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GotCha Chart – CDS 190

Goals

- Develop a verifiable control strategy for the robotic manipulation task of grasping a key and unlocking a door
- Create a verifiable, generic control strategy that can be applied to an extended set of robotic manipulation tasks
- Synthesize a controller for the scenario of unlocking a door that reacts to adverse actions from the robotic environment

Technical Challenges

- Learning the fundamentals of transition systems, LTL, and model checking
- Understanding the basics of modeling concurrent systems with the Promela language and using SPIN tools for verification
- Understanding how to express 2-person games in the GR(1) structure
- Modeling environment actions for a GR(1) game
- Learning how to use software tools to solve GR(1) games

Objectives

- For the scenario of unlocking a door, model robot arm and failures (e.g. dropping the key) with a transition system. Create an LTL specification and verify with SPIN.
- Create an algorithm that would take as input an ordered list of atomic propositions representing states and a label function that categorizes these states into classes such as 'Grasp', 'Manipulation', and 'Movement' states. The algorithm would output an LTL spec and transition system for a SPIN-verifiable control strategy.
- Test algorithm by verifying automatically generated strategies for unlocking a door and drilling a hole with a power tool. If an algorithm cannot be developed, verify custom control strategies for the two test scenarios.
- Express the interaction between the environment and robot as a GR(1) game and solve for a winning strategy for unlocking the door in the form of a Büchi automaton.

Approach

- Read sections of "Principles of Model Checking", "Principles of the Spin Model Checker" by Ben-Ari, and HYCON-EECI lecture notes for background.
- Develop transition systems and LTL specs for two test scenarios. Convert transition systems to Promela models and verify with SPIN.
- Attempt to create generalized algorithm.
- List all possible initial conditions and moves of the plant (robot) and environment as well as winning conditions for the task of unlocking a door. Formulate as a GR(1) game and solve with existing software tools.