Robot Navigation: Lecture 2

Litterature notes

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1 Sensor classification

Two important functional axes:

- Proprioceptive or Exteroceptive
- Passive or active

Proprioceptive sensors measures internal values of the robot, e.g. motor speeds, wheel loads joint angles, internal forces, battery voltage etc.
Exteroceptive sensors measures external information, i.e. from the environment. E.g. a Lidar
Passive sensors measures ambient environmental energy entering the sensor. E.g. temperature, humididty, microphones, etc.
Active Sensors can mange controlled interactions with the environment. These include wheel quadrature encoders, ultra sonic sensors and Lidar.

1.1 Performance

- Dynamic Range: Spread between lower and upper limits of the input values, during normal sensor operation. Measured in decibels dB and computed as $10 \cdot log[\frac{max}{min}]$.
- Resolution
- Lineariry
- Bandwidth

2 Sensors for Mobile Robots

There are 4 layers of information compression:
TODO: make slash snippet context based

1. Raw data
2. Features (corners, size, etc.)
3. Objects
4. Places or situations

Cognitive systems have to interpret situation based on limited information andonly partially available informations. This is a probability problem probabilistic reasoning
Wheel encoders are used for odometry, (Odometry is position estimation based on sensor information)

2.1 Accelerometer

We calculate the acceleration in accelerometers with: $F = \ddot{x} + c\overline{x} + kx$
where: $F = m\alpha$
and $\alpha = \frac{Kx}{m}$

2.2 IMU

The IMU is sensitive to noise in the accelorometer and the gyroscope. It has drift. Residual gravity vector results in a quadratic error in position

2.3 GPS

It uses trilatteration. The sattelite gives you only the position. The distance is not given. The distance is $c \cdot t$. We know the speed of the electromagnetic waves, i.e. the speed of light c. The position gives more like a gaussian distribution, which is used to estimate the position.

2.3.1 dGPS

We set up a base station with a known position, which is used to correct for position errors in moving objects.

2.4 TOF sensors

Time Of Flight sensors. Two different types:

1. Continous wave
2. Pulse wave

the distance is given as

$$d = c \cdot t$$

where, d is the distance, c is the speed of light, and t is time it took for the travel.

2.4.1 Laser Range Sensors

We can use phase shift measurement. Measured in pico seconds (1×10^{-12})

2.5 In Situ Sensor performance

- Systematic errors
- Random errors
- Precission
- Accuracy
- Resolution

We use a PDF to represent the possible sensor values. We use the mean value μ to represent the mean, where $\mu = E[X]$ Sensors can be independent. E.g. a temperature sensor and an IMU.
Whenever we can, we use the gaussian to represent the values. However this is often a simplification, which does not represent the realworld that well.
We use Variance and Covariance to represent the level of dependence. (Off. diagonal values in the covariance matrix)

3 Paper Reading

Papers will be presented and discussed in week 40 2 - 4 people in the group.
15 minute presentation, 5 minutes of questions. (RG)
Excel file for choosing papers.
Deadline for selecting: 17 september

4 Exercises

Compass calibration. Turn the tiago robot around, and plot the values.
Take the values and point move them to 0. Use the maximum and minimum values of the values to write the equation to move it into the origin. Then we need to reshape it from an oval to a sphere. Multiply it by the scaling factor.
We will get the projects on monday. We will get the projects on monday