PhyRC: **Phy**sical **R**obotic **C**aregiving Challenge: Proposal for an ICRA 2025 Competition

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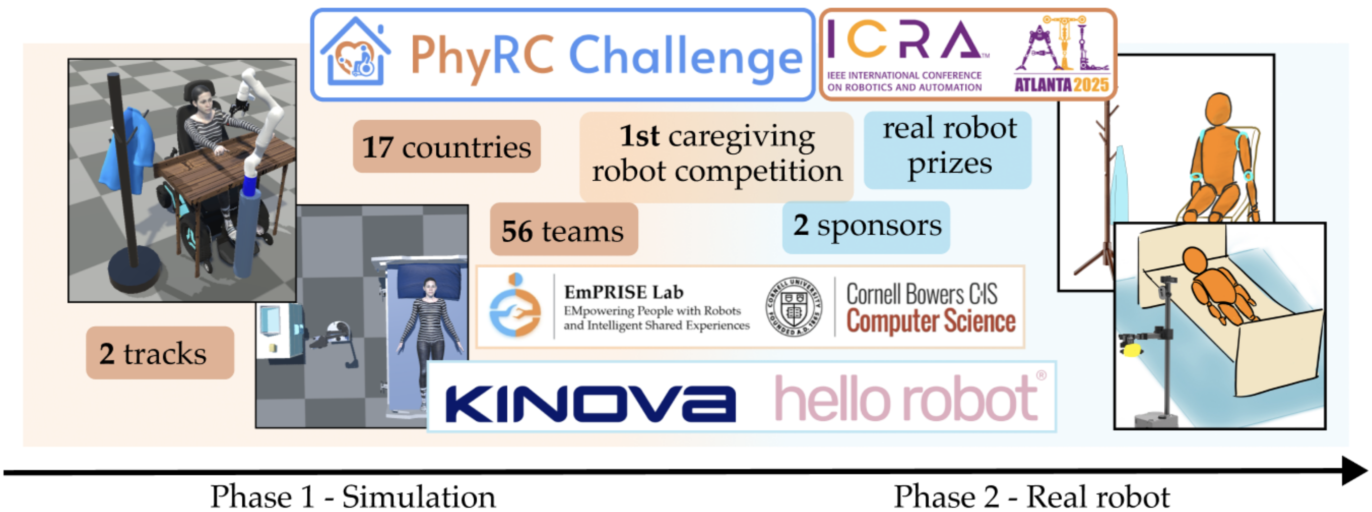

Fig. 1: **PhyRC**:We propose to host the **PhyRC** (**Phy**sical **R**obotic **C**aregiving) Challenge at ICRA 2025. The competition features two real-world tasks: (1) robot-assisted dressing; and (2) robot-assisted bed bathing. The competition has two phases. Phase 1 (simulation) is already ongoing; there are 56 teams from 17 countries signed up. We propose to host Phase 2 (real robot) at ICRA. Kinova and Hello Robot have generously sponsored real-robot prizes for the winners of Phase 2. To the best of our knowledge, PhyRC is the first ever competition for caregiving robots.

I. Why this competition and why now?

Millions of people worldwide require physical assistance with daily tasks, and with an aging population, this number is rising [1]. Caregiving robots have the potential to increase care recipient independence and reduce caregiver workload [2]–[8]. Despite considerable recent progress in the caregiving robotics field, it remains challenging to assess the state of the art, compare different approaches, and organize efforts around pressing open research questions. Simulation platforms such as RCareWorld [9] and Assistive Gym [10] make significant strides, but the need for real-world standardization remains.

Real-world competitions are a proven way to measure and accelerate progress in emerging fields. For example, the Amazon Picking Challenge [11] has driven significant advancements in robotic manipulation, while the DARPA Robotics Challenge [12] played an important role in developing robots capable of assisting humans in disaster scenarios. Taking inspiration from these and other successes, we propose a new real-world competition for the field of caregiving robotics.

In particular, we propose to host the **PhyRC** (**Phy**sical **R**obotic **C**aregiving) Challenge at ICRA 2025 (Fig. 1). To the best of our knowledge, PhyRC would be the **first ever competition for caregiving robots**. Our competition will feature two real-world tasks: (1) robot-assisted dressing; and (2) robot-assisted bed bathing. Dressing and bathing are both crucial activities of daily living (ADLs) that are also very challenging for state-of-the-art robotics, requiring deformable object manipulation, physical human-robot interaction, long-horizon planning, and reasoning under partial observability.

We expect strong participation if the competition is accepted. A preliminary simulation-only phase of the competition is already underway with **56 teams** participating. We will select the top teams from this phase to proceed to the real-world competition. We also have secured **generous sponsorship** from Kinova and Hello Robot: for example, winners will receive a real Kinova Gen3 7-DoF robot and a Stretch 3 robot as prizes (see Section III). Given this level of interest, we expect the competition to have **high impact** in the caregiving robot community and beyond.

In the remainder of this proposal, we describe logistics, rules, and other competition details. **See also our website** at https://emprise.cs.cornell.edu/rcareworld/challenge/.

II. Competition Summary

The PhyRC competition will have two tracks:

Track 1: Fixed-base Manipulation for Assisted Dressing.
Track 2: Mobile Manipulation for Assisted Bed Bathing.

Teams may participate in one or both tracks. The dressing and bathing tasks are described in detail in Section VII. The competition is also divided into two phases:

Phase 1: Simulation (already underway).
Phase 2: Real World (proposed for ICRA 2025).

Top teams from Phase 1 will be invited to proceed to Phase 2. These teams will bring their own real robots to the competition and compete in an environment arranged by the organizers.

III. Sponsors and Awards

The competition will be sponsored by Kinova and Hello Robot, who have agreed to provide the following support:

- **Prizes**: The winning team of Track 1 will receive a Kinova Gen3 7-DoF robot. The winning team of Track 2 will receive a Hello Robot Stretch 3 robot.
- **Shipping**: Kinova will reimburse up to 5 teams for real robot shipping costs (including international shipping).
- **Setup**: At the competition, Kinova will help set up the environment, including robots, sensors, and furniture such as the hospital bed and the table.
- **Marketing**: Kinova and Hello Robot will help advertise the competition.
- **Discounted Robot and Extra Hardware**: Kinova will potentially provide discounted robots to teams that want to participate with Kinova Gen3 robots for the competition. Hello Robot will potentially have 1 or 2 extra robots at the venue for the participants to use.

We thank the sponsors for their generous support.

IV. Requested Facility Support

To facilitate the competition, we request the following:

- **Utilities**: We would need tables, chairs, sockets for power supply, extension cords, power strips, tape, and white paper. We would also make use of a printing service at the venue if one is available.
- **Arena Size**: Ideally, we would have access to an arena that is at least 5m×4m for Track 1 and 5m×6m for Track 2. We also need a staging area for the participants which is roughly 5m×4m. Combined together, the area would be 70 square meters, but we are happy to negotiate the space requirements if there are hard space constraints at the venue. A ceiling higher than 3 meters would be sufficient.
- **Monitors or Projectors**: We would like participants to be able to present their work. Standing monitors at the arena or access to a room with a project or large screen would help make this possible.
- **Internet**: We would bring our own router but request a network jack to set up a WiFi environment.
- **Advertisement**: We would appreciate social media advertising support from the conference (optional).

V. Competition Timeline

Phase 1 of PhyRC commenced on August 10, 2024 and will continue until December 1, 2024. The top teams that proceed to Phase 2 will have over 5 months to prepare for the onsite competition. At the competition, teams will have three days to practice. The final competition will last for another three days. Winning teams will give a short presentation at the end of the competition. The full proposed schedule for the ICRA 2025 competition is as follows:

- **Dec 7, 2024 – May 17, 2025**: Phase 2 participants selected. Teams prepare for the real-world competition.
- **May 17 – 19, 2025**: Teams arrive at ICRA and practice in the competition arena.
- **May 20 – 22, 2025**: Teams compete during the conference. Winners give short presentations.

VI. Competition Rules

We now briefly describe rules and regulations for the PhyRC competition. Full guidelines will be distributed to the participants as Phase 1 concludes.

1) Participants are expected to bring their own robots for the competition, with no restrictions on the methods, robots, or sensors they choose to use.
2) Each onsite team should have no more than 5 people.
3) Each team must ensure that one member is responsible for holding the emergency stop or inform the competition organizers beforehand if a volunteer is required for this.
4) A spotter from the competition organizing team will be present to record scores.
5) Competition trials are limited to 20 minutes. Scores will not be recorded after the time limit expires. Participants may retry as many times as possible within the time limit.
6) In the event of technical issues or unforeseen circumstances affecting a robot's performance, participants will be given a limited time to attempt repairs or troubleshoot their systems. If a team is unable to resolve the issue within the allotted time, they may request to continue the competition using a backup robot or equipment, if available. However, no additional time will be provided beyond this contingency period.
7) Conference and competition organizers are not liable for any damage to participants' robots, sensors, or other hardware during the event.
8) Teams are responsible for ensuring that their robots meet safety standards, and the organizers reserve the right to halt any activity if safety concerns arise.

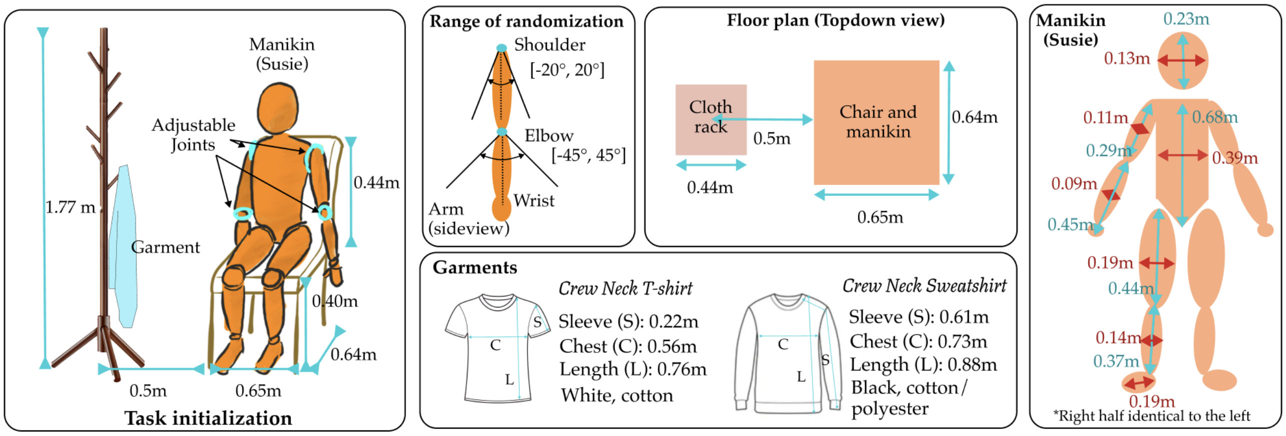

Fig. 2: Track 1 overview: **Task initialization** The task starts with the manikin Susie sitting on a chair, and the garment hanging on the cloth rack. Susie's arms hang down, with the shoulder joints and elbow joints in a randomized configuration. **Range of randomization** We show the range of the randomization of joint rotations for the shoulder and elbow joint. These two joint rotate along 1 axis in this case. **Floor plan** The floor plan from a topdown view. The participants are allowed to place their robots anywhere with their own robot mounts. **Garments** The dimensions and materials of a T-shirt and sweatshirt. We also provide purchase links for the garments. **Manikin (Susie)** The detailed dimensions of the manikin we use for both tasks.

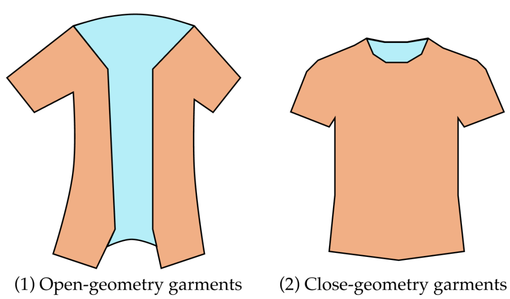

Fig. 3: Open-geometry vs. Close-geometry garments: Open-geometry garments such as hospital gowns and jackets have openings on the front or back, making dressing easier. We focus on close-geometry garments such as t-shirts, which are more challenging.

9) At the conclusion of the competition, participants may be required to give a presentation summarizing their approaches.

VII. Competition Task Details

The PhyRC Challenge features 2 tracks focusing on 2 different caregiving tasks. Track 1 involves **fixed-base manipulation assisted dressing** and Track 2 involves **mobile manipulation assisted bed bathing**. Both tasks are long-horizon and can be divided into multiple subtasks. The tasks will be performed on a manikin Susie [1] (we will provide the manikin). **No humans will be involved** as task participants to simplify IRB and other safety and privacy issues. We will ship all necessary devices to the competition including a manikin, multiple garments, a hospital bed, multiple sponges, and a chair. Later in this document, we provide links and dimensions of all devices so that the participants will be able to set up similar environments before the competition.

A. Track 1: Robot-assisted Dressing

a) Motivation: In robot-assisted dressing, a robot helps a care recipient put on clothing. Previous research has investigated dressing manikins or human with arms hanging in the air [5], [6], [13], but maintaining this pose is challenging for care recipients with mobility limitations. Dressing also remains particularly challenging for closed-geometry garments (t-shirts, sweatshirts) as opposed to open-geometry garments (hospital gowns, jackets); see Fig. 3 for a comparison. We design the dressing task with these open challenges in mind.

b) Task Description: The task requires the robot to dress a manikin with closed-geometry garments. We provide two garments, including a T-shirt[2] and a sweatshirt[3]. The T-shirt is a white T-shirt made of cotton. Its size is Large (L), with a sleeve of 0.22m, a chest of 0.56m, and a length of 0.76m. The sweatshirt (size L) is black and made of polyester and cotton with sleeves, chest, and length of 0.61m, 0.73m, and 0.88m, respectively. The robot needs to put the garment on a manikin sitting on a chair[4]. We illustrate the task in Fig. 2.

c) Initial State: The manikin sits in a chair without arm rests and both arms hang down. The garment hangs on a cloth rack 0.5m next to the chair. Participants can set up the robot anywhere in the scene (using their own mount).

d) Task Variation:

- Garment initial state: The garment is initialized randomly on one of the hooks. We will ensure the garment is hung to the hanger around the neck area.

[1]Simple Susie S206 - Nursing Care Patient Simulator

[2]https://tinyurl.com/t-shirt-phyrc

[3]https://tinyurl.com/sweatshirt-phyrc

[4]https://tinyurl.com/chair-phyrc

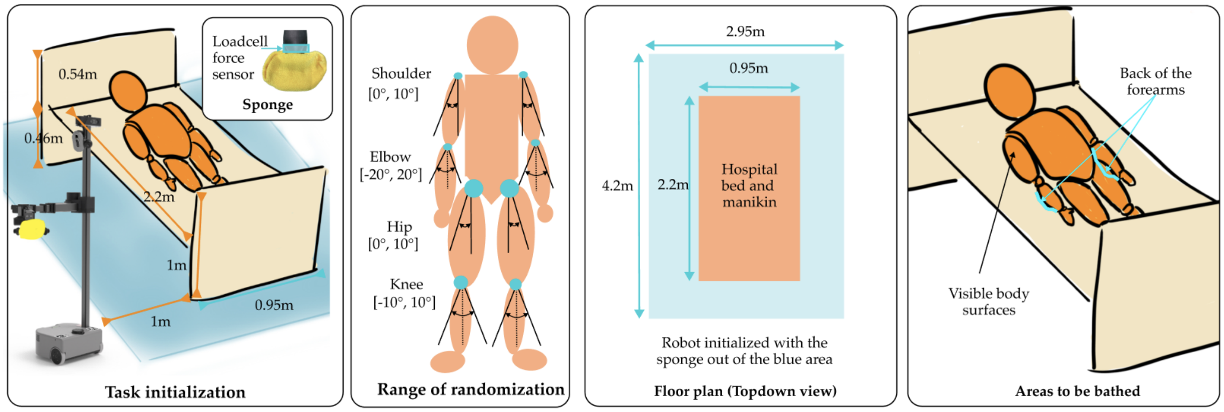

Fig. 4: **Track 2 overview**: **Task initialization** The task starts with the manikin Susie lying on a hospital bed. The robot has the sponge in hand. **Range of randomization** We show the range of the randomization of joint rotations for the shoulder, elbow, hip and knee joints. **Floor plan** The floor plan from a topdown view. The participants are allowed to place their robots anywhere but the sponge needs stay out of the blue box. **Areas to be bathed** The participants need to reach both the visible surface areas and the back of the forearms.

- Human arm state: The manikin's arms hang down naturally, and the joint positions of the shoulder joint and the elbow joints are randomized. Specifically, the shoulder joint can be randomized between $[-20°, 20°]$, and the elbow joint $[-45°, 45°]$.

e) Evaluation Plan: Teams will be awarded points for completing subtasks:

- Pick up the garment (5 pts): This task will be successful if the hospital gown stays in the robot's hand for 3 seconds when the robot's hand is lifting the garment in the air.
- Put one wrist in one sleeve (5 pts): The task will be successful if the manikin's one hand is in a sleeve.
- Put the other wrist in the other sleeve (5 pts): The task will be successful if the manikin's second hand is in the other sleeve.
- Put the head through the neck (5 pts): The task will be successful if the manikin's head is in the neck hole.
- Overall dressing (30 pts): n%8+m%10+ k%12 (n = length covered by the cloth/entire arm length of the first arm, m = same for the second arm, k=same for the body).

We will also take into account the efficiency of completion by dividing the score by the time taken for the entire task. We will evaluate the proposed solution with the two garments, each 3 times and take the average. We will take the average score on the two garments as the total score and select the team with the highest score as the winner of Track 1.

B. Track 2: Robot-assisted Bed Bathing

a) Motivation: In robot-assisted bed bathing, a robot uses a sponge to wash the body of a care recipient who is lying in bed. Previous research has identified limiting contact forces and covering the whole body to be key challenges [7]. While this previous work performs bathing only for the forearm area, we propose a full-body bathing task, which requires the robot to adapt to more diverse body shapes and have the mobility to move around to cover more body surfaces. Also, while the care recipient is lying down on the bed, it is challenging to reach the back of the body; this requires repositioning the body in general. We design the bed bathing task with these open challenges in mind.

b) Task Description: This task involves full-body bed bathing, where there is a manikin lying on the bed, and the robot needs to grab a custom-designed sponge[5] with a load-cell force sensor[6] inside. We will release design files so that the participants can recreate the sponge device. Participants may also request approval to bring their own modified sponge devices. To complete the task, the robot must wipe the visible manikin body surface and as well as underneath the arms. We illustrate the task in Fig. 4.

c) Initial State: The robot has the sponge in hand. The sponge has absorbed a certain amount of ink[7]. The manikin lies in a hospital bed[8]. The participants are allowed to place the robot in any position but the sponge needs to be at least 1 meter from the closest edge of the bed.

d) Task Variation: We will randomize the limb poses of the manikin. Specifically, we will randomize the limb positions of the arm and the legs. The shoulder joint will be randomized between $[0°, 20°]$, the elbow joint between $[-20°, 20°]$, the hip joint $[0°, 10°]$, and the knee joint $[-10°, 10°]$.

e) Evaluation Plan: Teams will be awarded points for completing subtasks:

- Move the sponge to the manikin (5 pts): This task will be successful if the scrubber is in the hand of the robot and in contact with any part of the manikin's body, and the force does not exceed the threshold.

[5]We adapt the sponge from the scrubber design in RABBIT [7] with a load-cell force sensor in it.
[6]https://www.te.com/en/product-20009605-23.html
[7]Green bodypaint ink
[8]Invacare HC Homecare Bed

Fig. 5: A world map with the country or region and the institutes with the participants. The participants from 56 teams come from 17 countries or regions.

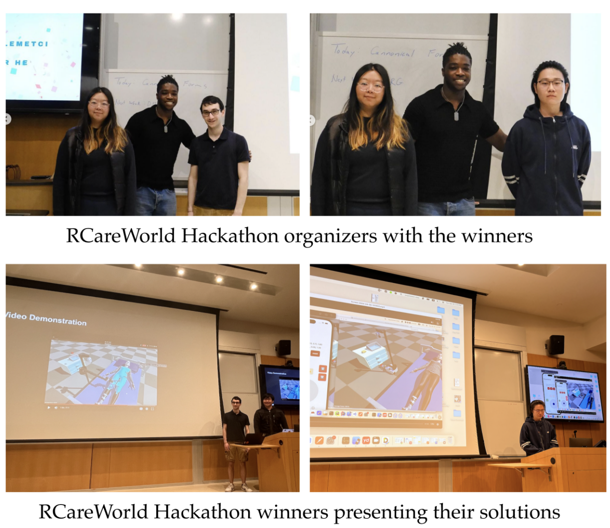

Fig. 6: RCareWorld Hackathon at Cornell

- Perform the full-body bed bathing by sliding the scrubber over the entire visible body part of the manikin (35 pts): Body coverage: n%*10 (n = area covered with water/entire top body), Force threshold: m%*25 (m = timestep of forces within the threshold/entire timesteps when the sponge is in contact with the human).
- Reach the back forearm (initially in contact with the bed): (20 pts) Body coverage: n%*10 (n = area covered with water/entire top body), Force threshold: m%*25 (m = timestep of forces within the threshold/entire timesteps when the sponge is in contact with the human).

We will also consider the efficiency by dividing the score by the time taken for the entire task. We will evaluate the solutions for 3 times and take the average, and select the team with the highest score as the winner of Track 2.

VIII. Potential Risks and Mitigation Strategies

The safety of all participants and attendees is our top priority. To mitigate risks, we will take the following precautions:

- **Use of a Manikin**: To mitigate safety, privacy, and IRB concerns, we will use a manikin instead of a live human subject, eliminating risks associated with human interaction during the competition.
- **Emergency Stop Protocol**: Every robot will be equipped with an emergency stop, and a designated team member will be responsible for activating it whenever the robot is in motion. If a team is unable to provide this person, we will assign someone from our team to oversee the emergency stop function.

- **Secured Competition Area**: The competition will take place in a secured, fenced-off area to ensure the safety of bystanders and participants. Only authorized individuals will be allowed within this area during the competition.
- **Clear Signage and Warnings**: Proper signage will be placed around the competition area, clearly indicating restricted zones and providing safety warnings.
- **Backup Equipment**: We will prepare multiple backup instrumented sponges in case one is damaged. Though the risk of damaging the manikin is low, we will also provide a backup manikin[9] just in case.

IX. History of the Competition

This competition would be the first of its kind. The closest related event is Cybathlon [14], which focuses on the development of assistive devices such as exoskeletons and brain-computer interfaces. Cybathlon hosts competitions for participants who use those assistive devices, e.g., track races for people with prosthetic legs. We share the broad mission of Cybathlon—to empower people with physical disabilities through technological advancement—but differ in our focus on caregiving robots.

In an effort to build towards the final PhyRC challenge, we have organized two related efforts: a hackathon and a simulation phase. We briefly describe these below.

A. RCareWorld Hackathon at Cornell

In preparation for the PhyRC competition, we hosted a RCareWorld Hackathon at Cornell in April 2024[10] in collaboration with Cornell Big Red APDI, a student organization focusd on developing assistive technologies for people with mobility limitations. We set up simulation environments for the bathing and dressing tasks and invited students at Cornell to participate. There were 96 teams registered for the hackathon. Students ranged from freshmen to seniors and came from diverse majors including Computer Science, Mechanical Engineering, Operations Research, Biology, Animal Science, Information Science, System Engineering, Hotel Management, and others. See Fig. 6.

To ensure the hackathon ran smoothly, we hosted 5+ info sessions to give participants crash courses about using RCareWorld and help them set up the simulation platform on their computers. The hackathon itself was a great success. For example, one of the winning teams proposed a teleoperation interface[11] that uses iOS devices as a space mouse to control robots in simulation. This is now integrated into RCareWorld.

B. PhyRC Challenge Phase 1 - Simulation Phase

The simulation phase of the PhyRC Challenge is ongoing until Dec 1, 2024. We are using RCareWorld simulation environments for the dressing and bathing tasks. So far, there are 56 teams from 17 countries across North America, South America, Europe, Asia, and the Middle East. We show a map of global participation in Fig. 5. We are using EvalAI to automatically run and grade the participants' solutions. Teams have already submitted successful full-task evaluations for both tracks. Though have not yet decided a final cutoff, we expect to select roughly 5 teams in each track.

To ensure the competition runs smoothly, we are maintaining a discussion forum where people can ask questions. We are also hosting regular online office hours. So far, there have been 10+ people attending the office hours and getting their questions resolved in a timely manner. Our online office hours have also helped resolve issues from people who use RCareWorld for their research.

X. Organizers

We list the short bio, contact information, and relevant events organized in this section. For full CVs, please check https://tinyurl.com/full-cvs

- **Ruolin Ye**: Ruolin Ye is a third-year PhD student in computer science, working with Professor Tapo Bhattacharjee. Before that, she received her B.Eng. in information engineering from Shanghai Jiao Tong University. She has also interned at Toyota Research Institute as part of the URP 2.0 program. Her research is in robot-assistive transferring and multi-agent collaboration with intelligent devices. She leads the development of RCareWorld. She previously organized the RCareWorld Hackathon at Cornell and Phase 1 of the PhyRC Challenge. She hosted multiple info sessions and office hours to make these competitions run smoothly. She has also served as a teaching assistant for SoNIC workshop to expose underrepresented students to robotics.
  Contact: *ry273@cornell.edu*
  Relevant events organized:
  - RCareWorld Hackathon at Cornell, 2024
  - PhyRC Challenge Phase 1 - Simulation Phase, 2024
  - SoNIC workshop, 2023
- **Tom Silver**: Tom Silver is a post-doc at Cornell and an incoming assistant professor at Princeton. His research is in robot planning and machine learning and often uses techniques from task and motion planning, program synthesis, and neuro-symbolic learning. He received his PhD from MIT (EECS) in 2024 where he was advised by Leslie Kaelbling and Josh Tenenbaum. Before graduate school, he was a researcher at Vicarious AI and received his B.A. from Harvard with highest honors in computer science and mathematics in 2016. He has also interned at Google Research (Brain Robotics) and the Boston Dynamics AI Institute. He is grateful for support from an NSF Graduate Research Fellowship and an MIT Presidential Fellowship.
  Contact: *tss95@cornell.edu*
  Relevant events organized:
  - PhyRC Challenge Phase 1 - Simulation Phase, 2024
  - CoRL 2023: Learning Effective Abstractions for Planning (LEAP) Workshop

[9] Rescue Randy
[10] https://emprise.cs.cornell.edu/hackathon/
[11] RCRemote Interface

- RSS 2023: Learning for Task and Motion Planning Workshop
- CoRL 2022: Learning, Perception, and Abstraction for Long-Horizon Planning Workshop

- **Justin Guo**: Justin Guo is an undergraduate at Cornell and an incoming software engineer at Robinhood. His research interests revolve around the use and development of software simulation platforms with industry practices. He gained an interest for robotics simulation platforms working at Maxar Technologies, a space robotics company in the summer of 2023. Afterwards, Justin has worked with EmPRISE Lab to aid in the development of the first phase of the PhyRC challenge and the overall development of the RCareWorld platform.
  Contact: *jjg283@cornell.edu*
  Relevant events organized:
  - RCareWorld Hackathon at Cornell, 2024
  - PhyRC Challenge Phase 1 - Simulation Phase, 2024
- **Shuaixing Chen**: Shuaixing Chen is an undergraduate interning in EmPRISE Lab at Cornell. He is a senior at Shanghai Jiao Tong University pursuing his B.Eng in Electric Engineering. He has worked on the the development of the first phase of PhyRC challenge and helped run office hours to make the competition run smoothly.
  Contact: *alkdischen@gmail.com*
  Relevant events organized:
  - PhyRC Challenge Phase 1 - Simulation Phase, 2024
- **Martin Leroux**: Martin Leroux has a master's degree in robotics from Polytechnique Montréal and has been with Kinova for 7 years. During the pandemic, he became the face of Kinova online by publishing many tutorial videos on YouTube and participating in and co-hosting multiple webinars. In 2021, he helped organize the Roboathlon competition, a friendly inter-university challenge where students have 2 days to accomplish a certain task without preparation - that year, they had to inspect, assemble, and deliver beer crates. Today, he is the head of customer service. He handles customer support, develops training programs, and provides technical assistance to Kinova's partners for their research and demos.
  Contact: *mleroux@kinova.ca*
  Relevant events organized:
  - Roboathlon competition, 2021
- **Binit Shah**: Binit Shah is the Senior Software Lead and Developer Relations at Hello Robot. In 2024, he showcased Stretch at ICRA in Yokohama, Japan. Previously, he led the real-robot segment at the Navigation University workshop during ROSCon 2023 and conducted live demos at CoRL 2023 in Atlanta, GA. He has also organized key community events, such as the Stretch Social developer community event in 2022, and led demos at major conferences including ICRA 2022 in Philadelphia, the Healthcare Robotics Engineering Forum in Boston, and IRIM Robotics Days at Georgia Tech. In 2021, he co-organized the Mobile Manipulation with MoveIt 2 session and presented live demos at ROSWorld.
  Contact: *bshah@hello-robot.com*
  Relevant events organized:
  - Stretch live demo at ICRA, 2024&2022
  - Stretch live demo at CoRL, 2023
  - Neurips 2023 HomeRobot Open Vocabulary Mobile Manipulation Challenge, 2023
  - Navigation University at ROSCon, 2023
  - Stretch Social developer community event, 2022
  - Healthcare Robotics Engineering Forum, 2022
  - IRIM Robotics Days for Industry, 2022
  - Mobile Manipulation with MoveIt 2, 2021
  - Live demo and talk at ROSWorld, 2021
- **Tapomayukh "Tapo" Bhattacharjee**: Tapomayukh "Tapo" Bhattacharjee is an Assistant Professor in the Department of Computer Science at Cornell University where he directs the EmPRISE Lab (https://emprise.cs.cornell.edu/). He completed his Ph.D. in Robotics from Georgia Institute of Technology and was an NIH Ruth L. Kirschstein NRSA postdoctoral research associate in Computer Science & Engineering at the University of Washington. He wants to enable robots to assist people with mobility limitations with activities of daily living. His work spans the fields of human-robot interaction, haptic perception, and robot manipulation and focuses on addressing the fundamental research question on how to leverage robot-world physical interactions in unstructured human environments to perform relevant activities of daily living. He is the recipient of TRI Young Faculty Researcher Award'24, NSF CAREER Award'23, and his work has won Best Paper Award Finalist at HRI'24, Best Demo Award at HRI'24, Best RoboCup Paper Award at IROS'22, Best Paper Award Finalist and Best Student Paper Award Finalist at IROS'22, Best Technical Advances Paper Award at HRI'19, and Best Demonstration Award at NeurIPS'18. His work has also been featured in many media outlets including the BBC, Reuters, New York Times, IEEE Spectrum, and GeekWire and his robot-assisted feeding work was selected to be one of the best interactive designs of 2019 by Fast Company.
  Contact: *tapomayukh@cornell.edu*
  Relevant events organized:
  - RCareWorld Hackathon at Cornell, 2024
  - PhyRC Challenge Phase 1 - Simulation Phase, 2024
  - HRI 2024 Workshop on Assistive Applications, Accessibility, and Disability Ethics
  - IROS 2021 Workshop on RoboTac21: New Advances in Tactile Sensation, Interactive Perception, Control, and Learning - A Soft Robotic Perspective on Grasp, Manipulation, & HRI
  - ICRA 2021 Workshop on Learning For Caregiving Robots
  - IROS 2109 Workshop on RoboTac 2019: New Ad-

vances in Tactile Sensation, Perception, and Learning in Robotics: Emerging Materials and Technologies

- Humanoids 2019 Workshop on Robotic Food Manipulation
- IJCAI 2019 Workshop on Artificial Intelligence and Food
- RSS 2017 Workshop on Tactile Sensing for Manipulation: Hardware, Modeling, and Learning

REFERENCES

[1] W. H. Organization, *Global report on health equity for persons with disabilities*. World Health Organization, 2022.

[2] R. K. Jenamani, P. Sundaresan, M. Sakr, T. Bhattacharjee, and D. Sadigh, "Flair: Feeding via long-horizon acquisition of realistic dishes," *arXiv preprint arXiv:2407.07561*, 2024.

[3] E. K. Gordon, R. K. Jenamani, A. Nanavati, Z. Liu, D. Stabile, X. Dai, T. Bhattacharjee, T. Schrenk, J. Ko, H. Bolotski, *et al.*, "An adaptable, safe, and portable robot-assisted feeding system," in *Companion of the 2024 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 74–76, 2024.

[4] J. Ondras, A. Anwar, T. Wu, F. Bu, M. Jung, J. J. Ortiz, and T. Bhattacharjee, "Human-robot commensality: Bite timing prediction for robot-assisted feeding in groups," in *6th Annual Conference on Robot Learning*, 2022.

[5] A. Jevtić, A. F. Valle, G. Alenyà, G. Chance, P. Caleb-Solly, S. Dogramadzi, and C. Torras, "Personalized robot assistant for support in dressing," *IEEE transactions on cognitive and developmental systems*, vol. 11, no. 3, pp. 363–374, 2018.

[6] J. Zhu, M. Gienger, G. Franzese, and J. Kober, "Do you need a hand?– a bimanual robotic dressing assistance scheme," *IEEE Transactions on Robotics*, vol. 40, pp. 1906–1919, 2024.

[7] R. Madan, S. Valdez, D. Kim, S. Fang, L. Zhong, D. T. Virtue, and T. Bhattacharjee, "Rabbit: A robot-assisted bed bathing system with multimodal perception and integrated compliance," in *Proceedings of the 2024 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 472–481, 2024.

[8] C.-H. King, T. L. Chen, A. Jain, and C. C. Kemp, "Towards an assistive robot that autonomously performs bed baths for patient hygiene," in *2010 IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 319–324, IEEE, 2010.

[9] R. Ye, W. Xu, H. Fu, R. K. Jenamani, V. Nguyen, C. Lu, K. Dimitropoulou, and T. Bhattacharjee, "RCareWorld: A human-centric simulation world for caregiving robots," in *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 33–40, IEEE, 2022.

[10] Z. Erickson, V. Gangaram, A. Kapusta, C. K. Liu, and C. C. Kemp, "Assistive gym: A physics simulation framework for assistive robotics," in *2020 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 10169–10176, IEEE, 2020.

[11] "Amazon picking challenge." https://www.amazonrobotics.com/#/roboticschallenge, 2015. Accessed: 2024-10-15.

[12] "Darpa robotics challenge." https://www.darpa.mil/program/darpa-robotics-challenge, 2015. Accessed: 2024-10-15.

[13] F. Zhang and Y. Demiris, "Learning grasping points for garment manipulation in robot-assisted dressing," in *2020 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 9114–9120, 2020.

[14] "Cybathlon: The global competition for assistive technology." https://cybathlon.ethz.ch/, 2020. Accessed: 2024-10-15.