

Probabilistic Foundations of SLAM — A Tutorial

[Reference Slides]

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Disclaimer

- These are reference slides only to show some complicated graphics.
- Please see video recording of the complete chalkboard talk at <http://cyphynets.lums.edu.pk/index.php/WFR2011-program>

Resources

Course material from

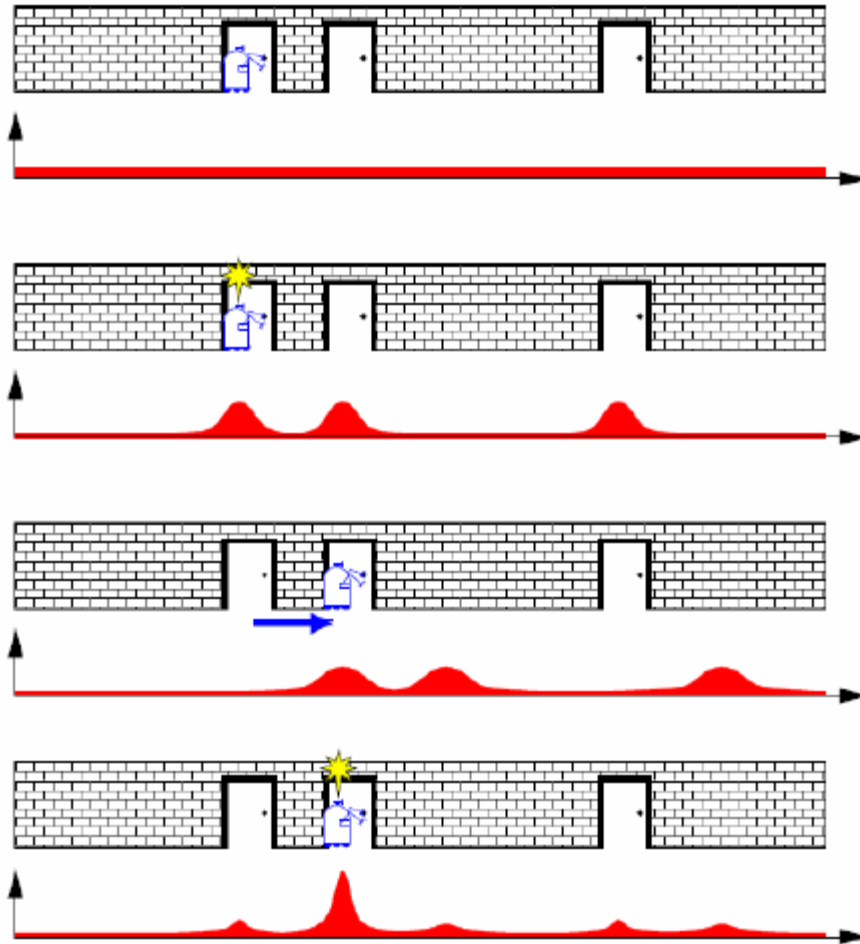
- Stanford CS-226 (Thrun)
- KAUST ME-410 (Abubakr, 2011)
- LUMS CMPE-633a (Abubakr, 2010)

<http://cyphynets.lums.edu.pk/index.php/Teaching>

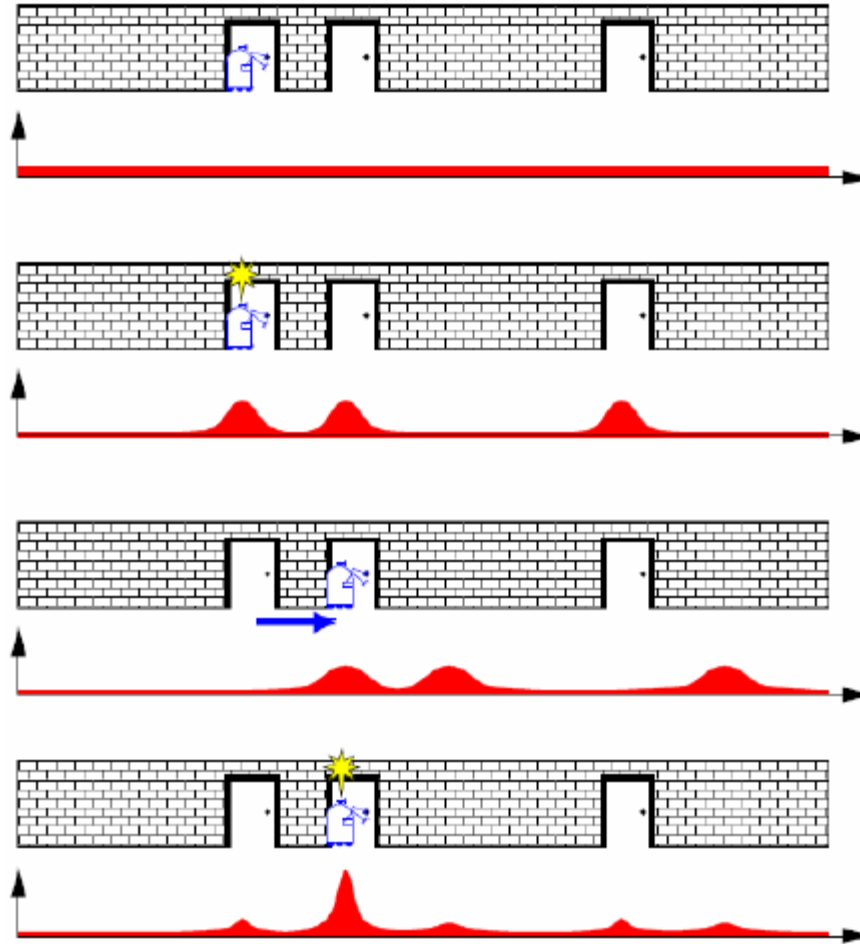
Textbooks

- Probabilistic Robotics by Thrun et al.
- Principles of Robot Motion by Choset et al.

Bayes Filter Example

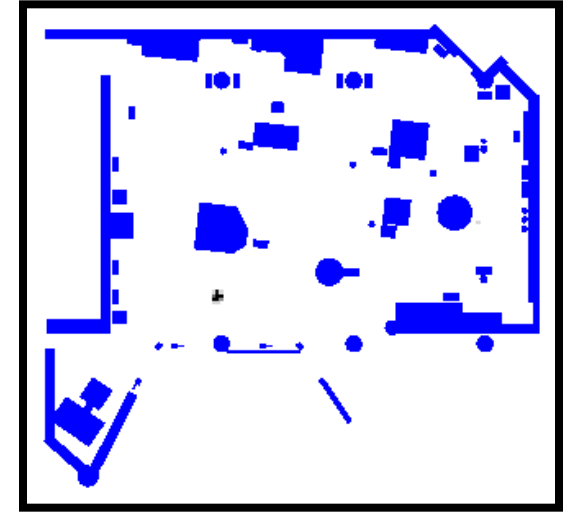
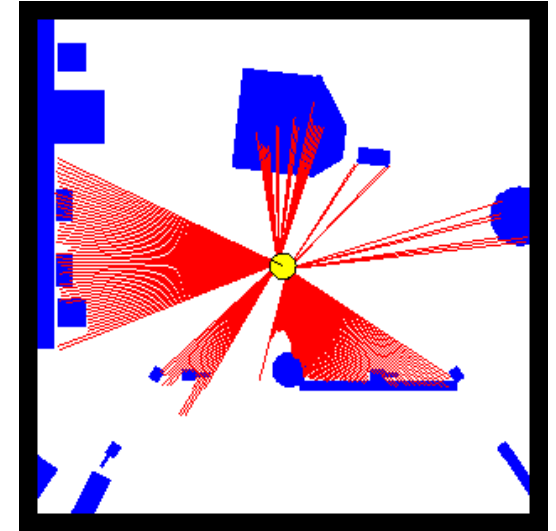
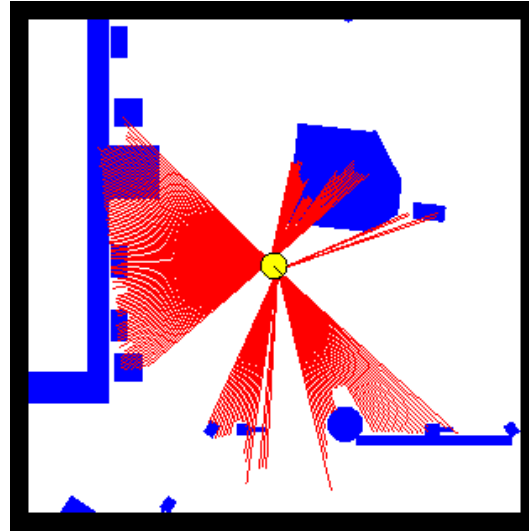
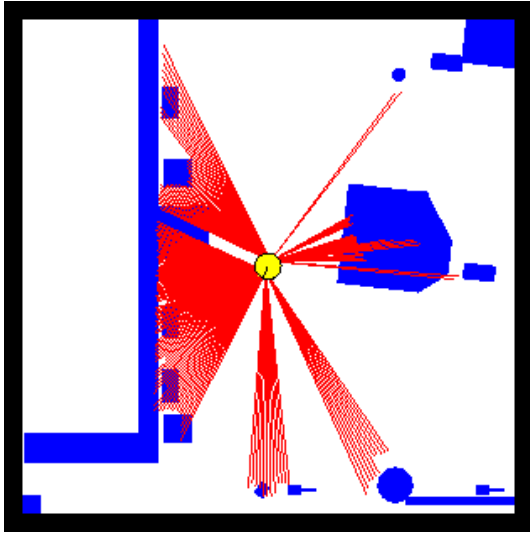


Bayes Filters in Localization



$$Bel(x_t) = \eta P(z_t | x_t) \int P(x_t | u_t, x_{t-1}) Bel(x_{t-1}) dx_{t-1}$$

Grid-based Localization

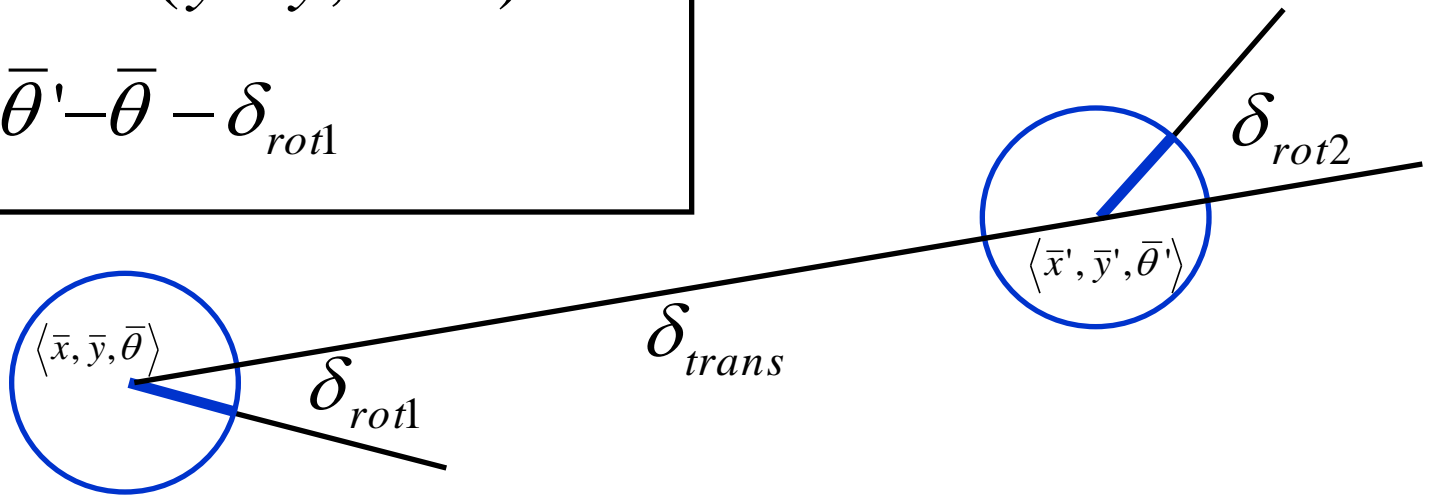


Odometry Model

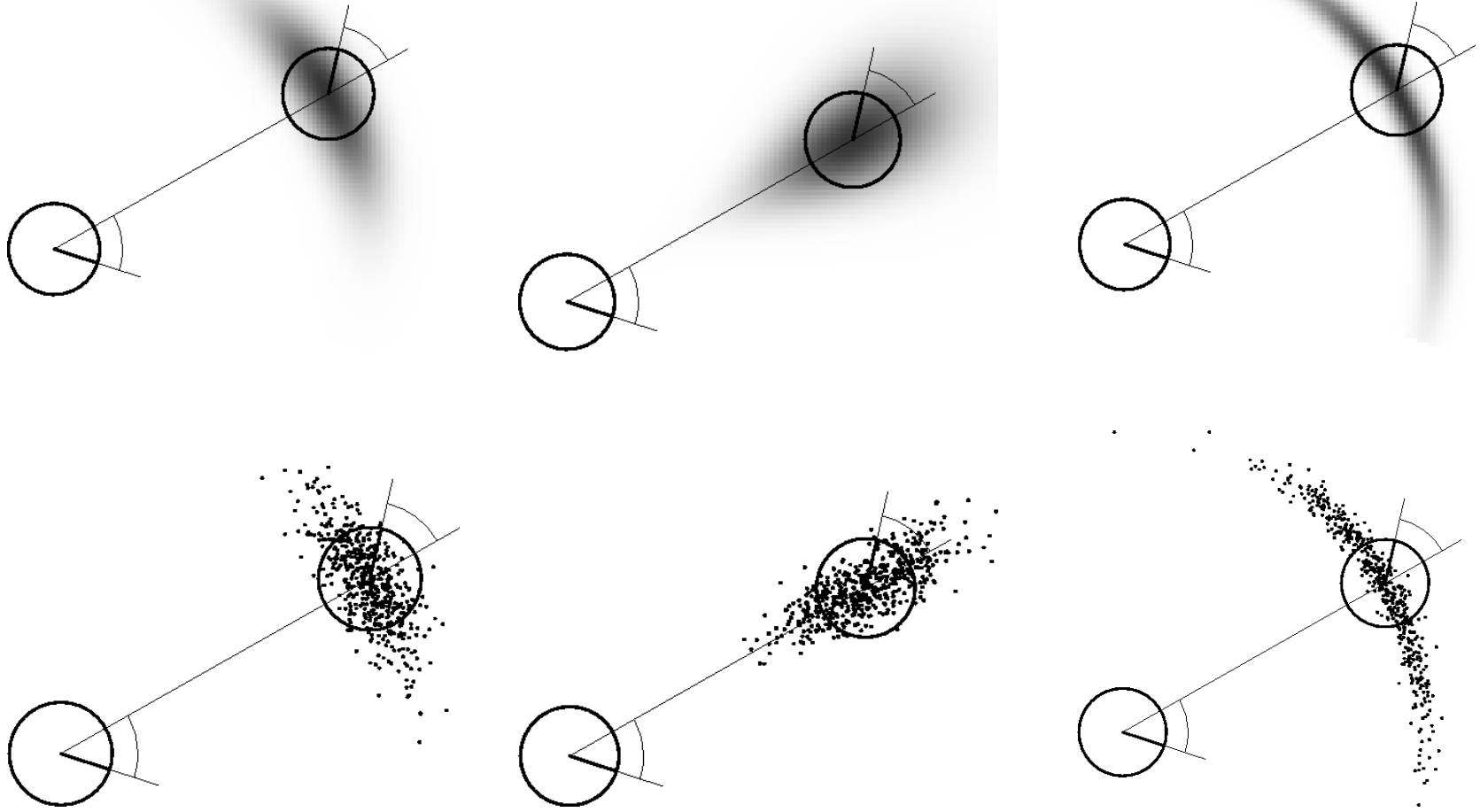
$$\delta_{trans} = \sqrt{(\bar{x}' - \bar{x})^2 + (\bar{y}' - \bar{y})^2}$$

$$\delta_{rot1} = \text{atan2}(\bar{y}' - \bar{y}, \bar{x}' - \bar{x}) - \bar{\theta}$$

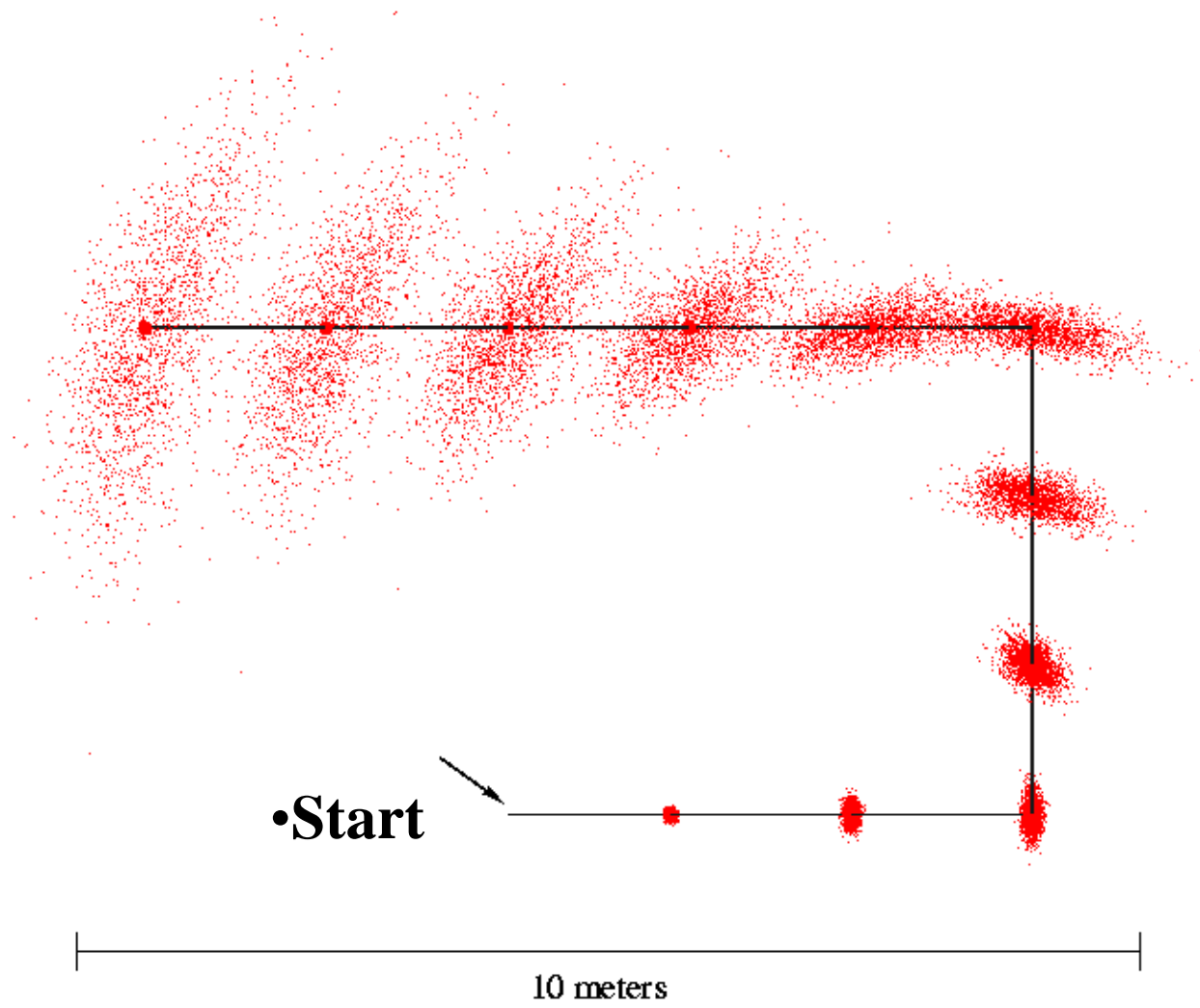
$$\delta_{rot2} = \bar{\theta}' - \bar{\theta} - \delta_{rot1}$$



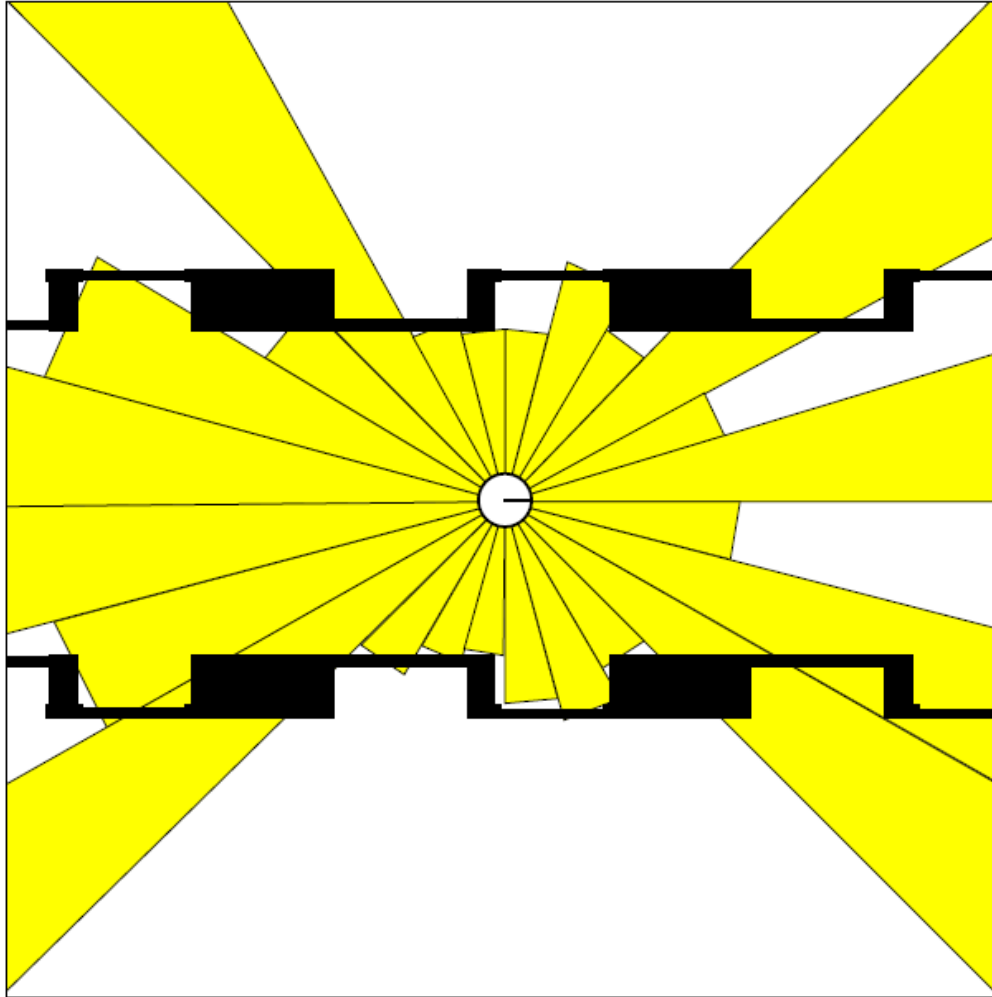
Examples



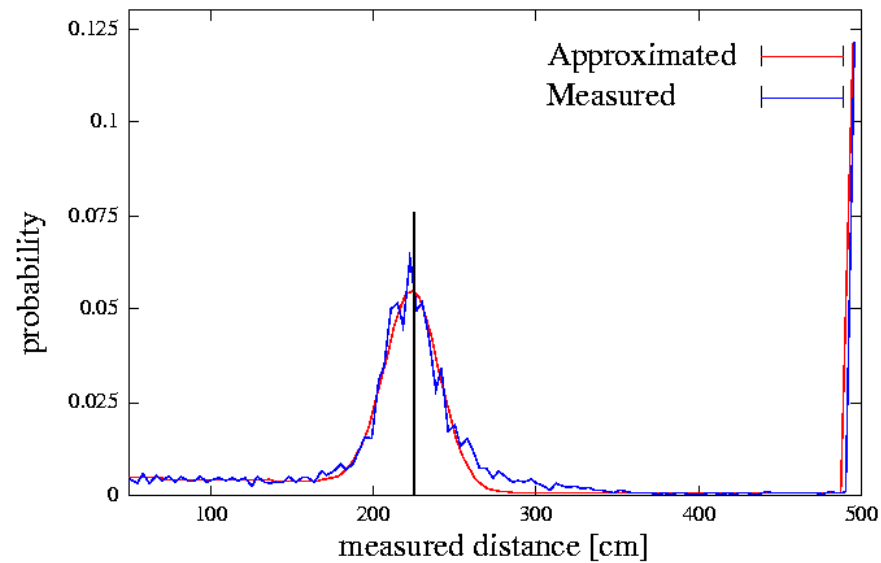
Error Propagation



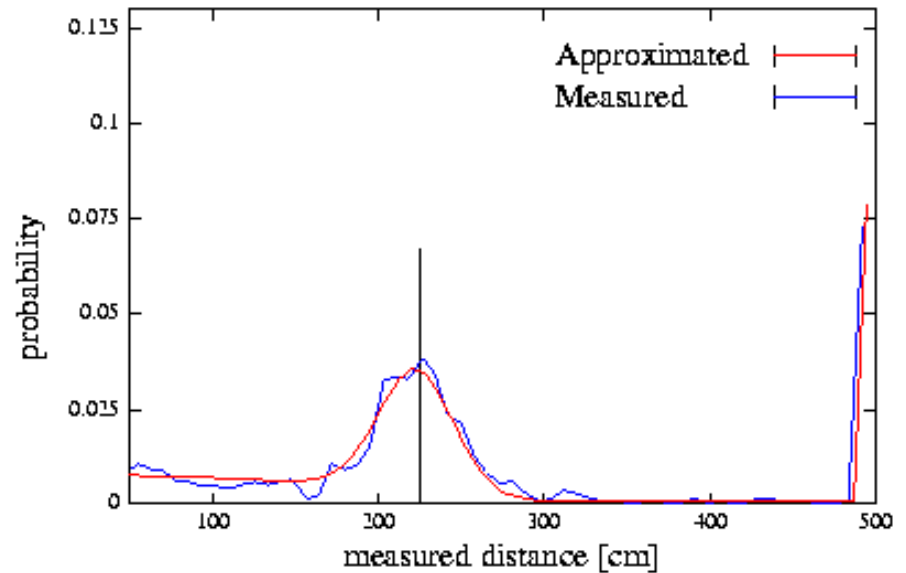
Typical Ultrasound Scan



Proximity Sensor Model



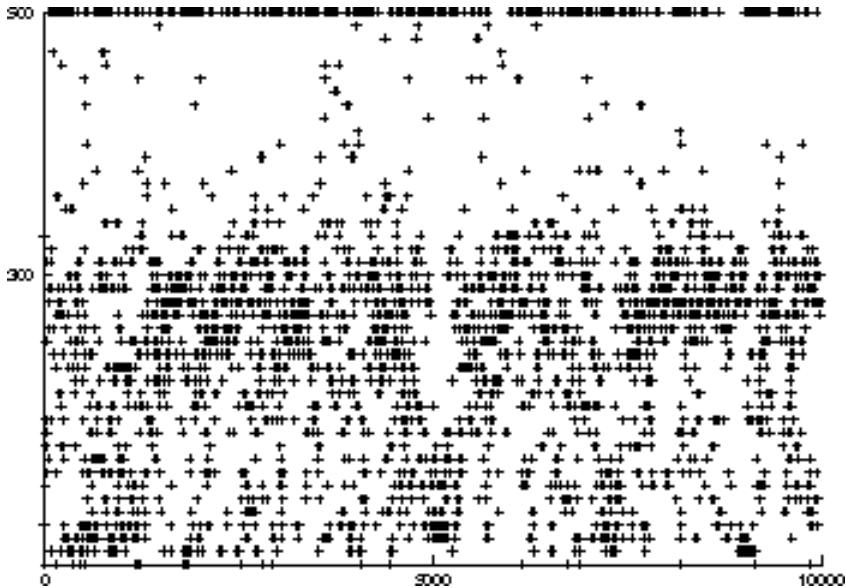
•Laser sensor



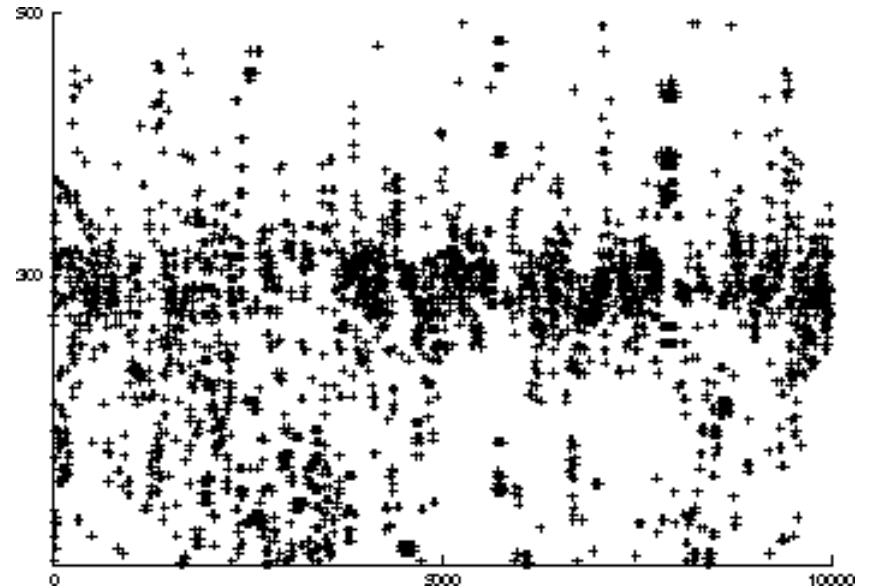
•Sonar sensor

Raw Sensor Data

- Measured distances for expected distance of 300 cm

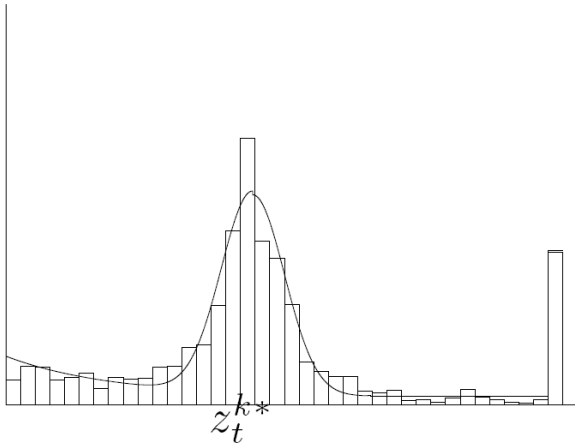


• Sonar

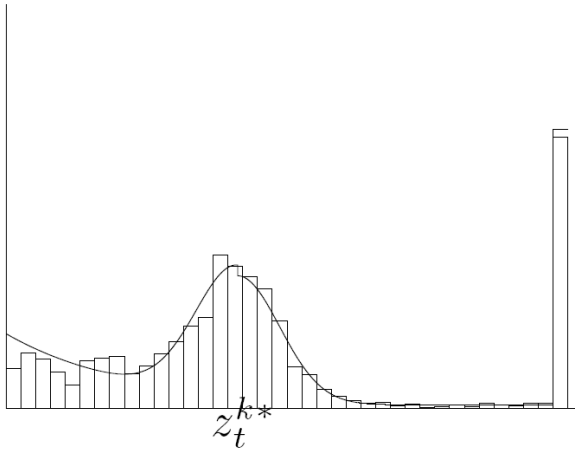
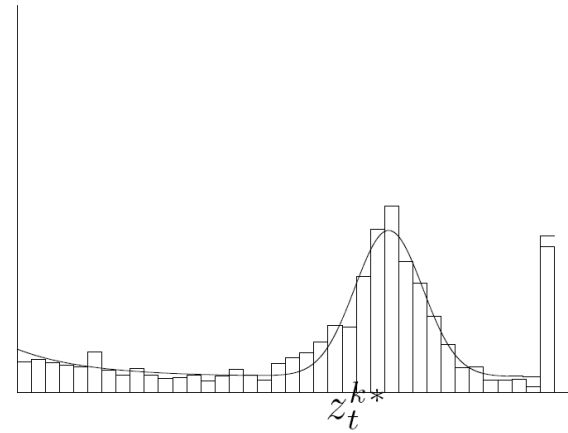


• Laser

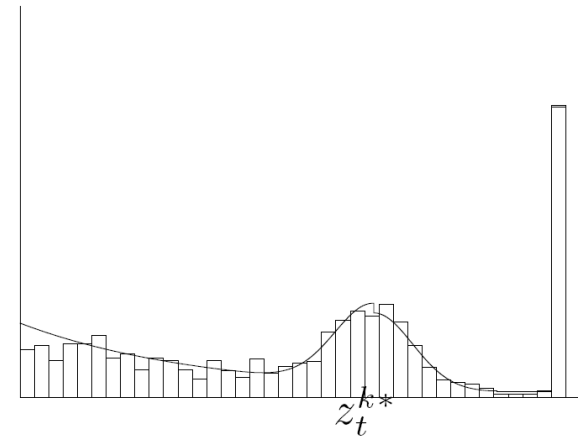
Approximation Results



• Laser



• Sonar

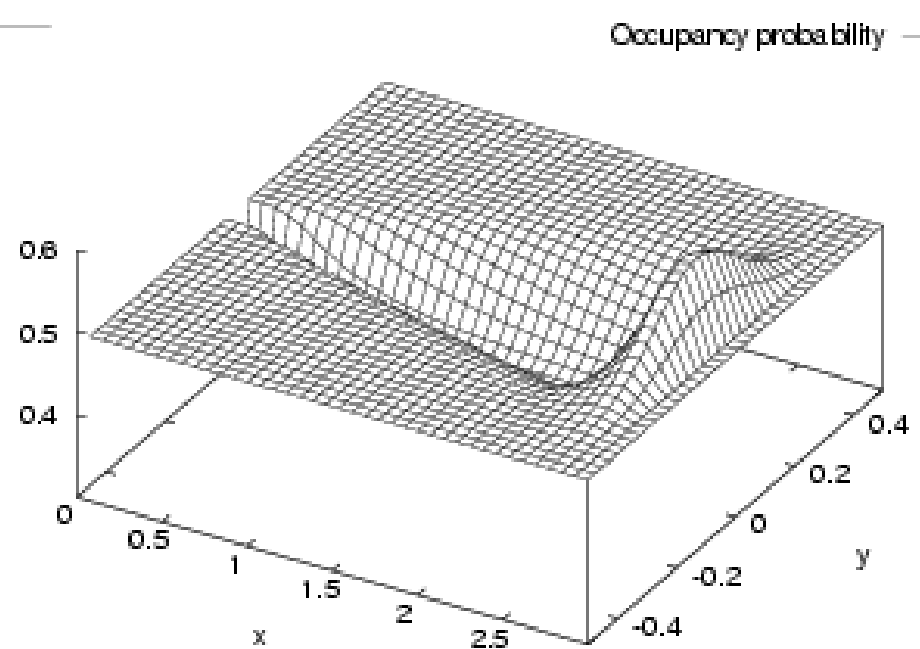
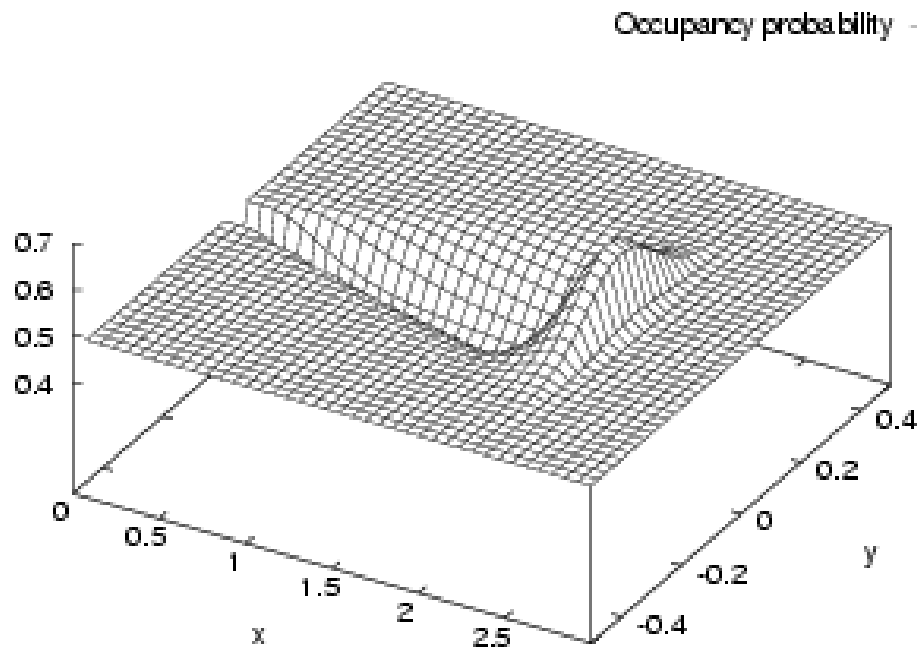


• 300cm

• 400cm

Typical Sensor Model for Occupancy Grid Maps

Combination of a linear function and a Gaussian:



Incremental Updating of Occupancy Grids (Example)

