Aerial Robotics

Perception

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Overview

Error Sources

- Error. the difference between the sensor's output measurements and the true values being measured
- Systematic errors. Factors or processes that can in theory be modeled.
- Random errors. Cannot be predicted using a sophisticated model; neither can they be mit- igated by more precise sensor machinery

In situ sensor performance

- Sensitivity. The ratio of output change to input change.
- Cross-sensitivity. Orthogonal to the target parameters for the sensor. The compass will also demonstrate high sensitivity to ferrous building materials.

$$error = \hat{z} - z \tag{1}$$

- Accuracy.

$$accuracy = 1 - \frac{error}{z} \tag{2}$$

- Precision. Reproducibility of the sensor results.

$$precision = \frac{range}{\sigma} \tag{3}$$

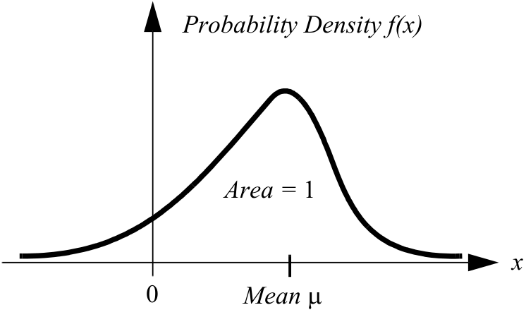
Uncertainty - Statistical representation

- A sensor takes n measurements

$$E[X] = g(p_1, p_2, \ldots, p_n) \tag{4}$$

where the true value is represented by a random variable X.

- A pdf defines the statistical properties of X.



Statistical representation

- Density

$$\int_{-\infty}^{\infty} f(x)dx = 1 .$$

- The probability of falling into an interval

$$p[a < X \leq b] = \int_{a}^{b} f(x)dx$$

- Mean value

$$\mu = E[X] = \int_{-\infty}^{\infty} xf(x)dx .$$

Statistical representation (2)

- Mean square value

$$E[X^2] = \int_{-\infty}^{\infty} x^2 f(x) dx .$$

- Variance

$$Var(X) = \sigma^2 = \int_{-\infty}^{\infty} (x-\mu)^2 f(x) dx .$$

Independence

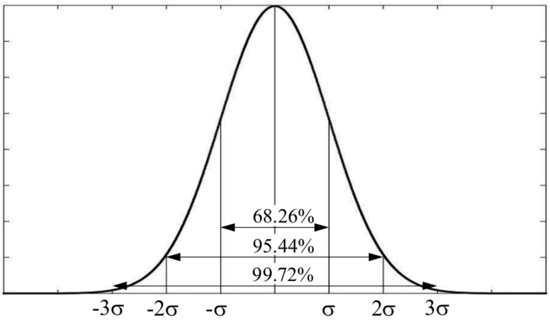
- Two random variables X 1 and X 2 are independent if the particular value of one has no bearing on the particular value of the other.
- The product of random variables is equal to the product of their mean values.

$$E[X_1 X_2] = E[X_1]E[X_2].$$

- The variance of their sums is equal to the sum of their variances.

$$Var(X_1 + X_2) = Var(X_1) + Var(X_2).$$

Gaussian Distribution



$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

Figura: Gaussian (normal) distibution.