Analysis of Lifting Activity to Facilitate Creation of AI Approaches that Recognize Worker Safety and Independence

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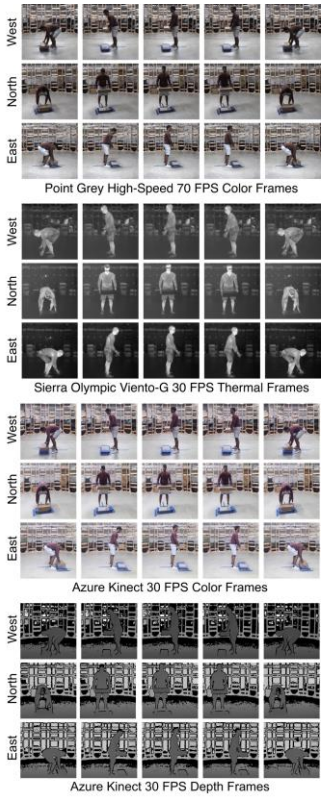
FW-HTF-P: Investigating Acceptability in the Workforce of Collaborative Robots that Provide and Request Assistance on an As-Needed Basis
Award #2026559, Co-PIs: Zhaleh Semnani-Azad, Todd Perry, Collaborator: Sean Banerjee

Goal: AI that enables robotic assistants to perform data-driven detection of when workers need help during lift, and to provide desired type of assistance.

- Lifting injuries accounted for 9.8% of occupational injuries in 2019[1].
- Lost time due to injuries impacts women and older workers[2].
- Fear of robotic replacements is prevalent in individuals with lower education[3], blue- and white-collar workers in manufacturing[4,5], and females and individuals of color[3].
- **Hypothesis:** Robotic assistants more likely to be trusted and accepted if they simultaneously ensure physical safety and preserve independence.

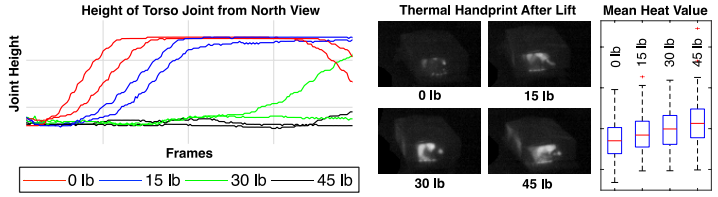
Multimodal Study of Lift Performance for Future Technology on AI-Driven Detection of Assistance Need

- Multi-viewpoint multi-modal data collected from 24 subjects performing 40 randomized lifts with identical packages weighing 0, 15, 30, and 45 lb.
- Subjects interact on a non-blind day when subjects are pre-informed of weights and a blind day when subjects lack prior weight knowledge.
- Data recorded includes subject ratings of effort on scale of 1 to 5, and pre- and post-guess of weight lifted on blind day.



Findings from Multimodal Study

- Correlation of 0.809 and 0.804 between effort and actual weight on blind and non-blind day. 94.4% accuracy of subjects correctly guessing weight.
- 71 / 77% and 77 / 81% accuracy using convolutional networks on joint time series / thermal handprint after lift for binary weight and effort detection.



- Findings inform continued research on fusing multimodal multi-viewpoint data to provide person-aware detection of need for assistance for improved inclusivity and awareness of worker safety and independence.

Large-Scale Questionnaire-Based Survey of 100+ Workers and Managers on Perception of Need-Aware Robotics in Future Work Environments

- Contacts have been established with nearly 20 companies in retail, automotive sector, warehousing, and transportation. Planned survey will have following sample questions:

Access and Inclusivity

How often do you feel that you encounter barriers to performing your task in your occupation?
a. Never
b. Rarely
c. Sometimes
d. Often
e. All the time

What is the nature of these barriers (select all that apply)?
a. Physical, e.g., I do not feel that I have enough physical help to be safe or to carry out my tasks
b. Social, e.g., I do not feel that I belong to a team
c. Psychological, e.g., I feel stressed out by the nature of my work or by the lack of safety

Contribution of Robotics toward Physical Safety and Independence

If a robot intervened all the time / helped only when you need its help, would you feel that
a. The robot ensures I do not have lifting-related injuries
b. The robot ensures I do not have lifting-related injuries, but I worry that the robot would injure me
c. The robot does not care whether or not I have a lifting-related injury

If a robot intervened all the time / helped only when you need its help, would you feel that
a. The robot respects my independence
b. The robot does not respect my independence

If a robot intervened all the time / helped only when you need its help, would you feel your job is at stake?
a. Not at all
b. Somewhat
c. Absolutely

Interpersonal Collaboration

Do you (or would you) feel comfortable receiving assistance from a co-worker during lifting operations?
a. Very comfortable
b. Comfortable
c. Somewhat comfortable
d. Not comfortable

When you require assistance from a co-worker in lifting, how do you (or would you) expect to receive it?
a. I prefer to let my co-worker know that I need assistance
b. I prefer that my co-worker figure out that I need assistance
c. It depends on the package I am carrying and how I feel at the time
d. Not applicable, as I work on my own

When receiving assistance from a co-worker in lifting, what form of interaction do you (or would you) prefer (select all that apply)
a. I prefer that my co-worker and I work together
b. I prefer that my co-worker intervene and take over the lifting task
c. It depends on the package I am carrying and how I feel at the time
d. Not applicable, as I work on my own

Concerns of Data Privacy

If your video / audio data is recorded, how concerned are you about privacy issues?
a. Very concerned
b. Somewhat concerned
c. Not concerned

- Enables evaluation of robotic trust dependent on dimensions of physical safety, independence, job security, and ethics of data privacy.

Broader Impacts

- Work has supported rural Upstate New York students, first generation college goers, students of color, and a female non-traditional student.

References

1 U.S. Bureau of Labor Statistics (2019). https://stats.bls.gov/.
2. King et al. (2009). Work-related musculoskeletal disorders and injuries: differences among older and younger occupational and physical therapists. J. Occupational Rehabilitation, 19, 274–283.
3. McClure (2018). "You're Fired," says the robot: The rise of automation in the workplace, technophobes, and fears of unemployment. Social Science Computer Review, 36(2),139–156.
4. Dekker et al. (2017). Fear of robots at work: the role of economic self-interest. Socio-Economic Review, 15(3), 539–562.
5. Smith and Anderson (2014). AI, robotics, and the future of jobs. Pew Research Center, 6.

Expanding Rural Ceramics Craft and Computational Fabrication: A Synergy, Award Number: 2026218

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Bring together ceramic craft, rural entrepreneurship, & computational fabrication

Develop new technologies + new opportunities for rural craftspeople

Interviews with master craftspeople

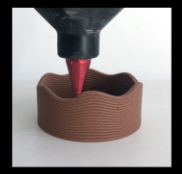
13 ceramic artists, in studio or home
Diverse backgrounds, practices, outlooks
3 indigenous artists
9 from rural areas
7 craft practice is primary source of income

Ceramics practice: materials, tools, processes, community and cultural context

Attitudes toward technology: use in current practice, concerns and fears, curiosity and excitement

Business practice: ability to make a living, technologies or training that could be beneficial, values driving business

New fabrication technologies



Technologies and Techniques
Clay 3D printers
Robot arms
Laser cutters
Other existing fabrication machines
Custom software

Ceramics Medium
Materials are not abstract-able
Unique material properties of clay
Plasticity, temporality, variety
Importance of scale
New fabrication approaches: work with tool-paths rather than geometries
Cultural history and significance

Residencies as new HCI research paradigm

Co-design residencies begin summer 2022

We need these partners
Rich development requires material expertise
Mastery impossible in short-medium time period

Anticipated benefits and opportunities
Unique opportunity for researchers to develop and leverage outside expertise

Engage people from diverse backgrounds in the development process, over months as essential collaborators

Mutually beneficial

A way to connect technology research to real world creative and business practices

#2128970 FW-HTF-R: Collaborative Research: Worker-AI Teaming to Enable ADHD Workforce Participation in the Construction Industry of Future

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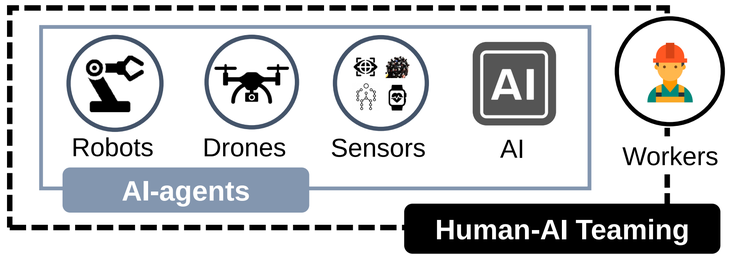
INTRODUCTION

Future Inclusive Safe Construction Sites

- AI-agents will take over construction tasks on future construction sites. Workers will be still in the loop to **build a team with AI-agents** on future jobsites.



ADHD vs Non-ADHD

- **4.2% of workers had ADHD**, resulting in 120 million days of annual lost work in the U.S.

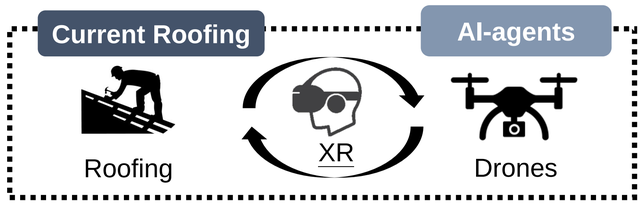
To achieve the safe, inclusive construction site of the future, AI systems must be able to understand, track and predict all types of workers' behavior.

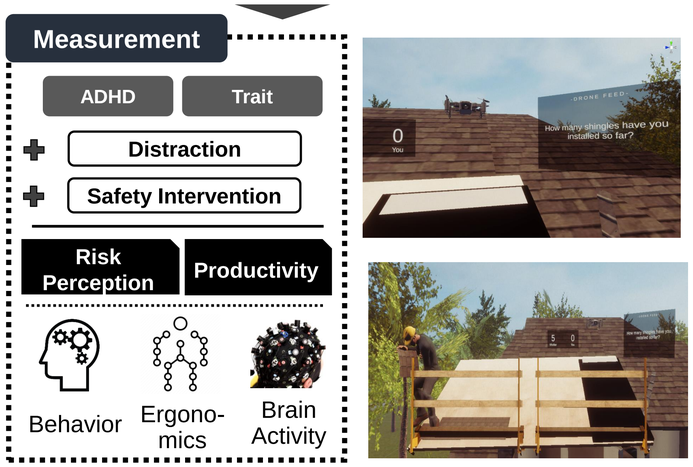
RESEARCH METHODOLOGY

Roofing Experiment

Q1 How will the **incorporation** of automation into the **current roofing** affect workers' safety behaviors and productivity?

Q2 How **safety interventions** affect workers' compensatory and overreliance behavior?

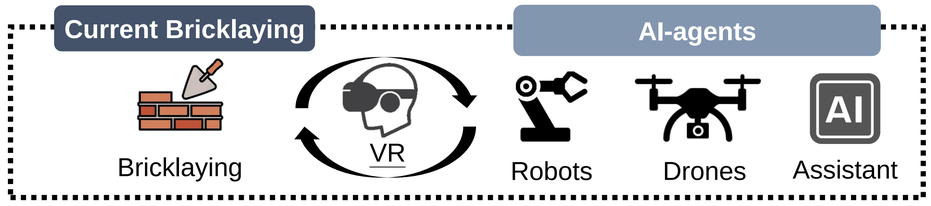




Bricklaying Experiment

Q1 How will the **teaming** with AI-agents during doing **future bricklaying** task affect ADHD workers' skill acquisition?

Q2 How does **workload, time pressure, and sudden noise** cause a distinct influence on safety performance of ADHD/ non-ADHD workers?



POINT OF DEPARTURE

- This research aims to **translate noninvasive biomechanical and psychophysiological metrics into data our AI system** that can ***assess***, ***model***, **and** ***leverage*** to predict and improve ADHD/non-ADHD construction workers' safety behaviors ***without*** **cultivating technological over-reliance or threats to privacy**

EXPECTED CONTRIBUTIONS

- Define the specific **conditions** that ADHD workers will execute more **risk-taking behaviors**.
- Understand the **interaction dynamics** between ADHD workers and AI-agents on future construction sites.

Foundational proof of concept for broadly distributing AI teammates in construction workplaces to support employment opportunities and safety outcomes for construction workers with varying abilities.

MERITS & BROADER IMPACTS

- A **feedback loop** for training personalized AIs to improve human-machine interactions.
- Understanding the **socioeconomic impacts** of a diverse construction workforce and Understanding **negative impacts** of adaptive AI-agents and wearable technologies.
- Enable **participation** and facilitate **inclusive construction** for workers with **neurodiversity** in the construction industry and beyond.

NSF FW-HTF DUE 1928711: Robotic Health Assistants: A New Human-Machine Partnership in Home Healthcare

PI(s): Weihua Sheng, Alex Bishop, Oklahoma State University
Barbara Carlson, University of Oklahoma Health Science Center
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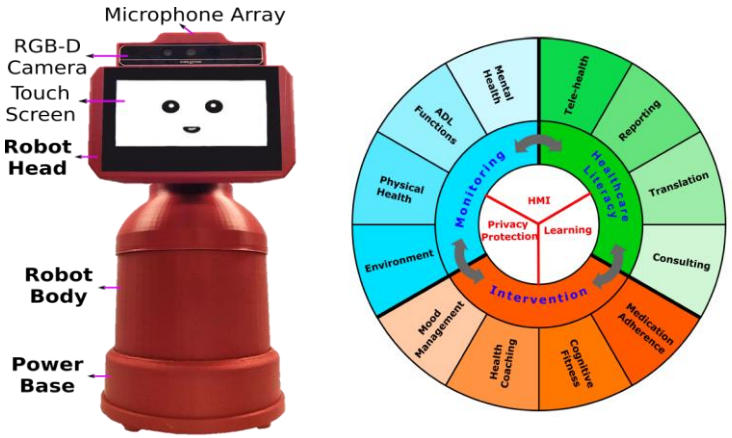
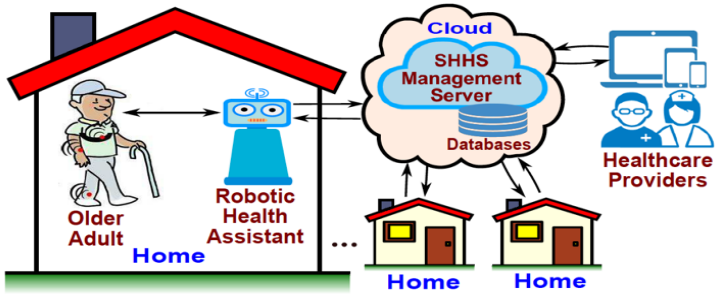
The **long-term goal** of this project is **to empower home healthcare providers to achieve high productivity and quality of work life** by developing a robotic health assistant (RoHA)-based smart home healthcare system (SHHS). The **objectives** of this planning project are two-folds: 1) building the research team and fostering collaboration with industry partners and stakeholders to develop the research concept of a Robotic Health Assistant (RoHA)-based Smart Home Healthcare System (SHHS); 2) conducting preliminary study and test of this new concept.

This project develops innovative robotics and artificial intelligence (AI) technologies to augment the productivity and quality of work life of home healthcare workers.
Fundamental research problems include:
Human Machine Interface; Robot Learning; Privacy Protection.



This project will deepen our understanding of the impact of AI on caregivers and uncover ways to help them adapt to this new work model. RoHA-base SHHS will assist healthcare professionals through the following core functions:
Health Monitoring; Healthcare Delivery and Healthcare Literacy.



This project will nurture a new generation of caregivers (particularly CNAs) who will embrace the inevitable transformation of the home healthcare industry.
A virtual workshop was conducted on to introduce the local healthcare community to the RoHA and its potential use in home healthcare. Over 40 healthcare professionals attended the workshop. For details please visit **https://rhassistants.wixsite.com/nsfworkshop**

Robotic Health Assistants: A New Human-Machine Partnership in Home Healthcare