Sadanand Modak

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PhD, Department of Computer Science | Autonomous Mobile Robotics Laboratory (AMRL)

College of Natural Sciences | Texas Robotics

The University of Texas at Austin

Education

2022 - Present	PhD in Computer Science	UT Austin	4/4 CGPA[2]
2018 - 2022	B.Tech[1] in Mechanical Engineering *(Minor in Robotics)*	IIT Delhi, New Delhi, India	9.660/10 CGPA
2018	Class XII (CBSE[3] board)	Ramjas Public School, New Delhi, India	96%
2016	Class X (CBSE board)	Ramjas Public School, New Delhi, India	10/10 CGPA

Scholastic Achievements

- Achieved Department Rank 1 in Mechanical Engineering department at IIT Delhi **2020-22**
- Received *Keshar Devi IIT Delhi Alumni Merit Scholarship* for being 1st in the department, based on CGPA **2020-22**
- Was awarded Semester Merit Certificate 6 semesters by IIT Delhi for being in the top 7% IIT Delhi students, based on CGPA **2018-21**
- Received a Merit Certificate by CBSE for securing top 0.1% rank in 1.3 Million Class XII students across India **2018**
- Secured a rank in top 0.1% among 1.2 Million students in All India IIT Joint Entrance examination (IIT-JEE) **2018**

Research – PhD

The Neuro-symbolic Preference Learner — ongoing
To be submitted to ECCV 2024

Advisors: Dr. Joydeep Biswas (Dept. of CS) and Dr. Isil Dillig (Dept. of CS), UT Austin

Proposing a novel framework to learn preferences (such as *"What is a good taxi drop-off spot?"*) from human demonstrations in a data-efficient manner. The framework represents the preferences as neuro-symbolic latent programs. First, LLM-powered synthesis is performed on the natural language input to produce a partial program (sketch) which is then synthesised using physical quantitative data from the human demonstration, to obtain an executable program that can be used to run in-

ference on any given new image. Our framework facilitates recursive learning as it recursively calls itself whenever previously unseen concepts are used by the human demonstrator and maintains a concept library to accomplish lifelong learning.

Perceived Social Intelligence and Human Compliance in HRI — Aug 2023 - Jan 2024
To be submitted to International Journal of Social Robotics (IJSR)

Advisors: Dr. Joydeep Biswas (Dept. of CS), Dr. Elliott Hauser (School of Info.) and Dr. Justin Hart (Dept. of CS), UT Austin

Studies whether quadruped body language and verbal cues positively influence the perceived social intelligence (PSI) of a quadruped robot requiring assistance to enter a building, and whether higher PSI is associated with higher human compliance. The study validated the hypothesis that quadruped body language and verbal cues positively influenced Social Information Processing (SIP) dimensions of the Perceptions of PSI self-report scores, and do so most effectively when combined. Additionally, PSI was positively

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[1] Bachelor of Technology   [2] Cumulative Grade Point Average   [3] Central Board of Secondary Education

correlated with human compliance. Based on this evidence, we argue that social intelligence is a key construct to evaluate in HRI studies of incidental encounters and human compliance. *Ongoing work focuses on replicating this video-based study into the real-world.*
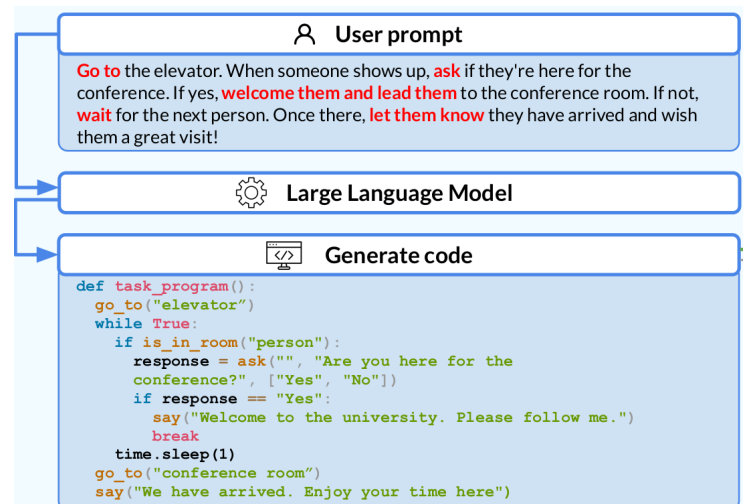
CodeBotler + RoboEval May 2023 - Nov 2023

Hu, Z., Lucchetti, F., Schlesinger, C., Saxena, Y., Freeman, A., Modak, S., Guha, A. & Biswas, J. (2024). Deploying and Evaluating LLMs to Program Service Mobile Robots. IEEE Robotics and Automation Letters.

Advisors: Dr. Joydeep Biswas (Dept. of CS, UT Austin) and Dr. Arjun Guha (College of CS, NEU)

Present `CodeBotler`, an open-source robot-agnostic tool to program service mobile robots from natural language, and `RoboEval`, a benchmark for evaluating LLMs' capabilities of generating programs to complete service robot tasks. `CodeBotler` performs program generation via few-shot prompting of LLMs with an embedded domain-specific language (eDSL) in Python, and leverages skill abstractions to deploy generated programs on any general-purpose mobile robot. `RoboEval` evaluates the correctness of generated programs by checking execution traces starting with multiple initial states, and checking whether the traces satisfy temporal logic properties that encode correctness for each task.

User prompt

Go to the elevator. When someone shows up, ask if they're here for the conference. If yes, welcome them and lead them to the conference room. If not, wait for the next person. Once there, let them know they have arrived and wish them a great visit!

Large Language Model

Generate code

```python
def task_program():
    go_to("elevator")
    while True:
        if is_in_room("person"):
            response = ask("", "Are you here for the
            conference?", ["Yes", "No"])
            if response == "Yes":
                say("Welcome to the university. Please follow me.")
                break
        time.sleep(1)
    go_to("conference room")
    say("We have arrived. Enjoy your time here")
```

Research – undergrad

Multi-Robot Task Allocation for Autonomous Mobile Robots Jun 2021 - Oct 2021

Collaboration between Addverb Technologies and IIT Delhi

Advisors: Dr. Amit Kumar (Dept. of CSE) and Dr. S.K. Saha (Dept. of ME), IIT Delhi

Studied the Bertsekas Auction algorithm for solving the assignment problem and implemented it in Python. Made use of virtual tasks to implement a *"1 robot does atmost N tasks"* case.

Social Distancing for COVID through Perception Jun 2020 - Jul 2020

Summer Internship at Omnipresent Robot Tech

Advisor: Ms. Bhawna Handa, Vision Engineer, Omnipresent Robot Tech

Developed a face-mask detection system to detect faces in a video feed and classify them into mask and no-mask categories, using a three-stage pipeline, and also a near real-time people-counter system. Integrated them using multithreading and multiprocessing in Python.

Soft Robotic Exosuit Feb 2022 - Apr 2022

Semester Project

Supervisor: Dr. Sitikantha Roy (School of AI), IIT Delhi

Studied some basics of biomechanics and musculoskeletal modeling. Investigated the OpenSim software. Developed a Python interface to OpenSim and implemented Gravity Compensation Control for the upper limb, while making use of the Static Optimization and the Inverse Dynamics tools from the OpenSim API.

Collaborative Multi-agent Learning for UAVs Aug 2021 - Nov 2021

Semester Project

Advisors: Dr. Arnob Ghosh (Dept. of ME) and Dr. Shaurya Shriyam (Dept. of ME), IIT Delhi

Studied thoroughly the basics and fundamentals of reinforcement learning (single-agent). Reviewed the state-of-the-art approaches to multi-agent reinforcement learning, including the deep learning based methods like MADDPG (Multi-Agent Deep Deterministic Policy Gradient). Investigated the effects of adding noise or delay in the observations of the agents on the convergence and performance of consensus-based IA2C (Independent Advantage Actor-Critic) algorithm.

Developing a novel 6-DOF Hybrid Manipulator   May 2021 - Jan 2022

Modak, S., & K, R. K. (2024). Kinematics and singularity analysis of a novel hybrid industrial manipulator. Robotica, 42(2), 579–610.

Advisor: Dr. Rama Krishna K (Dept. of ME), IIT Delhi

Developed a novel 6-DOF hybrid manipulator, which consists of a tripod mechanism and a 3-UPU parallel mechanism, for achieving translational motion of the end-effector in any chosen arbitrary oblique plane. Carried out the closed-form forward and inverse kinematic analysis of the hybrid manipulator and also verified the analysis numerically using MAPLE. Performed the singularity analysis of the manipulator and determined its loss and gain singularities. Simulated the 3D model of the manipulator using Simscape Multibody and Simulink in MATLAB.
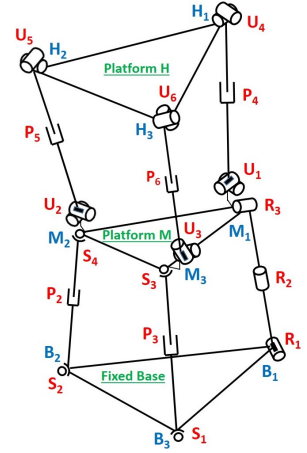
Select Coursework

- **Computer Science – PhD**

Numerical Analysis: Linear Algebra	Planning Search & Reasoning	Autonomous Robots

- **Minor in Robotics – undergrad**

Robotics	CAM & Automation	Control Theory & Applications
Kinematics & Dynamics of Machines	Data Structures & Algorithms	Embedded Systems

- **Deep Learning Specialization (Coursera)**

Neural Networks and Deep Learning	Improving Deep Neural Networks	Structuring ML Projects
Convolutional Neural Networks	Sequence Models	

- **Mechanical Engineering – undergrad**

Engineering Mechanics	Introduction to Materials Science & Engg.	Fluid Mechanics
Solid Mechanics	Introduction to Operations Research	Mechanical Engineering Drawing
Design of Machines	Numerical Methods & Computations	Introduction to Statistics
Calculus	Linear Algebra & Differential Equations	CAD & Finite Element Analysis
Manufacturing Processes	Gas Dynamics & Propulsion	Engineering Thermodynamics
Manufacturing System Design	Energy Systems & Technologies	Heat and Mass Transfer

Other research activities

- Paper titled *"Deploying and Evaluating LLMs to Program Service Mobile Robots"* accepted for a poster and a spotlight presentation at the AAAI 2024 Spring Symposium on User-Aligned Assessment of Adaptive AI Systems.   **2024**

- Workshop paper for *"Synapse: Learning Preferential Concepts from Visual Demonstrations"* accepted at VLMNM workshop at ICRA 2024.   **2024**

- Vid2Real: Perceived Social Intelligence dataset published on Texas Data Repository.   **2024**

- Participation in the ICRA 2023 BARN Challenge on autonomous navigation through obstacles.   **2023**

- Spotlight Talk and Workshop paper titled *"Multi-Factor Visual SLAM Failures in Mobile Service Robot Deployments"* at Towards Safe Autonomy: New Challenges and Trends in Robot Perception, RSS 2023 workshop.   **2023**

- *"Deploying and Evaluating LLMs to Program Service Mobile Robots"* Late-Breaking Results Poster accepted at IROS.   **2023**

Technical Skills

- **Programming Languages** : Python, C++, Octave, MATLAB

- **Frameworks** : HuggingFace Transformers, native PyTorch, TensorFlow

- **Tools & Softwares** : ROS and associated tools, OpenSim, ANSYS, SolidWorks, AutoDesk Inventor, Arduino IDE, Simulink, Simscape Multibody, Maple, CES Edupack, FluidSIM, Do-more Designer PLC, LaTeX