

Robotics

Mobile Robots Navigation

Vladimír Smutný

Center for Machine Perception

Czech Institute for Informatics, Robotics, and Cybernetics (CIIRC)

Czech Technical University in Prague

1

2

3

4

5

6

7

8

9

10

11



1

Dead reckoning also known as deduced reckoning estimates current position as original position plus integration of all moves since then.

2

odometry

3

Doppler shift method

4

inertial navigation

5

Triangulation - angles

6

Triangulation - distances

7

8

9

10

11



Odometry relies on measurement of wheel rotation (two or more wheels) or wheel rotation and heading angle. Problem is the accumulation of errors.

1

2

3

4

5

6

7

8

9

10

11



Inertial navigation relies on the integration of the longitudinal and angular acceleration measurement and its integration.

1

2

3

4

5

6

7

8

9

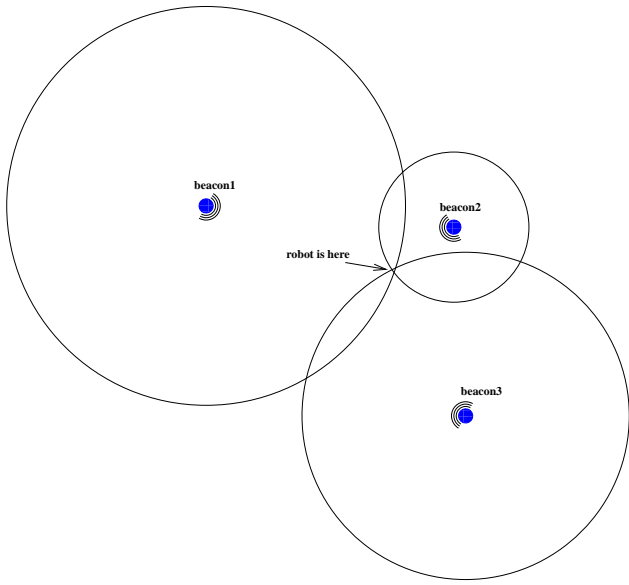
10

11

Accelerometers:

| Physical principle | Long. | Ang. | Measured variable |
|--------------------------------------|-------|------|----------------------|
| Mechanical gyro in Cardan suspension | No | Yes | 2-D orientation |
| Mechanical gyro in spring suspension | No | Yes | angular acceleration |
| Fiber optics gyro | No | Yes | acceleration |
| Mechanical accelerometer | Yes | Yes | acceleration |
| Solid state accelerometer | Yes | Yes | acceleration |

Position Estimation – Known Distances



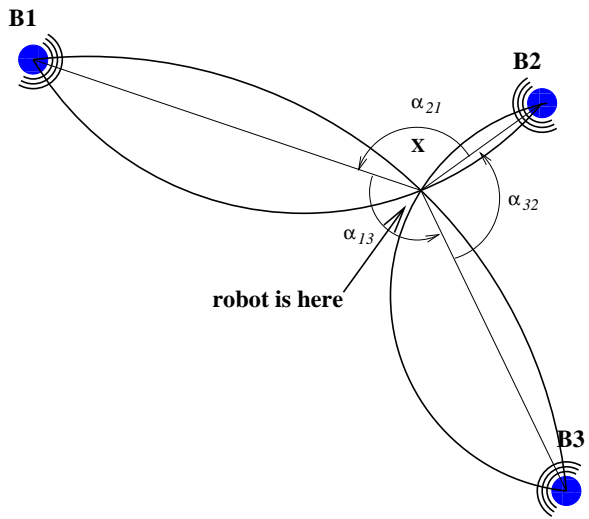
$$(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 = c^2(t - t_1)^2$$

$$(x - x_2)^2 + (y - y_2)^2 + (z - z_2)^2 = c^2(t - t_2)^2$$

$$(x - x_3)^2 + (y - y_3)^2 + (z - z_3)^2 = c^2(t - t_3)^2$$

$$(x - x_4)^2 + (y - y_4)^2 + (z - z_4)^2 = c^2(t - t_4)^2$$

Position Estimation – Known Angles

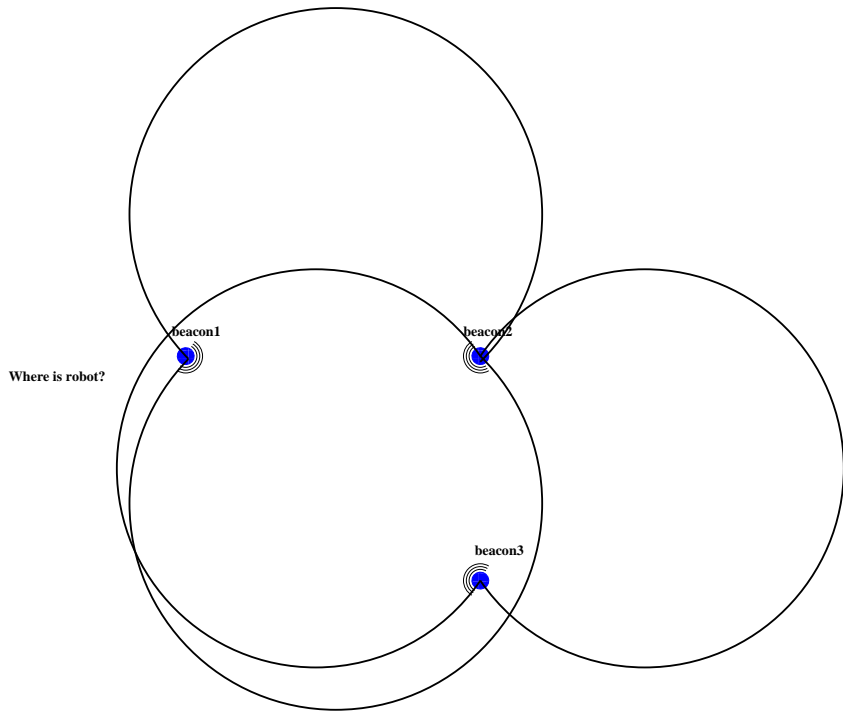


$$\|XB_1\|^2 + \|XB_2\|^2 - 2 \cos \alpha_{12} \|XB_1\| \|XB_2\| = \|B_1B_2\|^2$$

$$(x - x_1)^2 + (y - y_1)^2 + (x - x_2)^2 + (y - y_2)^2 - \cos \alpha_{12} \sqrt{((x - x_1)^2 + (y - y_1)^2)((x - x_2)^2 + (y - y_2)^2)} = (x_1 - x_2)^2 + (y_1 - y_2)^2$$

Set of two equations of fourth order gives four solutions as out from orientation of the measured angles α_{ij} seen on the next figure. The correct solution shall be checked

Position Estimation – Known Angles





Tactile sensors

Proximity sensors

1

2

3

4

5

6

7

8

9

10

11