

CS 378: Autonomous Intelligent Robotics

FRI II

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Today

- What makes a good project?
- Project Ideas
- Team Formation

Good Projects

- Start with a goal
 - A good scientific question
 - A novel method that can be fully implemented
- Your job is then to become informed
 - How do you know that your question is good?
 - How do you know that your method is novel?
 - **Answer: Literature Survey**

What is a literature survey?

The process

- Find out what work precedes yours
- Find the major conferences and journals discussing your topic
- Find what others have hypothesized and tested
- Is there a standard test regarding your question?

Example: My dissertation

- Previous mirror papers, mirror work in animals
- Robotics & AI conference, psych journals
- Bayesian approaches, image-based approaches
- The “mirror test”

Literature Surveys

- Situate your work in the literature
- In the case of scientific questions, inform your hypotheses and methods
- In the case of development, inform you of the state-of-the-art and help you to make good design decisions

Several Types of Class Projects

- A self-contained research project
- Groundwork for work that the lab will continue
- Development of needed infrastructure

Self-Contained Projects

- Should ask a relevant scientific question
- Should have all development take place during the semester
- Should be thoroughly tested
- Final report should report on scientific findings

Self-Contained Projects

- **Example: No Fair!! An Interaction with a Cheating Robot.**
 - Started as a class project
 - Was completed the following Summer/Fall
 - Asked what happens when a robot cheats.
 - Found attributions of agency, higher participant engagement
- Actually seeing a project through to publication will probably take more than this semester

Self-Contained Projects

- One **minor** exception.
 - If you're working on current lab research, and your project is unlikely to wrap in the current semester, then simply make sure you have enough of a partial result to make a good presentation.

Recent publications through the stream

Passive Demonstrations of Light-Based Robot Signals for Improved Human Interpretability

- Rolando Fernandez, Nathan John, Sean Kirmani, Justin Hart, Jivko Sinapov, and Peter Stone
- RO-MAN 2018
- Part of Rolando's master's thesis

PRISM: Pose Registration for Semantic Mapping

- Justin W. Hart, Rishi Shah, Sean Kirmani, Nick Walker, Kathryn Baldauf, Nathan John, and Peter Stone
- IROS 2018

Optimal Use of Verbal Instructions for Multi-Robot Human Guidance

- Harel Yedidsion, Jacqueline Deans, Connor Sheehan, Mahathi Chillara, Justin Hart, Peter Stone, and Raymond J. Mooney
- ICSR 2019

Plus 4 AI-HRI Symposium papers, and other publications less directly tied to the class

Soon to be submitted

- 2 papers to ICRA
- 1 paper to HRI

Projects in Progress

- Comparing virtual agent gaze cues to gaze cues on a 3D printed robot head
- Predicting human motion trajectories
 - Navigating based on predictions
- Comprehensive semantic maps of buildings
- Moving BWI outdoors and across campus
- New RoboCup@Home tasks

Groundwork

- Very similar to a self-contained project
- Works on an area or topic of **known** interest to the BWI lab
- More ambitious than self-contained project, not intended to be completed in 1 semester
- Still performs: Lit survey, Development, Testing
- However, where it ends is negotiated with instructor and is more flexible
- Not a guarantee of a scholarship, mentor position, or future employment
 - This may be continued by other members of the lab

Infrastructure

- Not experimentally-based
- Develops necessary equipment or software
- Literature survey used to establish that state-of-the-art techniques are used
- Intended to be completed entirely during the semester
- Testing demonstrates the capability and that the system works
- Still must write all reports
- May have experimental / novel components

Infrastructure

- Example
 - Remote server based operation of BWIBot
 - Running ROS over wifi can be slow
 - Need fast transmission of sensor data
 - Bandwidth
 - Latency
 - Need the robot to operate safely if the wifi drops
 - Challenges as system changes routers
 - VPN solutions can be challenging to deploy

Project Idea: Remote Servers for Service Robots

- Type: Infrastructure
- Goal: Control a robot running a remote server
- Purpose:
 - Allow more powerful (power consuming) machines to run deep networks and other CPU/GPU hungry resources, while safely remotely controlling the robot
- Immediate Plans
 - Process video and point cloud data offboard

Project Idea: Remote Servers for Service Robots

- Scope of work:
 - Build software on the robot side to allow it to safely recover if disconnected from the server
 - Implement communications protocols to communicate quickly, bypassing ROS
 - Demonstrate robot remote operation, with head node running high-level processes for the robot, and low-level interpreting commands and safely operating when disconnected

Project Idea: Imaging Turntable

- Type: Infrastructure
- Goal: Build and program a turntable that objects rest on for imaging from multiple angles
- Purpose:
 - 3D reconstruction
 - Object recognition
- Immediate Plans
 - Object recognition for RoboCup@Home and Semantic Mapping

Project Idea: Imaging Turntable

- Scope of work:
 - Design & manufacture or purchase a turntable
 - 3D printing, machining, servos, drivers, arduino
 - Controller for turntable
 - 2D/3D image capture
 - 3D point cloud merging, stitching, reconstruction
 - Device calibration for turntable & camera

Project Idea: Drive Up and Say Hi

- Type: Long-Term Research
- Goal: What should a service robot be able to do? What do people want?
- Purpose: Learn what people want from a BWIBot, support long-term interaction.

Project Idea: Drive Up and Say Hi

- How it unfolds is like this.
 - Have the robot “patrol.”
 - See if people talk to it, if you can approach them.
 - Record exactly what they say.
 - What did they want the robot to do?
 - How did they say it?
 - Can we do it?
 - Implement what they asked.
 - Have the robot do that.
 - Record what they say.
 - Where does the interaction break down?
 - Can we accommodate all of the interactions people want?

Project Idea: Object Delivery Follow-Up

- Type: Infrastructure
- Goal: Make an in-publication system work better.
- Purpose: Improve interaction quality, speed.

Project Idea: Object Delivery Follow-Up

- Recently, we submitted a paper where people ask the robot to find an object, pick it up, and deliver it to someone.
- Parts of this process can be slow, or lack robustness.
- The idea here is to re-implement this using newer pieces of infrastructure, and to improve some pieces that work slowly or use older techniques.
- This would support long-term BWI research and make the BWIBot all-around “better.”

Project Idea: New Arm / New Robot

- Type: Infrastructure
- Goal: Get new robot with UR5 arm working
- Purpose: We have a new UR5 arm which will go onto a new robot. The purpose is to get that project started.

Project Idea: New Arm / New Robot

- We received a new UR5 robot arm, which will go onto an updated arm robot.
- Need to get the arm performing grasps.
- Need to get it mounted onto the new robot base.
- Need to get the whole system working.

Project Idea: Speech & Language Speed-Ups and Improvements

- Type: Infrastructure
- Goal: Speed up parsing, integrate Google Wave
- Purpose: Portions of our speech pipeline are slow. We want them fast and good for BWI.

Project Idea: Speech & Language Speed-Ups and Improvements

- In recent work we have sometimes had problems because the robot takes a long time to parse natural language utterances. The idea here is to do a faster re-write of the same program to speed parsing.
- Similarly, we use festival for speech production, but Wave appears to be promising for speed and quality improvements.

Project Idea: Door Sign Localization

- Type: Self-Contained / Groundwork
- Goal: Very precisely localize door signage
- Purpose: Integrates into PRISM in order to help it better localize door signs.

Project Idea: Door Sign Localization

- PRISM is our system for semantic mapping / semantic SLAM.
- The idea here is partly that the system can read the building signage and mark it into the robot's map.
- You would build a system to very precisely locate where the door signs are.

Project Idea: Smart Obstacle Avoidance

- Type: Self-Contained / Groundwork
- Goal: Differentiate between people and static obstacles to improve navigation
- Purpose: Make the robot navigate in a smarter, smoother fashion

Project Idea: Smart Obstacle Avoidance

- Right now the robot treats people as obstacles when navigating.
- The problem with this is that the robot needs to be farther from people than it does from the wall, so it has a hard time navigating narrow spaces.
- Sometimes the robot reroutes around a person when it should, instead, simply wait for them to pass.
- Differentiating between the two means that the robot will be able to move better through doorways and other small spaces, or not replan around a non-static obstacle.

Project Idea: Elevator Navigation

- Type: Self-Contained / Infrastructure
- Goal: Program the robot to recognize, push the buttons on the elevator, and navigate in and out.
- Purpose: Get the robot to navigate between floors by riding the elevator.

Project Idea: Elevator Navigation

- We've wanted to do this for years, but it's tough.
- Need to visually recognize and read the elevator buttons.
- Need to work out the navigation.
- Need to work out pushing the buttons.

Project Idea: Person Modeling

- Type: Self-Contained / Groundwork
- Goal: Have the robot build a model of each person it interacts with so it can identify if it is the same person.
- Purpose: This is over long and short time-scales, for multiple reasons.

Project Idea: Person Modeling

- Picture a conversation with the robot and 5 people. How do you know which person asks a question if they aren't facing you?
- If you are following someone, or if someone is following you, how do you know if it's the same person?

Group Formation

- Break into groups of 2-3 students
- Collect
 - Your names
 - A project you'd potentially be interested in working on from the list
 - A project idea not from the list
 - Areas of computer science, AI, or robotics that interest you
 - Then email me this information
 - hart@cs.utexas.edu

Project Idea Recap

- Ideas
 - Remote Servers for Service Robots
 - Imaging Turntable
 - Drive Up and Say Hi
 - Object Delivery Follow-Up
 - New Arm / New Robot
- - Speech & Language Speed-Ups and Improvements
 - Door Sign Localization
 - Smart Obstacle Avoidance
 - Elevator Navigation
 - Person Modeling

Instructions

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 - Next class be prepared for 5 minutes of slides (3 slides) and 5 minutes of talk to debug your concept.