KARTIK RAMACHANDRUNI

2nd year PhD student in Robotics, Georgia Tech

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SUMMARY

I am a 2nd-year Robotics-IC 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 with minimal human instruction in novel, unstructured environments. Towards this direction, I am currently working on a semantic reasoning framework that determines a tidy configuration of objects for a tabletop rearrangement task. In addition to extending my current work, I am highly interested in working on developing semantic reasoning frameworks for other long-horizon robot task planning applications. I have also worked in research projects on human-robot collaborative task planning and vision-based imitation learning.

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

Semantic Reasoning Framework for Table-top Rearrangement   *2022-Present*
RAIL Lab, Georgia Tech   *Prof. Sonia Chernova*

· Building a semantic reasoning framework to infer the tidy placement of tabletop objects into containers from an incomplete arrangement of objects
· The reasoning framework will infer the tidy placement of all objects inside containers such that a) objects of similar semantic properties are grouped, and b) the organizational structure of the inferred arrangement aligns with that of the incomplete initial arrangement.
· We procedurally generated a dataset of around 4k table-top arrangements, consisting of a unique set of 54 objects, and originating from four arrangement schemas: arranging by WordNet class, by user utility, by object affordances, and as one of everything.
· Currently working on a graph neural network-based solution to reason about object grouping by leveraging object-level and scene-level semantic information from the partial arrangement.

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.
· Our 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 to select robot actions based on human activity feedback and the current state of the task as well as prune completed actions from the HTN.
· We validated our method 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 our study concluded that the UHTP framework results in reduced task execution time and is more preferred by the participants than a static action-sequence baseline. (*Under review as a journal article at the ACM Transactions on Human-Robot Interaction*)

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 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 to test the efficacy of entire framework (*Published at 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

PUBLICATIONS

· **K. Ramachandruni**, C. Kent, and S. Chernova, "SMAK-Net: Self-Supervised Multi-level Spatial Attention Network for Knowledge Representation towards Imitation Learning," (*Under review*)
· W. Liu, A. Daruna, M. Patel, **K. Ramachandruni**, and S. Chernova, "A Survey of Semantic Reasoning Frameworks for Robotic Systems," in RAS, 2022 (*Accepted*)
· **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. (*Link*)
· **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. (*Link*)

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

Placement Lead, ME branch *2017-18*
Student Career Development and Placements cell, IIT Jodhpur
· Responsible for ensuring 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 planning and regulating the timeline of each process and addressing numerous shortcomings in existing manufacturing techniques with innovative solutions
· Aided the design process of various sub-teams by providing essential inputs about the scope of manufacturing techniques and suggesting appropriate design changes

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