Objective Develop **transparent** and **intuitive** teleoperation interfaces to control nursing robots to perform nursing assistance tasks involving **dexterous manipulation**, **loco-manipulation** and **human-robot interaction** tasks; Evaluate the technological and social impacts on healthcare workers of diverse age and gender.

Significance Tele-Nursing Robots for **pandemic response** (Ebola, Zika, COVID-19); Benefit 2.9 million US **registered nurses and nursing practitioners**; Support in-home care, clinics, and hospitals given the **shortage of nursing workers**; Prepare healthcare workers for the future of work through **fusion of nursing and engineering education**.

Forces and Discrete Events

Arm/Hand Configuration

- Haptic Soft Force Feedback
- Vibrotactile Event Feedback
- Integrated Motion Tracking
- Muscle Effort Monitoring

- Force Measurement
- Manipulation
- Locomotion
- Active Telepresence Cameras

Jane Li **Cagdas Onal** **Jie Fu** **Jeanine Skorinko** **Yunus Telliel** **Paula Bylaska-Davies**

Robotics Engineering 🛡️**WPI** **Social Science** **WSU** **Nursing Department**

Note: Prof Jie Fu was affiliated with Robotics Engineering Department of Worcester Polytechnic Institute until 2021/08. She recently joined the Electrical and Computer Engineering Department of University of Florida. She is continuing working on this project through subaward.

PI: Zhi Jane Li[1] (zli11@wpi.edu), **Cagdas Onal**[1], **Jie Fu**[1], **Jeanine Skorinko**[2], **Yunus Telliel**[2], **Paula Bylaska-Davies**[3] .

80% Duty Cycle

TELEOPERATING

GOOD TO STACK
Height
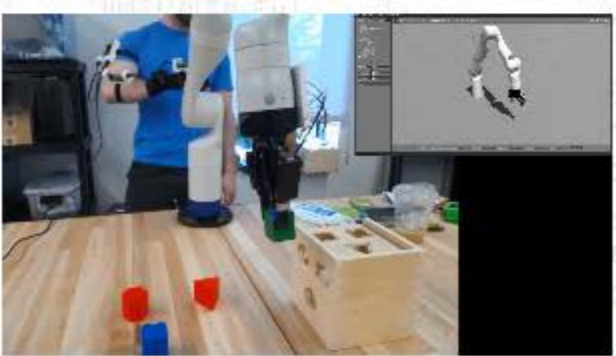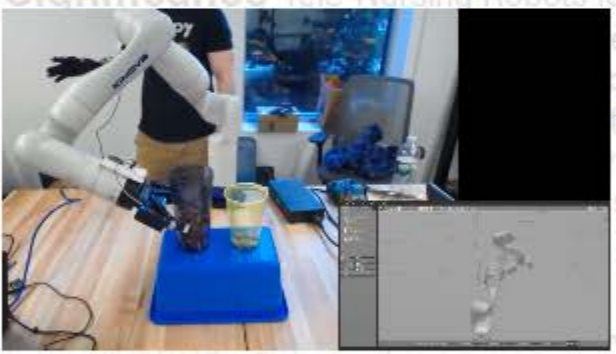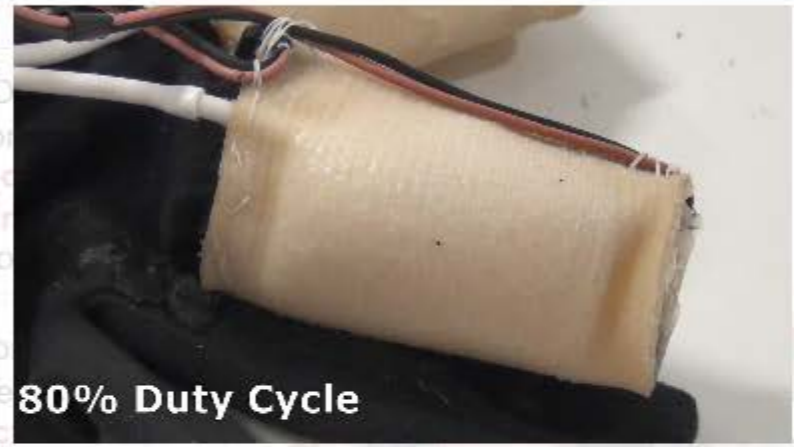
Haptic Cues

AR Visual Cues

Target Locator
Distance — Far — Close
Vibration

Constraint Alert
One-Shot Vibration

Grasp Affordance
Stop Vibrating

Grasp Confirmation
One-Shot Vibration

55% Duty Cycle

FSR

Tendon-driven finger with haptic muscle

Force on load cell

Load Cell

Research Seminar and Interactive Demonstration with Nursing Faculty and Students at WSU

WPI **WORCESTER STATE UNIVERSITY** Worcester Polytechnic Institute ([1] Robotics Engineering Department, [2] Social Science Department), [3] Worcester State University (Nursing Department)
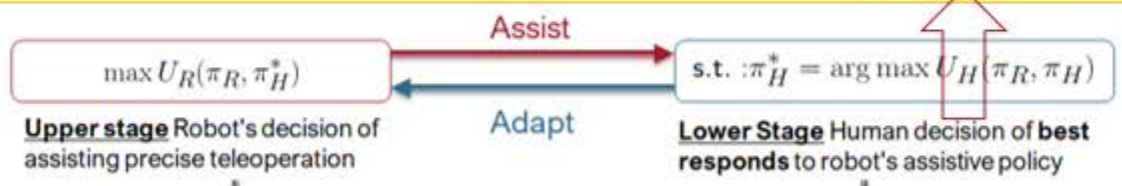
NSF Award #2024689 "Collaborative Research: NRI: INT: Transparent and Intuitive Teleoperation Interfaces for the Future Nursing Robots and Workers", 2020/09/01-2023/08/31. Funded by NSF NRI and NIOSH

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Nursing students interact with the robotic arm

$$\max U_R(\pi_R, \pi_H^*)$$

Assist → ← Adapt

$$\text{s.t.} : \pi_H^* = \arg\max U_H(\pi_R, \pi_H)$$

Upper stage Robot's decision of assisting precise teleoperation

Lower Stage Human decision of **best responds** to robot's assistive policy

New Nursing Robot under Development

Stackelberg game 1) **Deterministic** robot policy for predictability and fast adaptation; 2) **Balancing** task performance and human/robot's costs.

Evaluation 1) **Technological impacts** Testing the usability of the soft haptic glove to control general-purpose dexterous manipulation motor skills; Conducting user studies to understand the performance, workload, learning efforts of visuo-haptic sensory feedback, and user preference of sensory integration; 2) **Social impacts** Pilot interview registered nurses and nursing faculty to understand their perception of tele-nursing robots, experience with tele-nursing interface prototypes; understand their preferred interface design features.

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