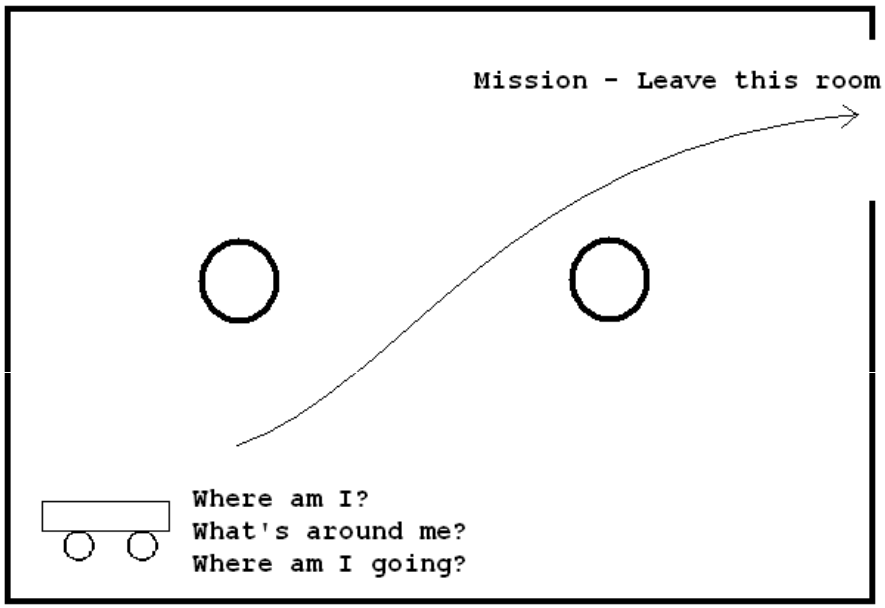
Mobile Robot Positioning



Figuring Out Location Based on Surroundings

Why does a robot need to know location?

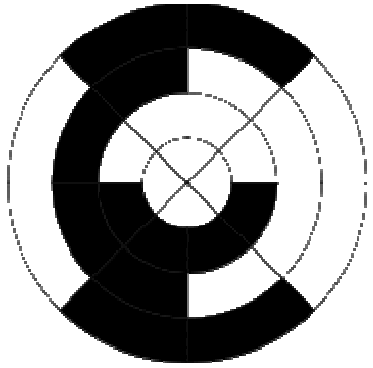
- Mobile robots should have a mission.
- To complete a mission, mobile robots usually need to know where they have been and where they are going.
- Manually entering complete map data of a location is not something that we want to do every time a robot goes into a new environment.
- The environment in which the robot is operating may be changing.
- Things like people, animals, vehicles, or other robots may be unpredictable.

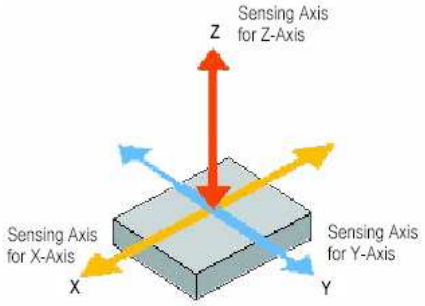
What kind of information is useful?

- Data provided by a person as a guide to the robot.
  - Waypoints and general directions.
- Data provided by another robot.
  - Collaborative efforts, previously completed missions
- Data collected from on-board sensors.
  - Ultrasonic, LIDAR, Vision (camera), Compass
- Data collected from navigational beacons.
  - GPS, waypoint beacons
- A fusion of any or all of the above.

Relative Position Measurements

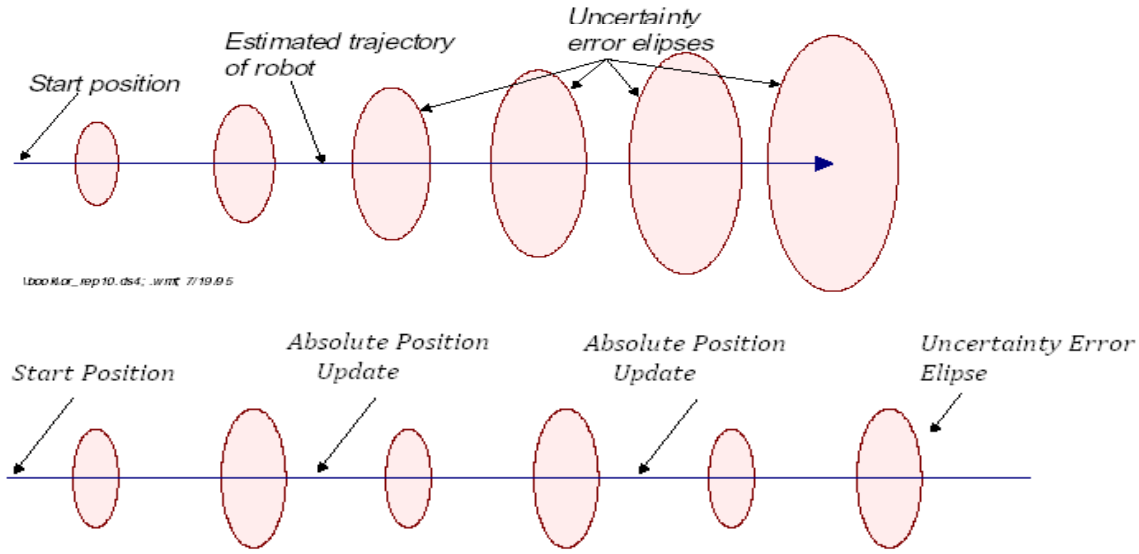
- **Do you really need to know exactly where you are?**
- **Or, is it good enough to know where you are relative to where you started?**
- **Odometry**
  - Count wheel rotations
  - Calculate distance based on wheel size
  - Uses simple multiplication and trigonometry
- **Inertial Navigation**
  - Use gyroscopes and/or accelerometers
  - Measure rate of rotation and acceleration
  - Integrate a time or two to get position
- **Either way, you will not be very accurate!**





Relative Position Measurements

- Odometry is a central part of almost all mobile robot navigation systems.
- Odometry is subject to incremental error and periodic absolute position updates are necessary.

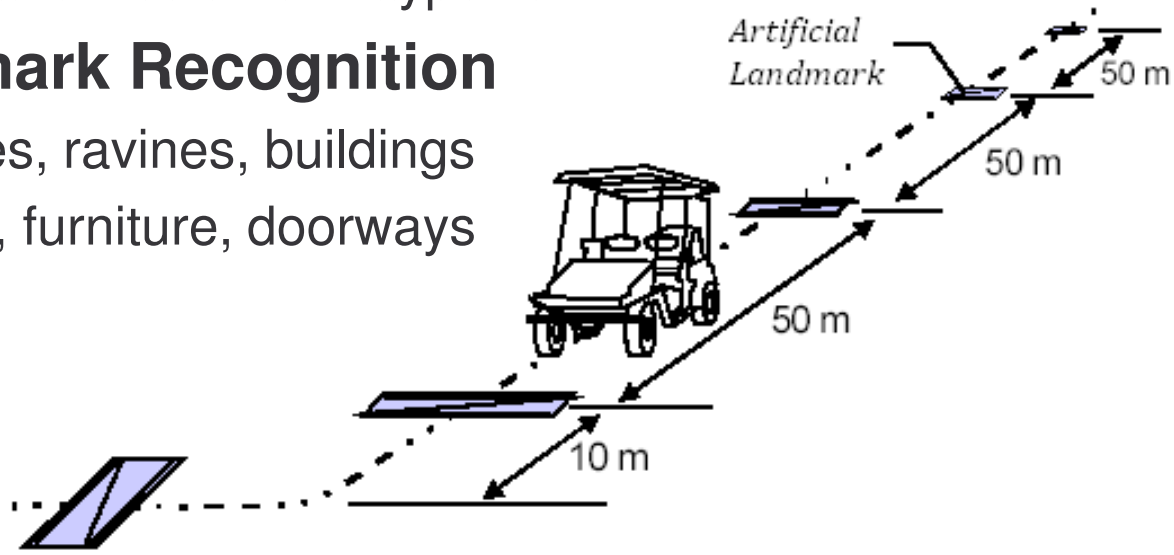


Absolute Position Measurements

Active Beacons

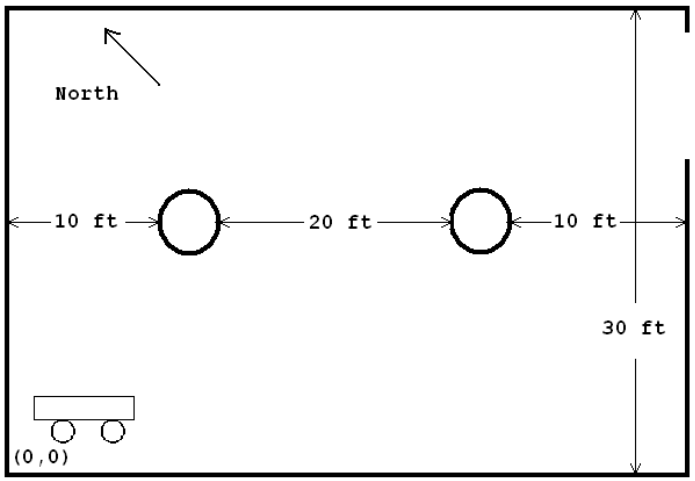
- Measure the direction of incidence of three or more beacons.
- GPS also measures the time of travel for the signal.

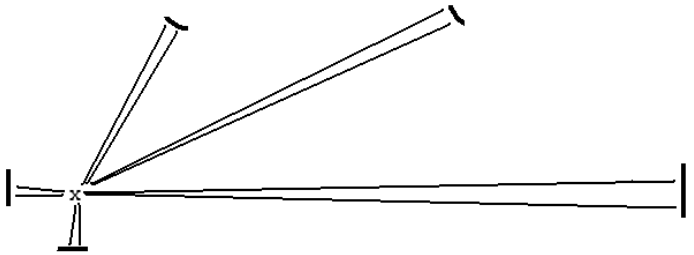
- **Artificial Landmark Recognition**
  - Short range transmission of waypoint
- **Natural Landmark Recognition**
  - Outdoor – trees, ravines, buildings
  - Indoor – walls, furniture, doorways



Absolute Position Measurements

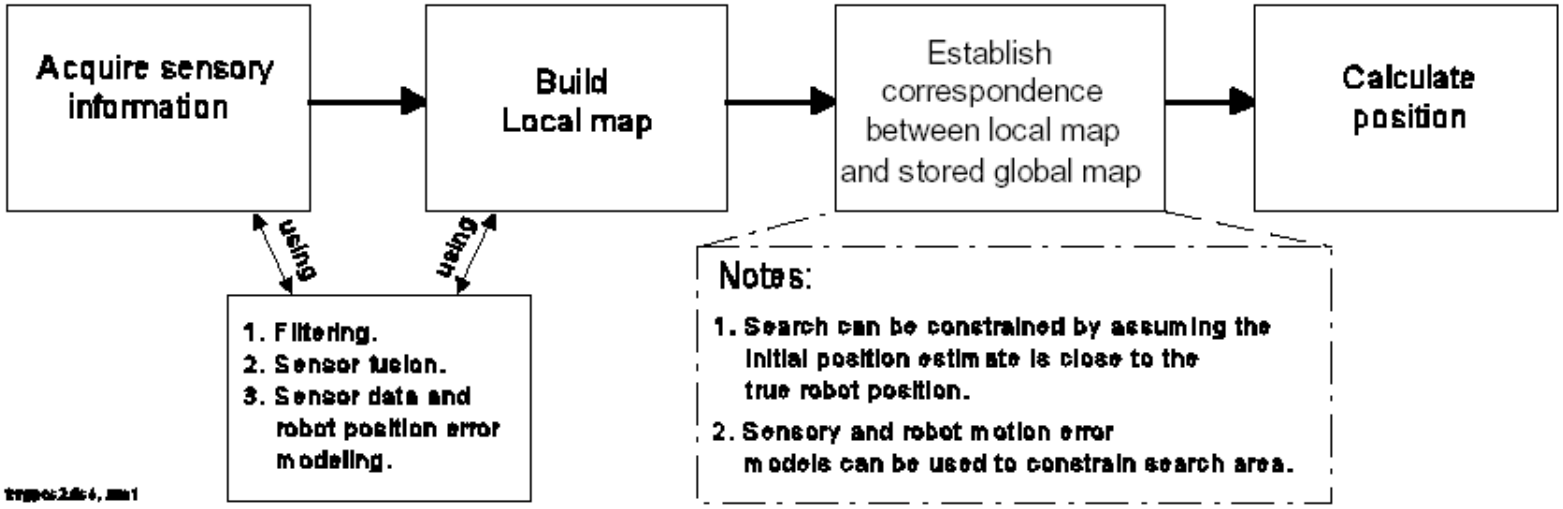
- **Model Matching**
  - A map, or model, is provided to the robot or created by the robot.
  - Active sensors obtain features surrounding the robot.
  - The features are matched to the map to obtain location.





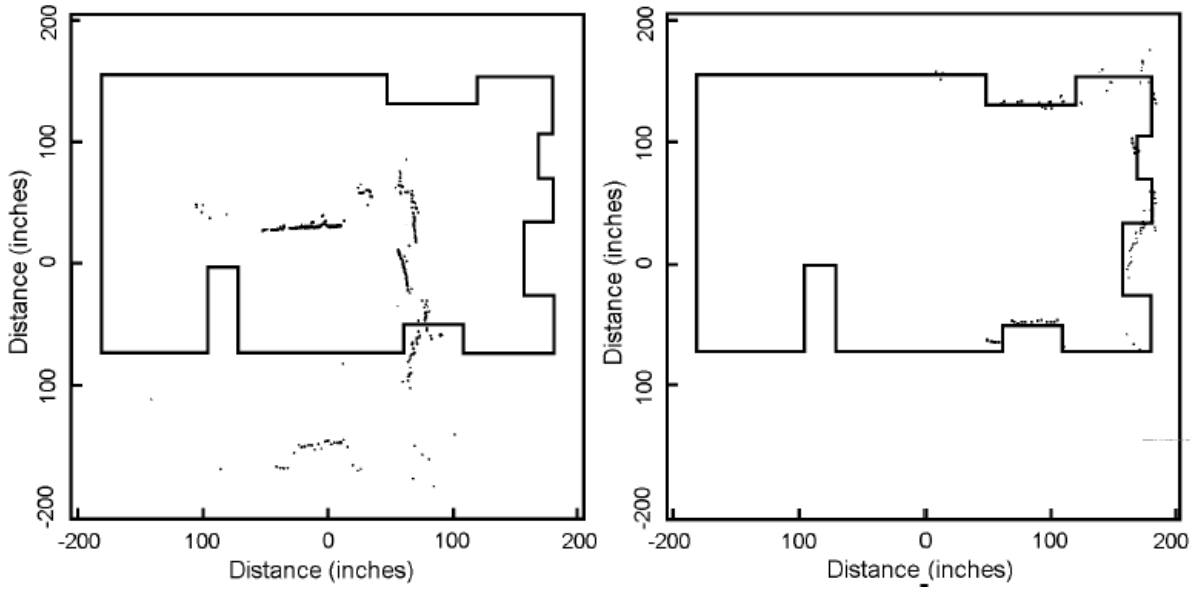
MAP-BASED POSITIONING

- Sensory data can come from ultrasonic, LIDAR, vision (camera), or compass devices.
- Map-based positioning allows a robot to learn a new environment and to improve positioning accuracy through exploration.
- A significant amount of sensing and processing power must be available.



Procedure for implementing map-matching algorithm .

1. For each point in the image, find the line segment in the model that is nearest to the point. Call this the target.
2. Find the congruence that minimizes the total squared distance between the image points and their target lines.
3. Move the points by the congruence found in step 2.
4. Repeat steps 1 to 3 until the procedure converges.



Correspondence between an internal geometric model and an observed scene.

- Geometric models often include three-dimensional models of buildings, indoor structures and floor maps.
- For localization, the two-dimensional visual observations should capture the features of the environment that can be matched to the preloaded model with minimum uncertainty.