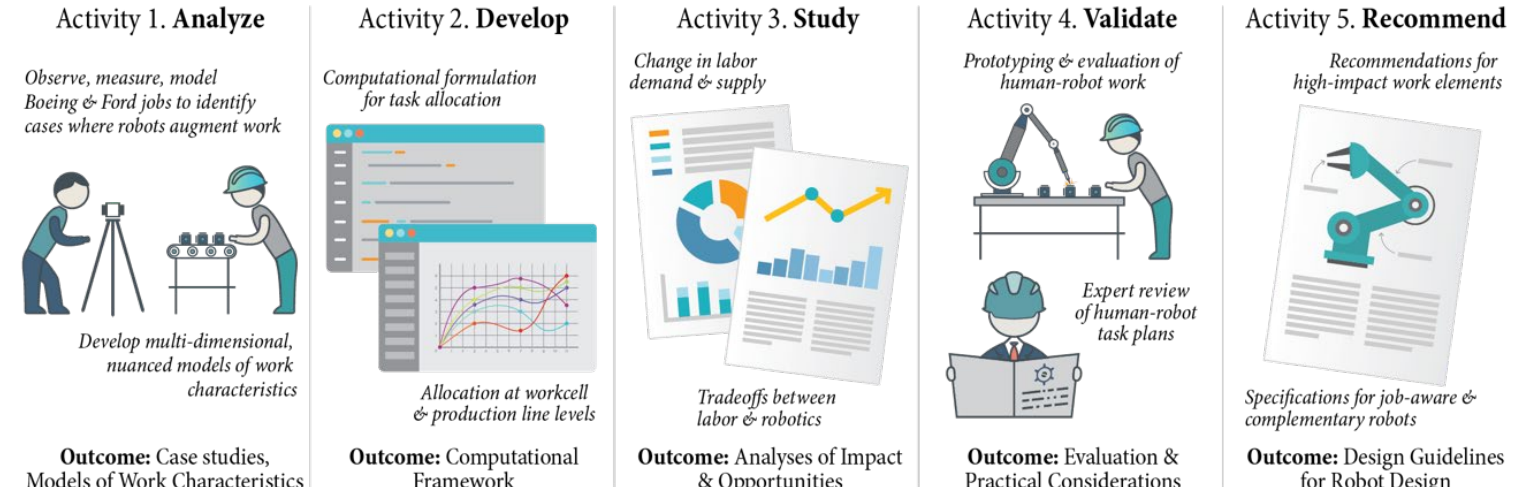
Place Presenter's Zoom Image/Video Here

We are developing principles and tools for enabling collaborative robots to augment human capacities to do manual work, that otherwise would be inefficient, unhealthy, unsafe, and even impossible, and to do it better than either alone

Future work: Rather replicating human capabilities, robotics development should focus on building competences that are complementary to uniquely human capabilities

*Future technology: D*esign for enhancing, rather than replicating capabilities, to expand work opportunities, through less "wear and tear," and for employing older and less physically able populations

Future workers: We seek to connect the design principles behind technological advancements with ensuing macroeconomic and societal shifts, and to design robots with those shifts in mind



1928718 Collaborative Research: FW-HTF-RM: Intelligent Facilitation for Teams of the Future via Longitudinal Sensing in Context

Sidney D'Mello U Colorado (Sidney.dmello@colorado.edu)
Stephan Mandt, Gloria Mark UC Irvine (mandt, gmark@uci.edu)
Aaron Striegel Notre Dame (striegel@nd.edu)

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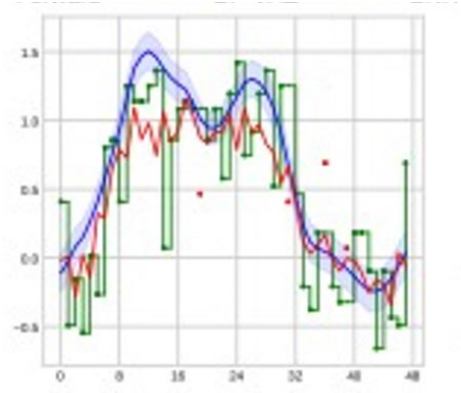
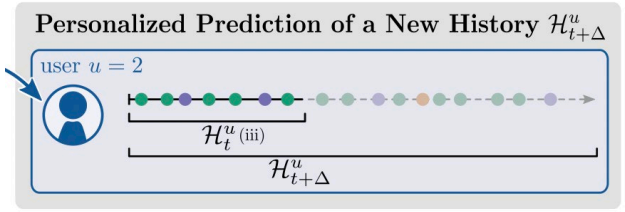
Using sensors and EMAs to understand team behavior, we will develop and validate an intelligent (AI-based) team facilitator utilizing sensing and dynamic intervention to promote better team coordination, cohesion, higher performance, and lower burnout.

Future Technology



Time series imputation



Personalized event forecasting

Future Work

Predictors	*std. Beta*	*p*	*Obs*
	Productivity		
Duration low stress (sec)	-0.00	0.812	1861
Duration high stress (sec)	-0.04	**0.041**	
	Cohesion		
	std. Beta	*p*	
Duration low stress (sec)	0.01	0.774	1131
Duration high stress (sec)	-0.02	0.539	
	Communication		
	std. Beta	*p*	
Duration low stress (sec)	0.01	0.543	1125
Duration high stress (sec)	-0.05	**0.025**	
	Coordination		
	std. Beta	*p*	
Duration low stress (sec)	0.07	**0.009**	1111
Duration high stress (sec)	-0.01	0.727	
	Conflict		
	std. Beta	*p*	
Duration low stress (sec)	-0.02	0.476	1101
Duration high stress (sec)	-0.03	0.194	
	Climate		
	std. Beta	*p*	
Duration low stress (sec)	0.03	0.128	1115
Duration high stress (sec)	-0.04	0.088	

Future Workers

Themes from interview data:

Diversity is broad (e.g. knowledge, home responsibilities, background, personality); promotes cohesion, performance

Adaptation to members' different chronotype patterns: work life balance, flexible scheduling, requires higher communication

Communication more formal, explicit

Scheduling involves extra effort

Team leaders manage stress, empathy

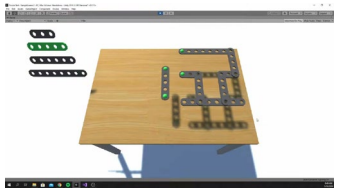
Cohesion helped teams make transitions

#1928502 FW-HTF-P: Optimizing Long-term Human Performance in Future Work.

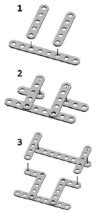
Benjamin A. Clegg[1], *Francisco R. Ortega*[1], *Matthew G. Rhodes*[1], *Anne M. Cleary*[1], *Eric D. Heggestad*[2].
[1] Colorado State University [2] University of North Carolina - Charlotte

Our research aims to examine how to optimize support to an individual learning a task, like assembly of an item from components, to maximize training outcomes. Emerging approaches like augmented reality have the potential to persuasively guide learners in an immersive fashion, but at the risk of impoverished learning.

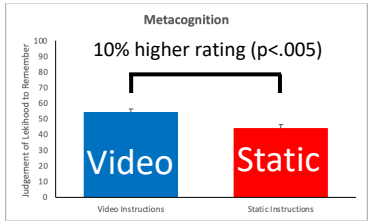
Completed: People think they learn more from Virtual Reality (VR) environment generated instructions, but they do not learn more. (n = 130)



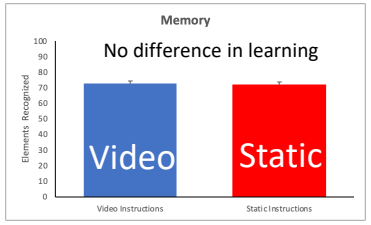
Video from VR



Static diagram

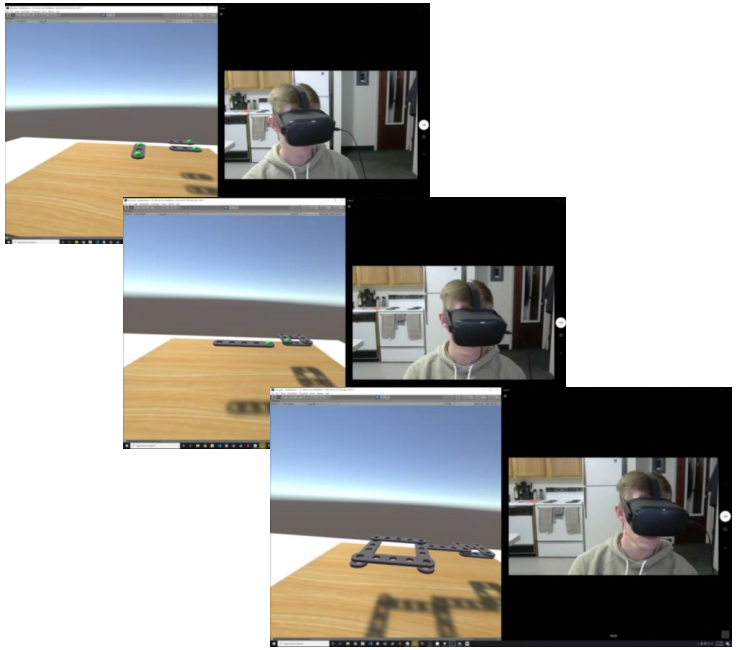


What you think

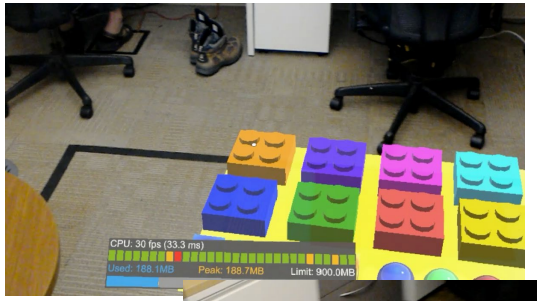


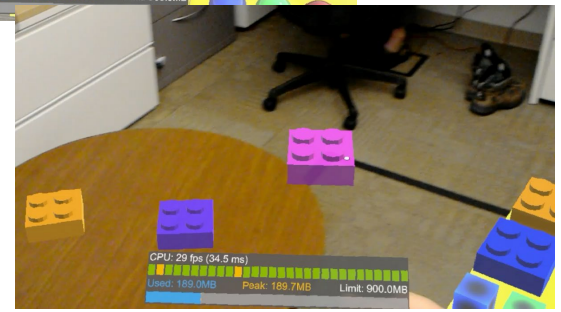
What you learn

Can training workers assembly tasks in a virtual reality environment make a difference?



Next step: Can we optimize future work through learning with real objects and augmented reality support?





#1928550 FW-HTF-P: Wearable Adaptive Cognitive Assistance to Auditory Situational Awareness for Workers Exposed to Complex and Dynamic Noises

PI: Tuyen (Robert) Le, Clemson University, tuyenl@clemson.edu

Place Presenter's Zoom Image/Video Here

- ***Idea:*** *AI-based sound filtering solution for hearing protector capable of bypassing safety-critical sounds*
- ***Goal:*** *Develop a full FW-HTF research proposal*
- ***Objectives:*** *Understand design constraints, refine research questions, explore technical approaches through field visits, workshops, preliminary data collection*

Future Technology

- Identified research gap on *risk-based sound suppression*
- Preliminary dataset of ~ 5 hours of construction sounds
- Identified and preliminarily *tested state-of-the-art deep learning methods*

Future Workers

- Identified research need on construction *workers' safety behavior* in human-AI system for auditory cognition
- Designed virtual environment-based experiments and evaluation

Future Work

- Research gap on socioeconomic modelling of the *adoption of safety and health hearable devices*
- Identified data sources, and statistical analysis approach