Zichao Hu

Austin, TX, 78723

✉ zichao@utexas.edu 📱 (330)869-7136

Research Statement

Zichao is interested in applying and fine-tuning large vision language models (LLMs/VLMs) for robot navigation. He is currently investigating the following directions: 1) Using temporal logic specifications to fine-tune CodeLlama for improved service robot program generation; 2) Applying code-writing LLMs to create navigation cost maps for preference-based navigation; 3) Identifying the implicatures in user instructions for robot tasks and fine-tuning LLMs with direct-preference optimization (DPO) to convert these implicatures into explicit instructions.

Education

University of Texas at Austin(UT)   **Austin, TX**
2nd year Ph.D. Computer Science, GPA: 3.83, Major GPA: 3.83   *2022-2027 (expected)*

University of Virginia(UVA)   **Charlottesville, VA**
B.S. Computer Engineering, GPA: 3.93, Major GPA: 3.97   *2018-2022*

Publication

○ **Zichao Hu**, Francesca Lucchetti, Claire Schlesinger, Yash Saxena, Anders Freeman, Sadanand Modak, Arjun Guha, and Joydeep Biswas, "Deploying and Evaluating LLMs to Program Service Mobile Robots," in *IEEE Robotics and Automation Letters (RA-L) 2024 (under review)*. [Paper][Code][Website: https://amrl.cs.utexas.edu/codebotler]

○ Amir Hossain Raj*, **Zichao Hu***, Haresh Karnan, Rohan Chandra, Amirreza Payandeh, Luisa Mao, Peter Stone, Joydeep Biswas, and Xuesu Xiao, "Targeted Learning: A Hybrid Approach to Social Robot Navigation," in *IEEE International Conference on Robotics and Automation (ICRA) 2024 (under review)*. [Paper][Video]

○ Hanzhi Zhou*, **Zichao Hu***, Sihang Liu, and Samira Khan, "Efficient 2D Graph SLAM For Sparse Sensing," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2022*. [Paper][Code][Video]

Project

Deploying and Evaluating LLMs to Program Service Mobile Robots   *May 2023 - November 2023*

○ Developed CODEBOTLER, an open-source tool that formulates service robot mobility, perception, manipulation, and human interaction skills as an embedded domain-specific language (eDSL) in Python and leverages LLMs' code-writing capabilities to generate robot-agnostic programs

○ Contributed ROBOEVAL, a benchmark for testing the correctness and robustness of LLM-generated service robot programs, which contains a symbolic simulator, a temporal trace evaluator, and a comprehensive set of 16 tasks and specifications tailored for service robots

○ Evaluated five LLMs, including GPT, PaLM, CodeLlama, and Starcoder, using ROBOEVAL and analyzed types of errors that cause these LLMs to fail to generate a successful program. Proposed a rejection-sampling strategy using the symbolic simulator to improve the performance of LLMs in generating programs.

Targeted Learning: A Hybrid Approach to Social Robot Navigation   *January 2023 - September 2023*

○ Examined the Socially CompliAnt Navigation Dataset (SCAND), a dataset created for social navigation to facilitate the learning from demonstration (LfD) research, and discovered that in many instances (up to 80%), the decisions of the classical geometric planner (Movebase) aligned with the choices made in human demonstrations

○ Proposed a hybrid paradigm, which involves 1) first training a classifier model to identify situations where a geometric planner would be adequate; 2) then, for scenarios where the geometric planner is insufficient, a policy network (behavior cloning) is then specially trained to handle these more complex social navigation situations

○ Implemented the hybrid paradigm policy on the Clearpath Jackal and the Boston Dynamic Spot robots and conducted user studies to validate the effectiveness of this approach

Efficient Graph SLAM For Sparse Sensing   *January 2021 - October 2021*

○ Initiated the first application of the graph SLAM algorithm to address SLAM challenges in sensing-constrained nanorobots, such as the CrazyFlie Drone which is limited to only four range measurements per scan

○ Proposed a novel dual-graph frontend approach that simultaneously constructs two factor graphs to maintain local odometry consistency while facilitating global pose optimization

○ Adapted the Cartographer's implementations of the real-time correlative scan matching algorithm to the proposed system, and extended with an approximate matching heuristic to address the sparse sensing problem

Work Experience

Scanoptix Inc., Fullstack Web Developer Intern *October 2019 - August 2020*
- Developed the Scanoptix's medical imaging Website with Angular 9, AWS S3/Lambdas, and GraphQL
- Implemented a image processing pipeline to achieve zooming, rotating, cropping, tuning functionalities and filter out noises using gamma correction
- Set up a dockerized localstack and used Postman API to emulate the AWS workflow
- Used OAuth 2.0 as the protocol to perform authentication and authorization

Projects

Plannable.org 🌐 [Video][Website: https://plannable.org/] *March 2019 - December 2019*
- Co-founded a free class scheduling website that has served over 4000 students
- Built the website with Vue.js, Typescript.js, and Webassembly
- Conducted market research through various pitches, on/offline surveys, and analysis of the exisiting solutions

Signature Replication Machine Capstone *September 2021 - December 2021*
- Programmed the TI's MSP432 microcontroller to control motors drivers and switch sensors
- Designed PCB schematic using Multisim and Ultiboard, and cutomized a boosterpack to interface with the MSP432
- Processed image using OpenCV such as denoising and line thinning and converted into voltage outputs

OpenStatics 🌐 [Website: https://openstatics.github.io/] *September 2019 - September 2020*
- Involved in developing instructional modules for the UVa MAE 2300/2310 courses to accelerate student comprehension through clean UI designs and intuitive user-controlled animations
- Utilized the JSXGraph library for the 2D/3D equation visualizations and animations
- Set up devops toolchains to enable effective collaborations among contributors

AWARDS AND ACHIEVEMENTS
- Best Beginner Hacks at HooHacks UVa, **March 2019**
- ICPC Regional Qualifier Ranking at 36/160, **October, 2019**