CS-417 INTRODUCTION TO ROBOTICS AND INTELLIGENT SYSTEMS

Midterm Review

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Overview

- History
- Sensors
- Actuators
- Mapping
  - Topological
  - Metric
  - Feature Based
  - Occupancy Grid
- Computer Vision

- Coverage
- Path-Planning
  - Visibility Graph
  - Bug (0, 1, 2, Tangent)
  - C-Space
  - Probabilistic Roadmaps
  - Potential Fields
  - RRT
  - Generalized Voronoi Graph (GVG)
- Multi-Robot Systems

Overview

417	Book
Introduction	1.1
History	1.2
Sensors	4.1-4.7
Actuators	3
Coordinate transform	--
Mapping	9,2.4
• Occupancy Grids	• 9.1
• Topological Graph	• 9.3
• Feature Based	• 9.2
Path Planning	6
• Visibility Graph	6.3
• Bug Algorithm	2.1
• Roadmap (Voronoi)	6.3.2
• Potential fields	6.3.4
• C-Space	6.1
• PRMs,RRT	6.3.6

417	Book
Coverage	--
Multi-Robot Systems	10
• Taxonomy	• 10.1-10.5
• Multi-Robot Coverage	• --
• Formations	• 10.6
• Marsupial Robotics	• --
• Cooperative Localization Mapping and Exploration	• 10.7-10.8
Vision for Robotics	5
Camera Model	• 5.1
Camera Calibration	• -
Basic Vision	• 5.2-5.3
Visual Servoing	• -
Stereo	• 5.5
Features	• 5.4

Sensors

- **Proprioceptive Sensors**

  (monitor state of vehicle-propagate)
  - IMU (accels & gyros)
  - Wheel encoders
  - Doppler radar …
    - **Noise**

- **Exteroceptive Sensors**

  (monitor environment-update)
  - Cameras (single, stereo, omni, FLIR …)
  - Laser scanner
  - MW radar
  - Sonar
  - Tactile…
    - **Uncertainty**

Sensors

- Tactile
- Close-range proximity
- Angular position
- Infrared
- **Sonar**
- Laser (various types)
- RADAR
- Compasses, Gyroscopes, Accelerometers - IMU
- Force
- GPS
- Vision

Actuators

- Hydraulic Actuators
- Pneumatic Actuators
- Air Muscle
- Shape Memory Alloy Actuators
- Electric Actuators
- Stepper Motors

Actuators

	Power	Stiffness	Speed	External Source	Precision	Cost
Hydraulic Actuators	High	High	High	Yes	Medium	High
Pneumatic Actuators	High	Soft	Low	Yes	Low	Low
Air Muscle	Medium		Low	Yes	Medium	Medium
Shape Memory Alloy Actuators	High	Medium	Low	No	High	High
Electric Actuators	Medium	High	High	No	High	Low
Stepper Motors	Low	High	High	No	Very High	Very Low

Mapping

- Occupancy Grids
- Sonar model
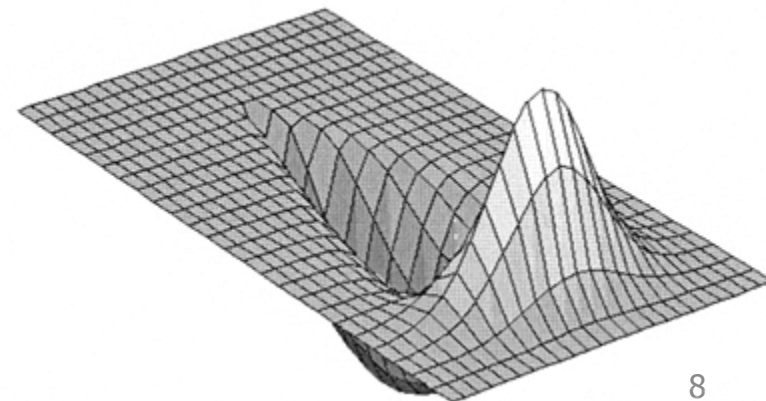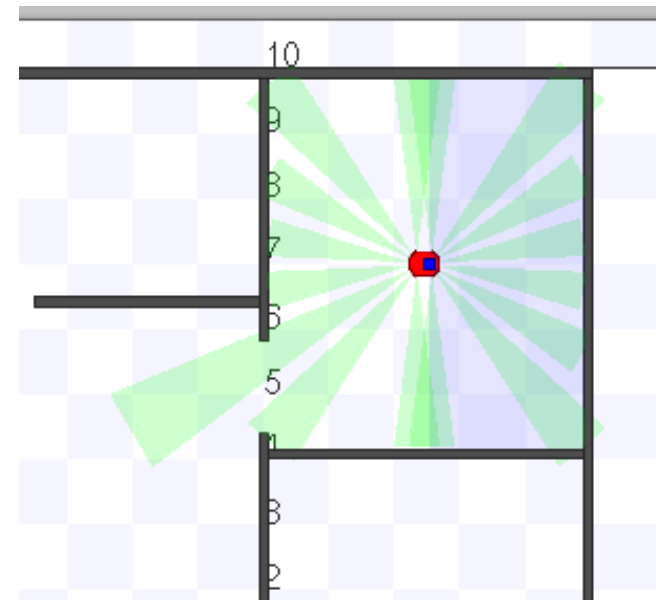
Path Planning

World
- Indoor/Outdoor
- 2D/2.5D/3D
- Static/Dynamic
- Known/Unknown
- Abstract (web)

Robot
- Mobile
  - Indoor/Outdoor
  - Walking/Flying/Swimming
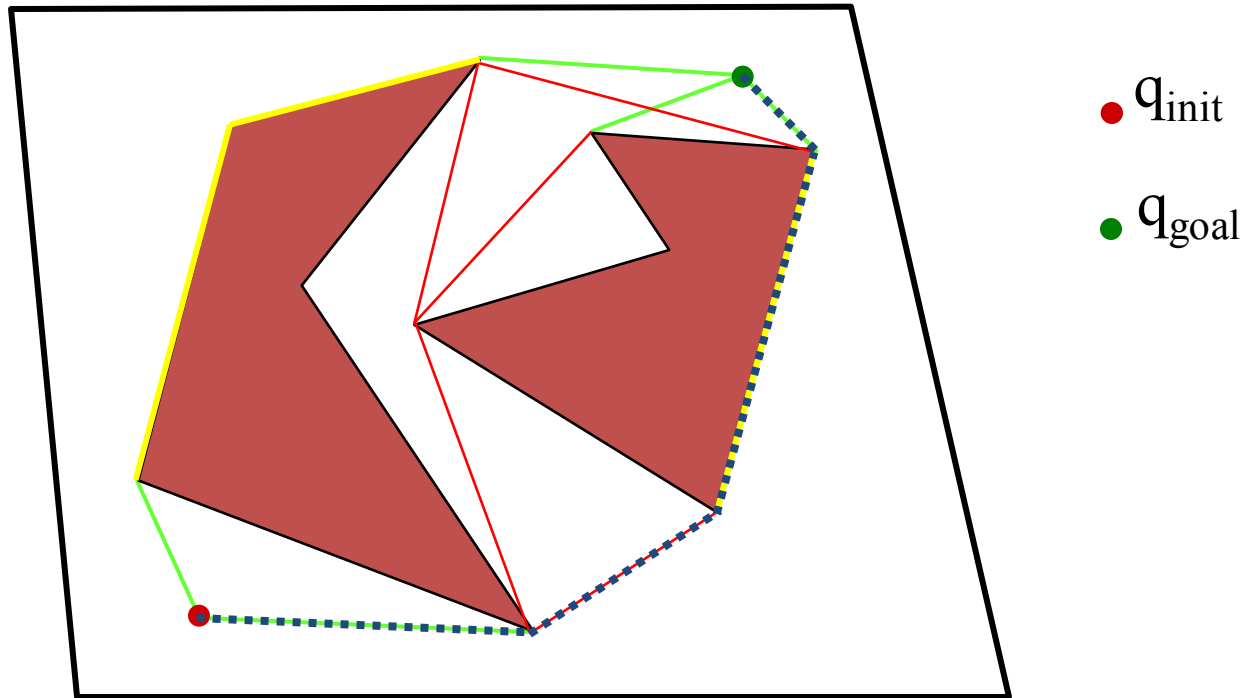- Manipulator
- Humanoid
- Abstract

Map
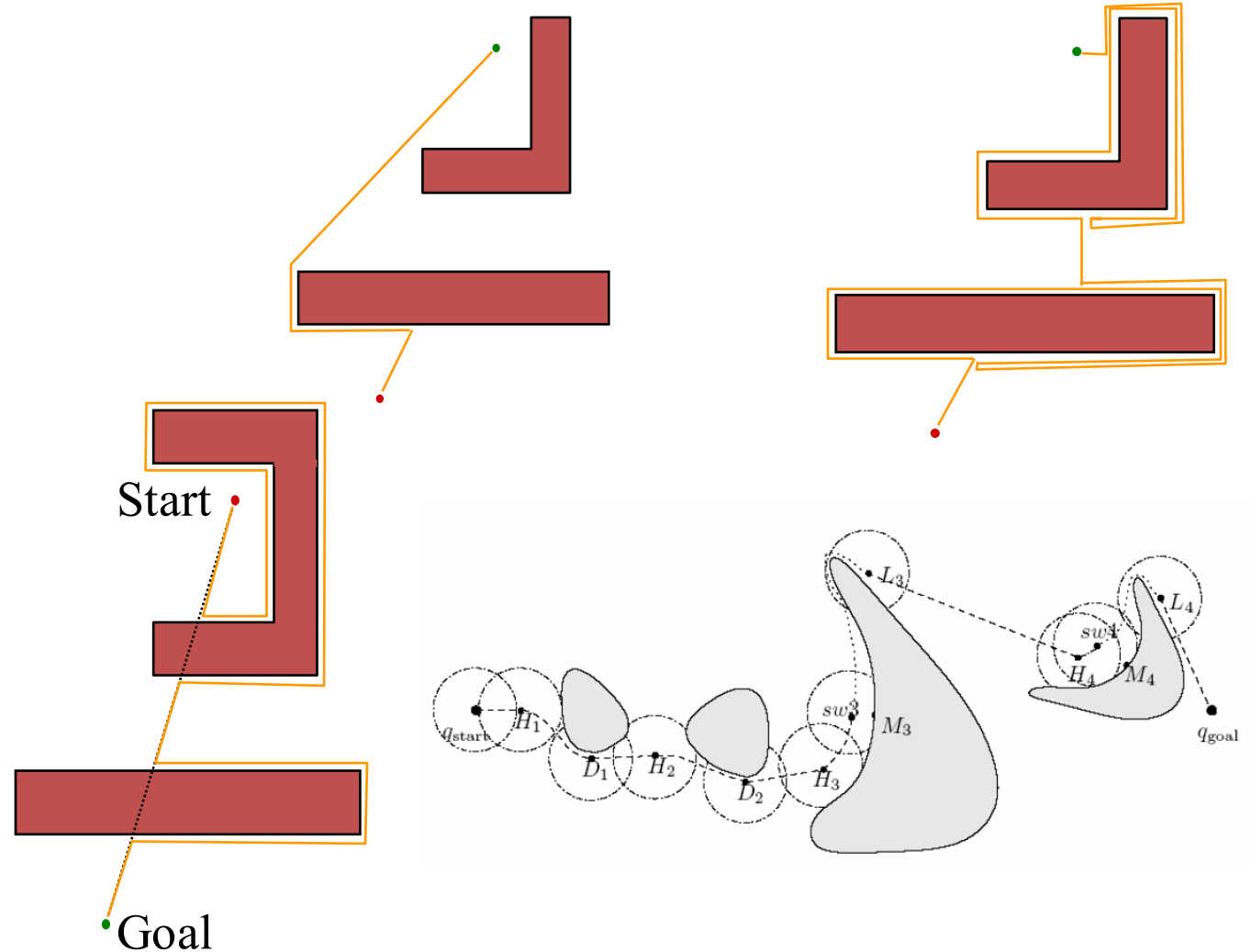- Topological
- Metric
- Feature Based
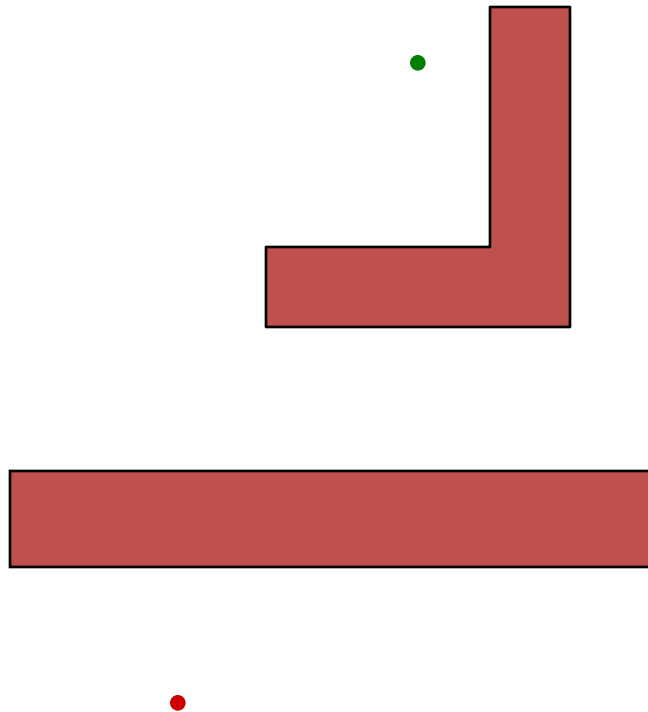- 1D,2D,2.5D,3D

Path Planning

- Visibility Graph

q_{init}

q_{goal}
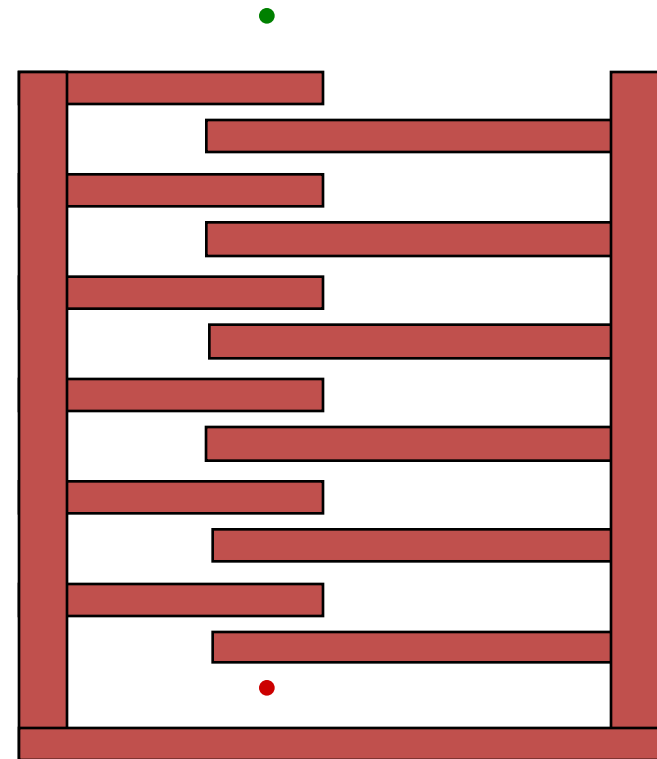
Bugs

- Bug0
- Bug1
- Bug2
- Tangent Bug

Start

Goal

Head-to-Head Comparison
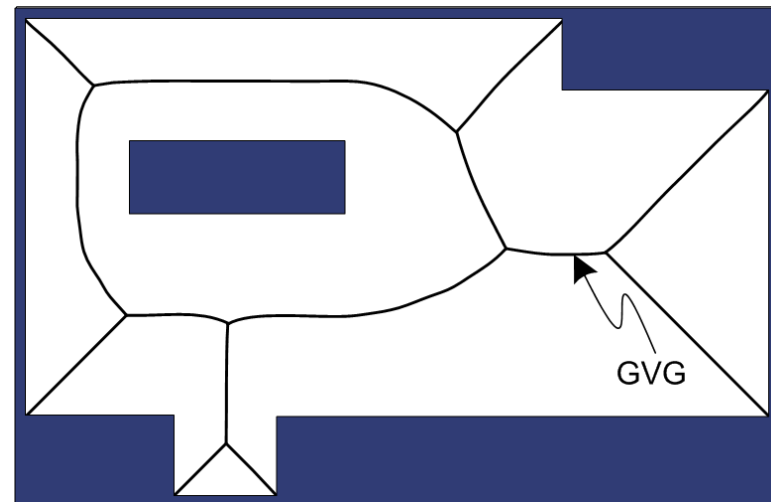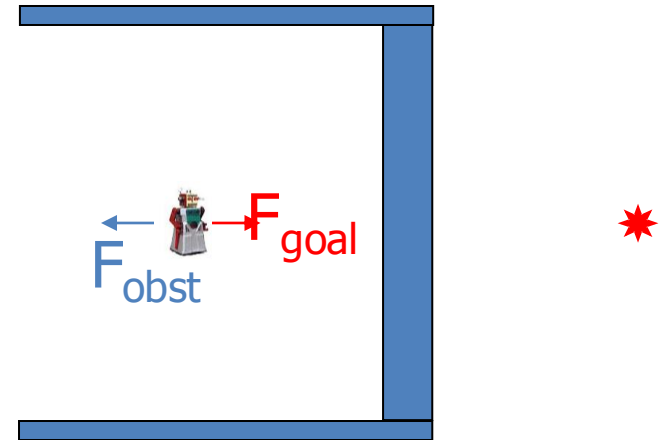
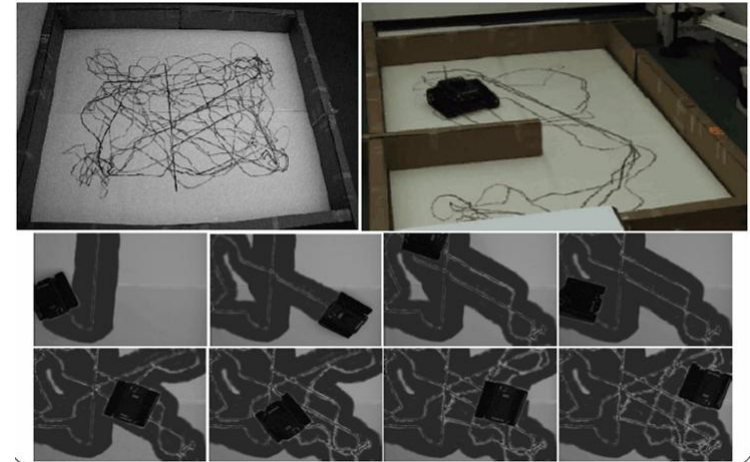- Bug 2 beats Bug 1

- Bug 1 beats Bug 2

Path Planning

- Potential Field Path Planning
- Generalized Voronoi Graph
- Wavefront Planner
- Configuration Space
- Probabilistic Roadmaps
- Rapidly Exploring Random Trees (RRT)

F_{obst} F_{goal}

GVG

Coverage

- Complete?
- Deterministic?
- Optimality
- Applications
- Boustrophedon
- Multi-Robot Coverage

Computer Vision

- Camera Geometry (Perspective Transformation)
- Ill Posed Problem
- Correspondence Problem
- Gaussian Blur
- Fiducial Markers
- Stereo Vision

Multi-Robot Systems

- Coverage
  - Communication capabilities
- Auctions
- Marsupial Robotics
- Formations
- Cooperative Localization
- Cooperative Mapping and Exploration