KARTIK RAMACHANDRUNI

4th year PhD student in Robotics, Georgia Tech

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SUMMARY

I am a 4th-year Robotics Ph.D. student working with Prof. Sonia Chernova in the RAIL lab. My long-term research interest is to enable service robots to assist users in unstructured and highly personalized human spaces with minimal user supervision. I am currently working on modeling user organizational preferences for object rearrangement without explicit instructions using contextual cues from a partially arranged initial state of the environment. Additionally, I have worked on human-robot collaboration and vision-based imitation learning projects.

EDUCATION

Ph.D. Student, Robotics *2021-Present*
School of Interactive Computing, Georgia Tech
Advisor: Sonia Chernova GPA: 4.0/4.0

B.Tech, Mechanical Engineering (ME) *2014-18*
Indian Institute of Technology (IIT) Jodhpur
GPA: 9.59/10.0

PROFESSIONAL EXPERIENCE

Student Researcher (Summer Internship) *Summer of 2023*
Google Cerebra

Graduate Research Assistant *2021-Present*
School of Interactive Computing, Georgia Tech

Robotics Researcher *2018-2021*
TCS Research & Innovation Labs, Bangalore

Undergraduate Researcher *2015-18*
Indian Institute of Technology (IIT) Jodhpur

RESEARCH PROJECTS

User-personalized Object Rearrangement Without User Instruction or Demonstration *2022-Present*
RAIL Lab, Georgia Tech *Prof. Sonia Chernova*

· Developed ConSOR, a user-personalized object rearrangement framework to assist users in human-organized environments without any user goal specification.
· ConSOR leverages contextual cues from a partially arranged environment (e.g., a half-empty kitchen cabinet or a fridge half-filled with groceries) to infer a user's preferred object placement model and applies this inferred preference to place new objects in the same environment. This eliminates the need for users to communicate their preferences via explicit goal specification or task demonstrations.
· ConSOR also learns to generalize to objects unseen during training using prior commonsense knowledge from ConceptNet. Our framework strongly outperforms an existing baseline from prior work and the GPT-3 large language model in every tested category. *Published at IROS 2023*
· I am currently extending this rearrangement framework by relaxing the assumption of a closed set of user preferences and evaluating the framework across diverse real-world environments.

UHTP: User-aware Hierarchical Task Planning Framework for Communication-Free, Mutually-Adaptive Human-Robot Collaboration *2021-2022*
RAIL Lab, Georgia Tech *Prof. Sonia Chernova*

· Developed UHTP: a User-aware Hierarchical Task Planner for shared manipulation tasks that minimizes overall task execution time while allowing the human and robot to adapt to each other's action preferences without explicitly communicating with one another.
· The framework broadly consists of A. a modified Hierarchical Task Network (HTN) to encode agent role assignments and agent-specific costs, and B. an online task planning algorithm that selects robot actions based on human activity feedback and the current task state, and prunes completed actions from the HTN.

· I validated UHTP by conducting a within-subjects user study of 35 participants in which participants work together with a JACO 7-DOF robotic arm to assemble power drills. Results from this study concluded that UHTP results in reduced task execution time and is more preferred by the participants than a static robot policy. (*Published at ACM THRI 2023*)

Self-supervised Imitation learning framework from video demonstrations 2018-2020
TCS Research & Innovation Labs *Dr. Swagat Kumar*

· Designed a deep learning framework that generates feature representations from video frames and uses them to imitate the demonstration with a Reinforcement Learning (RL) agent
· The CNN based feature extractor uses multi-level spatial attention module to learn task-specific feature representations invariant to background and appearance, while a model-free DDPG agent imitates the task using feature representations as state space.
· Experimental setup in Gazebo simulator used to test the efficacy of entire framework (*ICRA 2020*)

INTERNSHIP PROJECTS

Detecting Decision Uncertainty of an Large Language Model (LLM)-based UI Automation agent *Summer of 2023*
Google Cerebra *Dr. William Bishop*

· Formulated the research problem of agent decision uncertainty in UI Automation tasks arising from extrinsic factors such as under-specified task goals or un-affordable actions within the task.
· I created a taxonomy of extrinsic uncertain scenarios in UI automation, and constructed a novel dataset of extrinsic uncertain scenarios from expert demonstrations of users performing tasks on their phone based on this taxonomy.
· I proposed a novel uncertainty detection technique for LLM-based agents based on in-context learning and chain-of-thought prompting and compared this approach to other baseline techniques from prior work that measure LLM prediction uncertainty in natural language generation and QA tasks by benchmarking their performance on my dataset.

RESEARCH PUBLICATIONS

· **K. Ramachandruni**, M. Zuo, and S. Chernova, "ConSOR: A Context-Aware Semantic Object Rearrangement Framework for Partially Arranged Scenes," in *2023 IEEE IROS*, IEEE, 2023
· **K. Ramachandruni***, C. Kent*, and S. Chernova, "UHTP: A User-Aware Hierarchical Task Planning Framework for Communication-Free, Mutually-Adaptive Human-Robot Collaboration," in *ACM Transactions on Human-Robot Interaction*, 2023.
· W. Liu*, A. Daruna*, M. Patel**, **K. Ramachandruni****, and S. Chernova, "A Survey of Semantic Reasoning Frameworks for Robotic Systems," in *RAS*, 2022 (*Paper*)
· **K. Ramachandruni**, M. Vankadari, A. Majumder, S. Dutta and S. Kumar, "Attentive task-net: Self supervised task-attention network for imitation learning using video demonstration," in *2020 IEEE ICRA*, IEEE, 2020. (*Paper*)
· **K. Ramachandruni**, S. Jaiswal and S. V. Shah, "Vision-based control of UR5 robot to track a moving object under occlusion using Adaptive Kalman Filter," in *Proceedings of Conference on Advances in Robotics*, ACM, 2019. (*Paper*)

TEACHING EXPERIENCE

BridgeUP STEM Program 2023, 2024: Volunteered and taught in the Bridge-up STEM program to introduce basic AI concepts to select female high-school students from various schools across Atlanta.
TA for CS 6601 (2023): Worked as a GTA for the Introductory Grad AI course at Georgia Tech and conducted extra classes for undergraduate AI students to relate the course content to research topics in robotics.

PROFESSIONAL SERVICE

Reviewer for the International Conference on Human-Robot Interaction (HRI) 2024
Reviewer for the 2023 President's Undergraduate Research Awards (PURA)

ACADEMIC ACHIEVEMENTS

Board of Governors Prize, 2018: Best academic performance in graduating class of 2018 of B.Tech. ME program, IIT Jodhpur

Academic Distinction Award, 2015-18: Best academic performance in Semesters I-VII among B.Tech. ME students, IIT Jodhpur

LEADERSHIP AND TEAM ROLES

Placement Lead, ME branch *2017-18*
Student Career Development and Placements cell, IIT Jodhpur
· Ensured smooth placement & internship procedures of ME students by acting as a liaison between industry and student population

Student Mentor, Racers IITJ *2017-18*
SAE Baja India 2018 team of IIT Jodhpur
· Co-mentored the student ATV team for the national level SAE Baja competition of 2018

Manufacturing Lead, Racers IITJ *2016-17*
SAE Baja India 2017 team of IIT Jodhpur
· Directed the entire fabrication process of an ATV vehicle for the SAE Baja 2017 competition by regulating the timeline of each process and addressing shortcomings in manufacturing with innovative solutions
· Aided the design process of various sub-teams by providing essential inputs regarding the scope of manufacturing techniques and suggesting design modifications

RELATED COURSEWORK/SKILLS

· Graduate courses: Intro to Artificial Intelligence, Machine Learning, Computer Vision, Intro to Deep Learning, Evaluation of Human-Integrated Systems, Human-Robot Interaction, Intro to Robotics Research, Introduction to Graduate Algorithms
· Software experience: Python (including OpenCV, Numpy, Tensorflow, Pytorch), ROS (including Gazebo, MoveIt)
· Robot experience: Kinova JACO, UR5, Fetch mobile manipulator