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
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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.

No assistance with light package

Assistance with heavy package

Multimodal Study of Lift Performance for Future Technology on AI-Driven Detection of Assistance Need
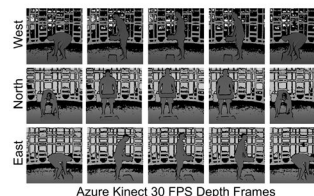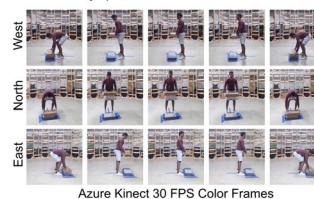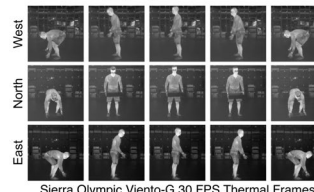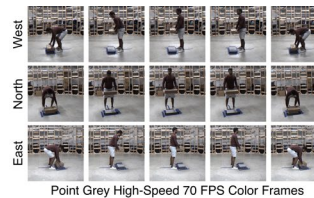- Multi-viewpoint multi-modal data collected from 24 subjects performing 40 randomized lifts with identical packages weighing 0, 15, 30, and 45 lb.
- Subjects interact on a non-blind day when subjects are pre-informed of weights and a blind day when subjects lack prior weight knowledge.
- Data recorded 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 (Currently Under Review)
- 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.

Height of Torso Joint from North View

Mean Heat Value

0 lb   15 lb   30 lb   45 lb

lb   45 lb
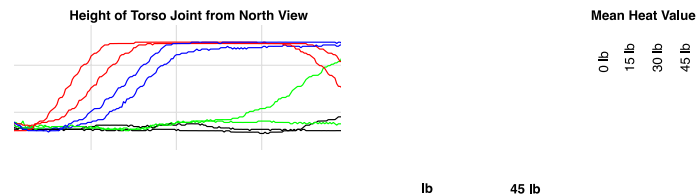
- Findings inform continued research on fusing multimodal multi-viewpoint data to provide person-aware detection of need for assistance for improved inclusivity and awareness of worker safety and independence.

West / North / East
Point Grey High-Speed 70 FPS Color Frames

West / North / East
Sierra Olympic Viento-G 30 FPS Thermal Frames

West / North / East
Azure Kinect 30 FPS Color Frames

West / North / East
Azure Kinect 30 FPS Depth Frames

Large-Scale Questionnaire-Based Survey of Workers and Managers on Perception of Need-Aware Robotics in Future Work Environments
- Responses acquired from 424 workers (265 male, 148 female, 11 prefer not to mention)
- 94 surveys acquired from USA, 152 from Canada, 146 from UK, and 32 from Australia
- Manager surveys are currently under way
- Following is a sampling of questions assessed in the survey:

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

- Currently evaluating collected data to understand 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.

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References
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5. Smith and Anderson (2014). AI, robotics, and the future of jobs. Pew Research Center, 6.