# RoMAT: Exploiting a Multi-Agent Model for Data Fusion

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We have investigated the use of multi-agent system for Multi Sensor Data Fusion (MSDF) where percetual and interpretation agents interact according to cooperation strategies. The resulting Robotic Multi-Agent Testbed (RoMAT) is applied to a mobile robot concerned with map building in unknown structured environment.

## Multi-Agent Approach for Data Fusion

Data Fusion is defined as a process of integrating information from multiple sources to produce the most specific and comprehensive unified data about an entity, an activity or an event.

We propose a multi-agent model to build adaptive hybrid multi-sensor data fusion systems which are composed of two categories of agents:

- *perceptual agents* which are defined for perception activities and manage one or several sensors. They process numerical data using signal processing algorithms to extract pertinent information.
- *interpretation agents* that handle the resulting information to build and maintain a (partial) symbolic model of the system environment at a higher level of abstraction.

Each agent is built as a set of specialists (which represent skills) that communicate through a space of shared-memory.

Inter-agent communication is ensured by message passing: perceptual agents send percepts to interpretation ones which respond with messages that inform about the environment model or with perception request.

Agent activities are coordinated to ensure cooperation and an optimal behavior of the society in any kind of situation. The problem is to adjust the flow of percepts to the activities of interpretation agents, i.e., not to overwhelm interpretation agents with amounts of percepts which are predictable or unreliable. This is achieved by communication protocols which aim to reduce conflicting activities and to favor complementary activities. Protocols policy the communication bandwidth: since perceptual agents act autonomously they have to individually adjust the frequency of message sending to the workload of interpretation agents.

## Application to mobile robots

This model has been applied in robotics within the RoMAT experimental testbed (which is a Nomad 200) that comprises laser and sonar units for long range sensing, and infrared and bumper sensors for short range sensing. The application is dedicated to build and maintain a map of the robot environment (thus only laser and sonar sensors were used in our experiments).

The application is composed of two perceptual agents (one to manage sonar units and one to manage the laser system) and one interpretation agent for map building. They are implemented as Unix processes, agent communicate together via IPCs and with the sensors via sockets.

We performed several experiments with the robot simulator to investigate coordination protocols that can be used in data fusion system. Results have been examined towards the map building process.

These experiments show that local autonomy in a data fusion system increases the quality of interpretation. They have also shown that modulating the interactions between agents is a good way to adapt the system to its context. Appropriate cooperation strategies intend to adapt the MSDF activities to the primary goals of the system with real time constraints. The agent architecture is such that adaptation to new kind of sensor can be achieved by only providing a new specialist to the concerned perceptual agent without bringing into question the society.

Future work will focus on developing auto-adaptive communication strategies in order to improve system adaptation to its context and to include the data fusion system in a global platform for mobile robotics.

## References

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