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Sony's Aibo

Map Building & Localization

Robotics Seminar CSI445/660
Spring 2009, MW 4:15-5:35

Instructors: Tomek Strzalkowski, Nick Webb & Michael Ferguson
University at Albany, SUNY

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Administrative

- HW2 due 2/25
- HW3 out tomorrow, due 3/4
- Give me your MAC address

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Overview of Today

- What is Mapping and Localization?
- What can Tekkotsu offer?
- How is it done in the real world?
- Probably more questions than answers. This is a very active research field.

Why map or localize?

- We've been doing reactive behaviors.
- What happens when we have real goals and problems?
- How do we find where we are?

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Several Scenarios

1 Map is known, location is known
- Just navigate, then we'll be in case 2:

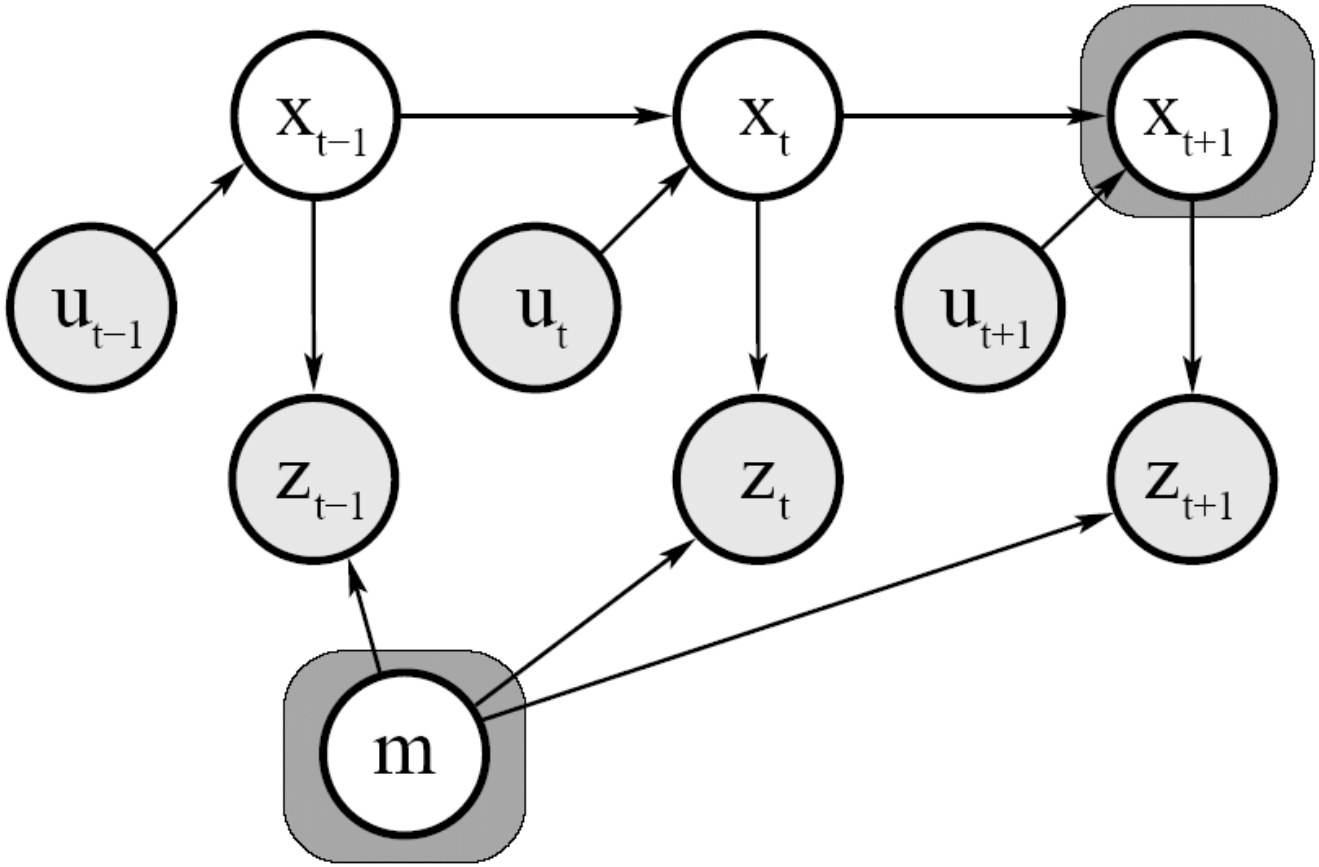
2 Map is known, location unknown
- Need to localize, which is just a special form of case 3:

3 Map is unknown, location is unknown
- Simultaneous Mapping and Localization (SLAM)

Overview of SLAM

- We keep a global map
- Set a course, move to a new location (Control update, u)
- Take sensor readings (z)
- Merge the local map onto the global map, and find new location
  - Typically done probabilistically, since there is always error.
- Is a Markov process (for the mathematically inclined)

A Graphical View



Map Building in Tekkotsu

- Features
  - Sketches can be found (Wed. Lecture)
  - From these sketches we can build local maps. (HW4)
  - Local maps can be meshed into world maps. (final project?)
- Limitations
  - Entirely visual
  - Entirely 2D

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Sketches

- Cognitive Science approach
- Break visual stimuli down into series of lines
- Very difficult, translating from camera view to a usable format is time consuming.
- We'll return to this Wednesday

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Local Map Builder

- Merges several frames of sketches together.

Here In The Real World

- Vision is just not reliable enough.
- Maps typically built from sensor readings: sonar, IR, LIDAR
- Probabilistic approaches to localization: Monte Carlo, particle filters.
- SLAM is often it's own course, this is just a taste....

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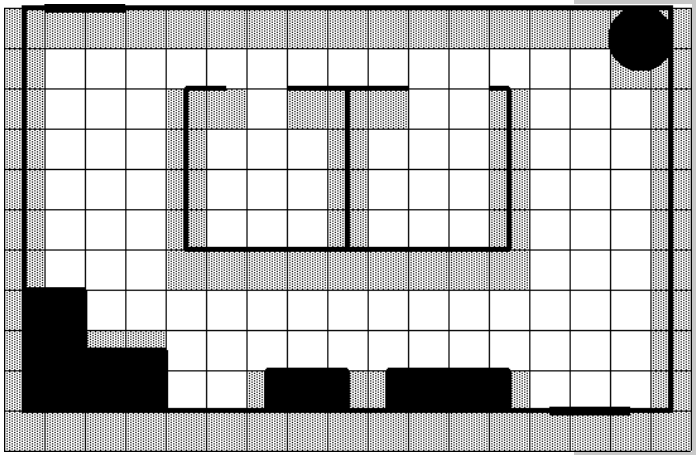
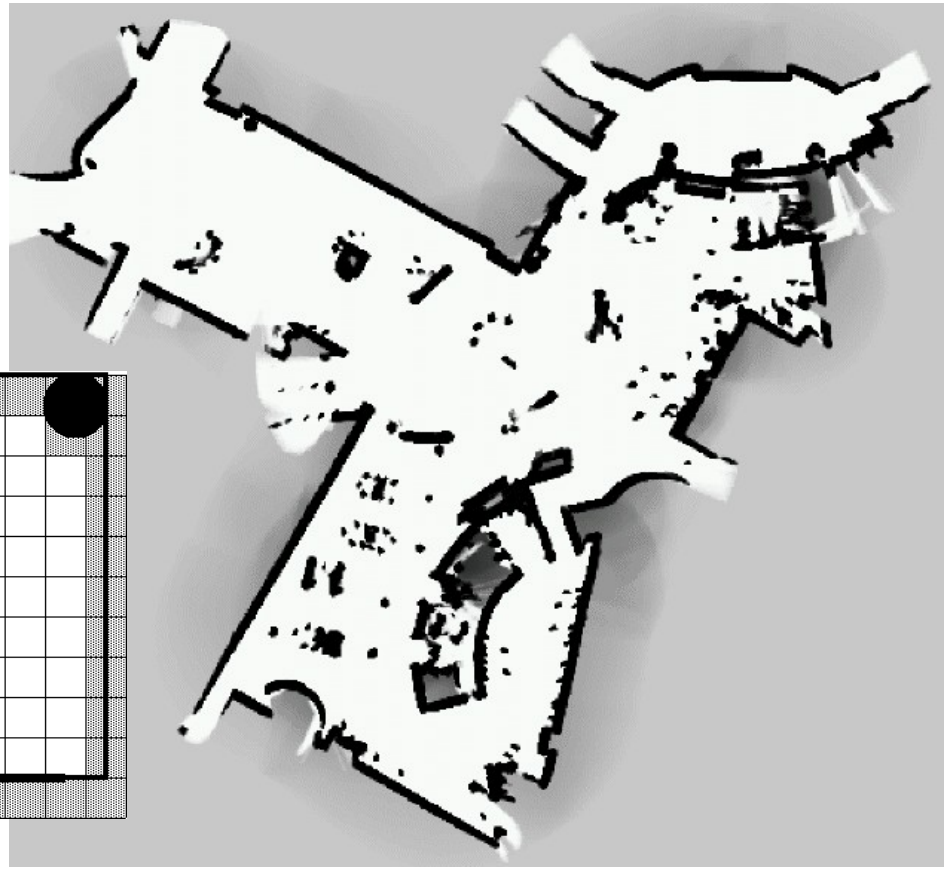
Metric Maps

- Occupancy Grids
- Histogram in Motion Mapping (HIMM)





Metric Issues

- Metric maps are expensive for planning:
  - Search takes a long time using any of:
    - A*
    - Wavefront
- Maps themselves become very large!
- Errors add up over time.

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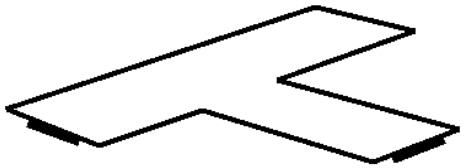
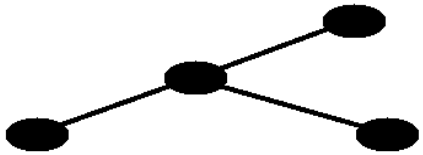
Topological Maps

- Throw out the grids... just save way points. Similar to road map.



Metric: distances, directions, shapes in coordinate system



Topological: connectivity

Landmark definitions, procedural knowledge for traveling

Topological Issues

- How do we define landmarks?
- Too many/too few landmarks
- Shouldn't distance play some role?

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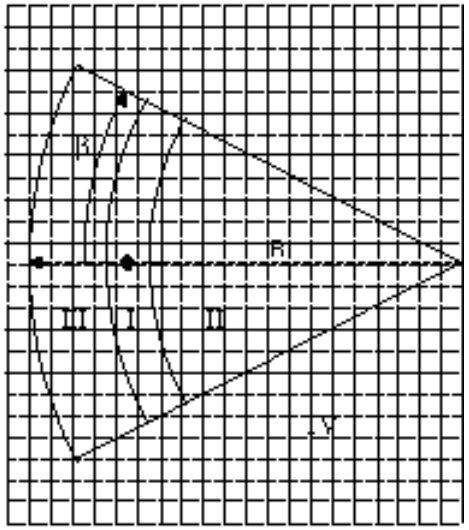
Sensor Models

- Sonar
- IR
- LIDAR
- Encoders



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Localization

- Where am I?