KARTIK RAMACHANDRUNI

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SUMMARY

I am a 3rd-year Robotics Ph.D. student working with Prof. Sonia Chernova in the RAIL lab. My long-term research interest lies in enabling robot agents to execute real-world tasks without user instruction in previously unseen environments. Towards this direction, I am working on a semantic reasoning framework for object rearrangement that determines a tidied environment configuration from partially arranged initial states without explicit goal specification. **I am also interested in developing generalizable semantic reasoning frameworks for real-world long-horizon robot tasks such as bin packing, room rearrangement, and tidying households**. Additionally, I have previously 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

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

ConSOR: A Contextually-aware Semantic Object Rearrangement Framework for Partially Arranged Scenes   *2022-Present*
RAIL Lab, Georgia Tech   *Prof. Sonia Chernova*

· ConSOR is an object rearrangement framework that infers the tidied arrangement of objects from an environment that is partially arranged (e.g., a half-full cabinet or a fridge with objects already on some of the shelves) without explicit goal specification from the user.

· ConSOR uses a transformer model to generate an object-centric latent space mimicking the desired goal arrangement by leveraging contextual cues in the partially arranged initial state. ConSOR also learns to generalize to objects unseen during training using prior commonsense knowledge from ConceptNet.

· ConSOR was evaluated on a dataset of rearranged states generated from AI2Thor household objects, with each goal state associated with one of four predefined organizational *schemas*. Our framework strongly outperforms an existing baseline from prior work and the GPT-3 large language model in every tested category.

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 action-sequence baseline. (*Under review as a journal submission at ACM THRI*)

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 (*2020 IEEE ICRA*)

Vision-based control of UR5 robot to track occluded objects   *2017-18*
IIT Jodhpur   *Prof. Suril V. Shah*

· Developed an eye-in-hand visual servoing system equipped with a novel Adaptive Kalman Filter estimator to follow occluded targets
· Implemented the proposed AKF on a UR5 6-DOF robot arm to follow a moving object in a 2D plane (*2019 ACM AIR*)

RESEARCH PUBLICATIONS

· **K. Ramachandruni**, M. Zuo, and S. Chernova, "ConSOR: A Context-Aware Semantic Object Rearrangement Framework for Partially Arranged Scenes," (*Under review at IROS 2023*)
· **K. Ramachandruni***, C. Kent*, and S. Chernova, "UHTP: A User-Aware Hierarchical Task Planning Framework for Communication-Free, Mutually-Adaptive Human-Robot Collaboration," (*Under review at ACM THRI*)
· 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): Provided teaching assistance to the BridgeUP STEM research classes to introduce basic AI concepts to high-school female scholars
CS 6601 TA (2023): Currently TA'ing the Introductory Grad AI course at Georgia Tech and conducting extra classes to introduce applications of AI in robotics

PROFESSIONAL SERVICE AND ACADEMIC ACHIEVEMENTS

Reviewer for PURA 2023: Reviewer for the 2023 President's Undergraduate Research Awards (PURA)
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, Introduction to Robotics Research
· Software experience: Python (including OpenCV, Numpy, Tensorflow), ROS, MoveIt
· Robot experience: Kinova JACO, UR5, Fetch mobile manipulator