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Sensor Fusion for Irregular Sampled Systems

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Chapter 1

Introduction

1.1 Motivation

Nature has learned to merge multiple information from several sources a long time ago, in order to have a better perception of the environment. Animals combine signals received by different senses, such as sight, hearing, smell, taste and touch to recognize the surroundings. Plants have an analogous sensory system, used to water consumption modulation, leaf-colour changes or structure bending towards the light, for instance. Throughout history evolution has led to highly complex and efficient muli-sensor systems in living beings.

Nowadays information fusion is studied in many fields of science, as a way of exploiting information from multiple sources to achieve better outcomes in comparison to those obtained if any of theses sources were used separately (Dasarathy, 2001). Other terms have been used to denote the merge of information in technical literature, e.g. "data fusion", "sensor fusion", "multi-sensor fusion" or "multi-sensor integration". To avoid confusion, the terminology used by (Elmenreich, 2002) will be adopted, whereby information fusion is understood as the overall term and sensor fusion is used in case the sources of information are sensors.

Some research fields have been taken increasingly advantage of sensor fusion techniques, such as robotics, military, biometrics and image processing. The main benefits expected are related to accuracy, due to the use of redundant or complimentary data, dimensionality, i.e. additional information being created by a group of data and robustness against failure and interference.

The most common application of sensor fusion is to estimate states of a process, based on the system dynamics, the measurement model, the disturbances and the prior information (Bar-Shalom et al., 2001). If the system is linear and Gaussian, the Kalman filter (KF) guarantees optimal estimation. For nonlinear processes, KF generalizations were proposed, such as the extended Kalman filter (EKF) or the unscented Kalman filter (UKF). Particle filters (PF) on the other hand can be used to deal with both nonlinearities in the dynamics and non-Gaussian distributions.

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Bibliography

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