Systems Engineering for Autonomous Systems
Defence Technology Centre

SEAS DTC

Exchanging Multi-Level Maps (SEN016)

This SEN016 IF study has succeeded in developing a proof-of-principle that shows it is possible to:

- Exchange three maps: two maps were input, one was output;
- Represent uncertain knowledge of a small 2d world;
- Consider multi-sensor and multi-resolution maps.

The development of QinetiQ's Bayesian Modelling Toolkit (BMT) software, made it possible to develop this proof-of-principle. However, the fact that the BMT is a general purpose tool, the internal representations used are currently too general to facilitate high throughput processing.

Aim

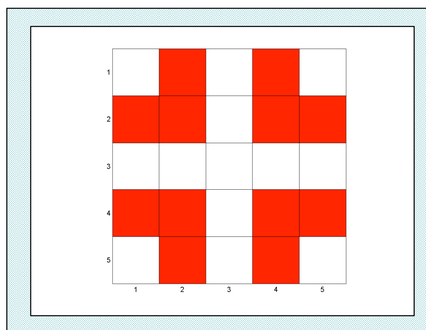
Develop a data-structure that can act as an atlas and facilitate the exchange of maps derived from different sensors at different resolutions. This enables an autonomous robot to capitalise on all other robots' historic data and O/S maps.

Approach

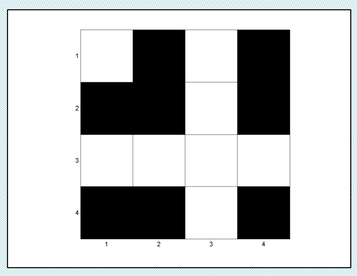
The assumption is that the problem is dominated by the uncertainty associated with the transformations between maps and the content of the world. The approach adopted is to model this uncertainty in a Bayesian Network.

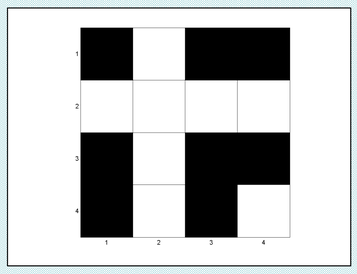
Outcomes

The IF study has developed a proof-of-principle which shows it is possible to use the proposed approach to solve the identified problem. Interaction with other projects has highlighted the scope potential future A&A and SEN research.

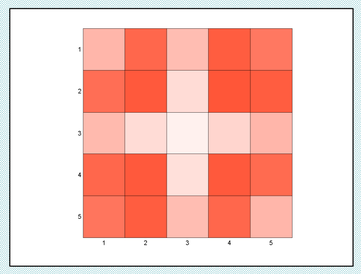


The "world" is the underlying (and unknown) true state.

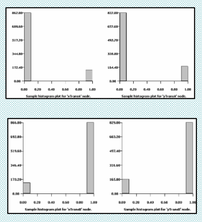




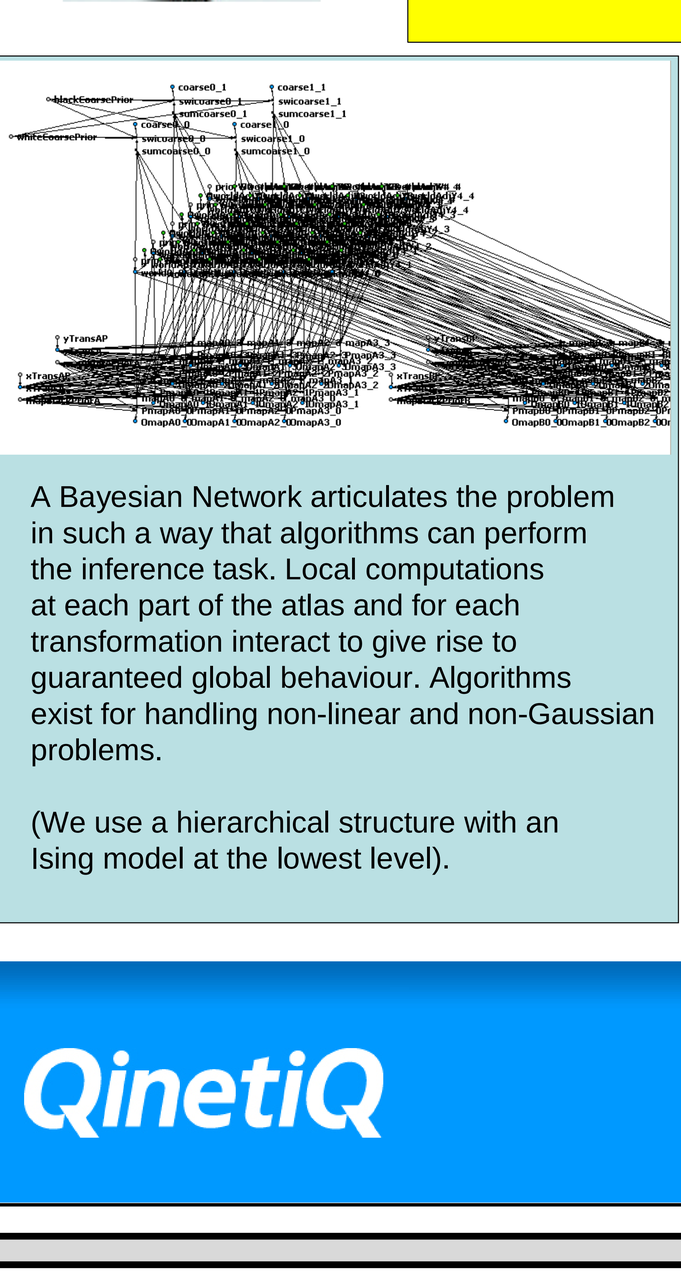
Sensors 1 and 2 make maps of part of the world with noise and an unknown parameter for the transformation.



The "atlas" contains the uncertain knowledge of the world (from which estimates can be derived), inferred from the observed maps.



The "atlas" also contains the uncertain knowledge of the transformations, inferred from the observed maps.



A Bayesian Network articulates the problem in such a way that algorithms can perform the inference task. Local computations at each part of the atlas and for each transformation interact to give rise to guaranteed global behaviour. Algorithms exist for handling non-linear and non-Gaussian problems.

(We use a hierarchical structure with an Ising model at the lowest level).

Future work in A&A Theme: Consistent Large-Scale Metric SLAM

Discussion with Oxford University highlighted that metric mapping is statistically inconsistent over large time-scales. Recent research highlights the relevance of novel sequential parameter estimation technique.

QinetiQ

UNIVERSITY OF OXFORD

Potential future work in SEN theme: Exchanging Multi-level 3D Maps

Discussion with Waterfall Solutions highlighted potential to apply technology with 3D visualisation technologies being developed in the SEN theme.

The discussion also highlighted the potential utility of using probabilistic techniques to perform robust localisation of landmarks (ie handle association ambiguity)

QinetiQ

waterfall SOLUTIONS

Contact : srmaskell@qinetiq.com

QinetiQ

SEAS DTC

DTCs : Industry and the science base working in partnership with UK MoD to develop innovative defence technology

The work reported here was funded by the Systems Engineering for Autonomous Systems (SEAS) Defence Technology Centre established by the UK Ministry of Defence