

CS 309: Autonomous Robots

FRI I

Good Final Projects

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What makes a good final project?

- Have a real scientific question or engineering goal
 - FRI II will **require** a good scientific question
- Scientific questions should relate directly to Artificial Intelligence or Human Robot Interaction
 - How can a robot identify common household objects?
 - How can a robot localize itself?
 - How can a robot recognize itself?
 - Is there a faster way to learn some policy?
 - Can I reach a robot to <blank>?
- Engineering goals should solve real problems for the BWIbots.

Human-Robot Interaction Projects

- Focus on understanding how the human interacts with the robot
 - Terrible HRI projects begin with assumptions that are not true about people, and try to force people to do what the robot expects them to do.
 - Sometimes, HRI projects are *exclusively* about the person
 - Sometimes, this is through the lens of AI
 - Can a robot interpret human gaze?

Machine Learning

- **Classification**

- Tell me the names of objects in the environment?
 - Can I improve YOLO

- **Reinforcement Learning**

- Can I train the robot to
 - Pick up this object?
 - Navigate to this goal?
 - Avoid a certain area?

- We did not cover ML in this class, so only choose this if you already have an idea of how to accomplish your goal.

Engineering Components into BWI

- **Examples:**

- Read the CS events calendar and provide information and directions based on the events in it.
- Make semantic mapbuilding autonomous by adding an exploration algorithm.
- Compress data streams to improve recording and network performance.
- Enhance virtour
- Add Wizard of Oz and remote operation components
- Add telepresence capabilities to the BWIBot

Be practical about this

- Your project should be able robotics and help you learn more
- I and the mentors will help you along the way.
 - Make it relevant to us and our work so we can make the project great
- Your project should be tractable
 - Do not pick things you know nothing about
 - Do not pick things that cannot be accomplished in a month
- Your project should be ambitious
 - Do pick a challenging project
 - Do pick a project where, if you were in the audience listening to the talk, or if you were reading the paper, that you would find the project interesting

Past strong projects

- Is the lab empty?
 - A robot drove to the 3rd floor lab, counted the people inside (using YOLO, compared against the number of workstations, and then tweeted whether there were seats available
- GDC events integration
 - Integrated with the events calendar so users could interface the robot to find out what is going on in the department.
 - Included touch-screen and speech interfaces, plus location guidance.
- Speaker identification in crowded rooms
 - Multiple people are speaking. Which is speaking to the robot?
Where is this person?

Past strong projects

- Object location mapping
 - Robot drives, identifies objects, and then later is asked to return to the object. Store the object location so it can be found later.
- Object delivery
 - Person wants item X in location Y, bring it to them.
 - We *can* simulate arm robots.
- Person following
 - Person following is a perennial problem. This is only interesting if you can follow the person when they turn a corner outside the view of the robot, or when another person crosses their path.

Past strong projects

- Robot says hello
 - Get people to talk to the robot and see what they ask for.
 - Ideally, this helps us to identify desirable functionality for the robot.
 - This only works well if you get the software working quickly and get a lot of raw data
 - Do not report this as, “Entertainment, delivery..”
 - Report as, “Pick up my pizza. Check my mail. Buy me a coffee.”

Moving projects online

- Leverage available resources
 - Simulators
 - Datasets
 - ROS development
- You can still do fantastic projects entirely from home and online
- We have started a seed list of project ideas, but you can add to this list!

Project Ideas – Compressed Sensor Streams

- The brief rosbag I sent you was 12 GB!
- You should be able to achieve only a few megabytes through data compression
- Doing so would
 - Improve performance when robots are operated remotely over the network
 - Allow us to log more data
 - We really want both of these capabilities for research in the lab

Project Ideas – RoboCup@Home in Simulation

- The RoboCup@Home Rulebook
 - <http://www.robocupathome.org/rules>
- Toyota has an HSR simulator that we can get you access to
- Choose a round of RoboCup@Home
 - Build the necessary area in simulation
 - Perform the task in simulation, or at least the parts you can!
- You can also leverage the team's code in your simulation, and attempt to make improvements for next year's competition
- There may be an online event held when RoboCup would have happened this year.

Project Ideas – Robot Status Board

- Coordinate with Max Svetlik
- Website that reports which robots are currently running and what they are currently doing.
- We are planning on featuring this information on a display on the front of the BWI lab. You can write this interface!

Project Ideas – Return home on dead battery

- Currently, the robots send us emails when the battery dies
- However, the robots make no attempt to return to the laboratory first.
- For this project, the robot should detect when its battery is low, and then attempt to return to the lab and park, rather than simply dying wherever the battery gets too low.
- Even better, send a map of where the robot dies, or put this information into virtour

Project Ideas – Virtour Enhancements

- Virtour is a website that allows visitors to see the robot's perspective as it drives around GDC
- Enhancements, allowing users to control the robot, or providing more information about the robot would be very interesting and possible to do from Gazebo
- One possible enhancement is a Wizard of Oz interface, allowing complete remote control for use in experiments.

Project Ideas – Wizard of Oz Interfaces

- Good remote control of the robot
 - Visual
 - Sensor and navigation
 - Choosing simple behaviors
 - Text to speech
- The goal here is that a remote operator could emulate robot behavior in order to see how people would *ideally* interact with the robot.
- Once you know what the robot *should* do, we can go back and implement that using AI, but it is rare that we know exactly what the robot *should* do. This helps with that process.

Project Ideas – Manipulation

- We have an arm robot.
- Operating robot arms is tricky.
- This would be able getting the arm back up, running, and useful.
- We have both a mobile base with a Kinova Mico and a UR-5.
- Getting the UR-5 up and running in simulation using MoveIt would be a fantastic project!

Project Ideas – Multi-Agent Coordination

- Each BWIBot runs its own roscore on its own computer.
- Each has its own localization and sensing.
- Coordinating the behavior of the BWIBots is a challenge because they are each separate.
- This project would be able providing the back-end software necessary to coordinate multi-robot behaviors.

Project Ideas – Simulated Scavenger Hunt

- In the Scavenger Hunt project, the robots roam around the building doing things.
- One of these things is finding objects, but unlike a traditional scavenger hunt, the tasks may be “navigate 5 miles” or “find a person writing on a whiteboard.”
- The Gazebo simulation is fairly minimal at this point.
- The first part would be adding objects into Gazebo, getting YOLO to recognize them, and then recording locations.

Project Ideas – PRISM in Gazebo

- The current Gazebo simulation lacks things like room signage.
- Add signage to Gazebo.
- Get PRISM working in Gazebo.
- Begin adding enhancements.

Project Ideas – Vision and Point Cloud Library Projects

- Many vision projects have online datasets
- I can sample rosbags of point cloud data at home

Project Ideas – Social HRI Support Software

- Recognize & Greet people
- Person leading
- Person following
- Gesture recognition
- Naturalistic interactions

Project Ideas – Brainstorming Doc

<https://docs.google.com/document/d/1Z94umYTDz34LEQUiiYzIRmiOvI0YICCCQ6T1g26KRfMc/edit?usp=sharing>