Integrating Planning, Execution and Monitoring for a Domestic Service Robot

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Dynamic environment
SMACH - State MACHine

NOT Flexible
NOT Reusable
NOT Portable
NOT Robust
Unexpected situations

Monitoring actions
Error handling
HTN Planning

Flexible

(bring_object ?robot ?object ?to-person)

(bring_object ?robot ?object ?from ?to-person)

(fetch_object ?robot ?object ?from)

(drive_robot ?robot ?from)

(!move_base ?robot ?to)

(fetch_object ?robot ?object ?from)

(detect_object ?robot ?object ?from)

(grasp_object ?robot ?object ?from)

(move_to_detect_object_pose ?robot ?object ?from)

(move_to_pre_grasp_pose ?robot)

(!move_to_detect_object_pose ?robot)

(detect_object ?robot ?object ?from)

(!detect_object ?object ?from)

(move_to_pre_grasp_pose ?robot)

(grasp_object ?robot ?object ?from)

(pickup_object ?object ?from)

(...)


Executing the plan

Flexible  
Reusable  
Portable

Planning
HTN Operators

(\!move\_base \ ?robot \ ?to)

(move\_to\_detectobject\_pose \ ?robot)

(detected\_object \ ?object \ ?from)

(move\_to\_pregrasp\_pose \ ?robot)

(pickup\_object \ ?object \ ?from)

: 

(\!announce\_goodbye \ ?robot)

Execution
SMACH Action States

move\_base(to)

move\_to\_detectobject\_pose()

detect\_object(object,from)

move\_to\_pregrasp\_pose()

pickup\_object(object,from)

announce\_goodbye()
Monitoring actions

Flexible
Reusable
Portable
Robust
Overview

Software Components

User

Command

Speech Recognition

Parsed Command

Scenario Manager

Goal

Planning Domain

Planning Problem

Planner (JSHOP2)

Perception

Manipulation

Navigation

...
Planning Process

\[ P = (s_o, S_g, D) \]

- \( s_o \) - initial state
- \( S_g \) - goal
- \( D \) - domain: \( \{ \text{methods, operators} \} \)
Planning Process: Bring an Object task network

bring_object jenny pringles guest
pickup_object pringles dinner_table
Execution Monitoring Process

Software Components

1. User
2. Planning Domain
3. Planning Problem
4. Command
5. Goal
6. Speech Recognition
7. Parsed Command
8. Scenario Manager
9. Planner (JSHOP2)
10. Perception
11. Manipulation
12. Navigation
13. ...
Execution Monitoring: State Transitions

**EXECUTING**

- **FINISHED**
  - Monitoring action confirms successful execution
  - Monitoring action failed

- **VERIFIED**

- **ABORTED**

- **FAILED**
  - Monitoring action signals failed execution
  - Counter still valid

- **RETRYING**
  - Counter still valid

- Action completed
- Action could not be completed
Experimental Results

Initial State
(at jenny base)
(at pringles dinner_table)
(in guest living_room)
(at-init-pose jenny)
(at ketchup dinner_table)

Goal:
(bring_an_object jenny pringles guest)

Plan
(move_base jenny dinner_table)
(move_to_detectobject_pose jenny)
(detect_object pringles dinner_table)
(move_to_pickupobjectpose jenny)
(pickup_object pringles dinner_table)

(move_base jenny living_room)
(release_object pringles guest)
(move_to_home_pose jenny)
Integrates HTN planning
Modeled the planning domain for two scenarios
Generated and executed plans
Created modular, re-usable, dynamically-executable states
Built the monitoring system

Extend the planning domain
Integrate a knowledge base
Enable online task planning
Build a more holistic monitoring and fault-detection system
Thank you for your attention!
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