



Data Fusion

Quite often, a measurement is obtained from different devices, or from the same device, used at different times or at different locations. For instance, a position may be estimated from the GPS, from inertia, and so on. An angle may be estimated from several points of view.

Each time, the same problem arises: how to "conciliate" the measurements ? The different devices do not give exactly the same answers, and even a single device gives different answers at different times.

This problem is known as "data fusion". It is often solved practically in an empirical manner. For instance, one attributes "weights" to each device, taking into account the level of confidence that one wants to give to them.

In order to solve this type of problem, SCM has developed a simple and robust methodology, which relies entirely upon probabilities. This method takes into account systematic biases, when they exist, and the scale factors (a scale factor appears when the device does not have the same precision all over the measurement scale, which is the case in practice: most devices are less precise at the end points of the measurement scale).

Our method explains how to realize "calibration tables", which are in fact conditional probabilities, in the mathematical sense, and how to use them for data fusion.

There is no a priori assumptions upon the errors of each device. For instance, the errors are not supposed to be gaussian. The method does not use filters, such as Kalman filters.

What we obtain is not just the most likely value, combining all the data. What we get is in fact a complete probability law: given all the available information, the method indicates what is the probability of any location. The most likely value is the expectation, and we also get intervals or ellipsoids of dispersion, when they are needed.

It applies to all situations where data fusion is needed, from two measurements or more. It indicates how the devices have to be calibrated, and, when this calibration is made, how to treat and combine the measures. Our method does not reduce to a computational protocol, but covers also the measurement phase. It provides a solid methodology for the treatment of complex data fusion problems.

References

1. Books

[MPPR] Méthodes Probabilistes pour l'étude des phénomènes réels. SCM SA, ISBN 2-9521458-0-6, ISSN 1767-1175. Second Edition, 2016 (in French).

2. Recent contracts

The theory was initially developed by us for the "Service des Missiles Tactiques", Délégation Générale pour l'Armement, French Ministry of Defense, between 1997 and 1999. It was used and validated in 2000, in a joint contract between Matra BAe Dynamics and SCM, for the "Service des Programmes de Missiles Tactiques": our method lead to a very significant improvement of the final precision of an air-to-ground missile, using the information given by an infra-red camera.

- SNECMA Propulsion Solide, 2009-2010: Probabilistic Methods for reliability.
- Groupe Total, 2010: Probabilistic methods for the evaluation of the amount of pollutant.
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- Commission Européenne (with the Poyry Group), 2011-2012: Probabilistic methods for water quality.
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- Suez Environnement, 2011-2012: Probabilistic methods for water quality.
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- DCNS, Indret, 2013 : Hierarchy of parameters in an industrial process.
- Coop de France déshydratation, 2013 : Hierarchy of parameters and their influence upon a deshydration process.