1.6 Artificial Intelligence Architecture for Shepherds and Sheepdogs

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Overview

1.6.1 Shepherds and Sheepdogs Autonomy Architecture

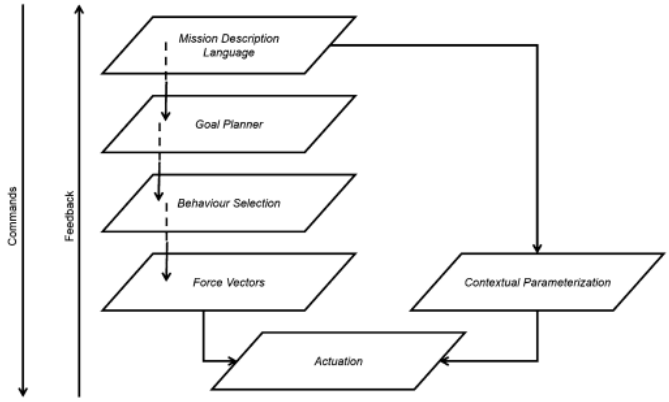


Fig. 1.2 An artificial intelligence architecture for the decision making functions for shepherding

Example for the structure:

"Collect all sheep and bring them to the goal location within 30 minutes from now, while not stressing the sheep, using two sheepdogs of type A and three sheepdogs of type B"

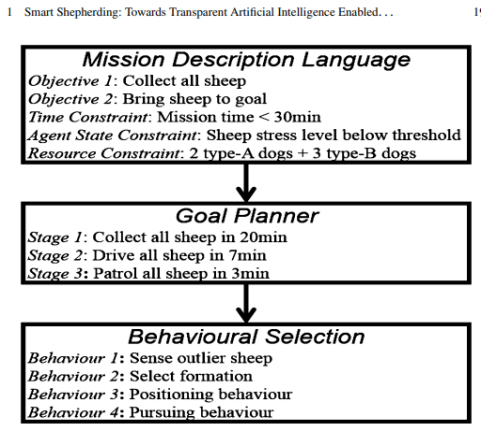


Fig. 1.3 A shepherding example using key components of the autonomy architecture

1.6.2 Shepherds and Sheepdogs Contextual Awareness Architecture

Situation Awareness: perception, comprehension, and projection

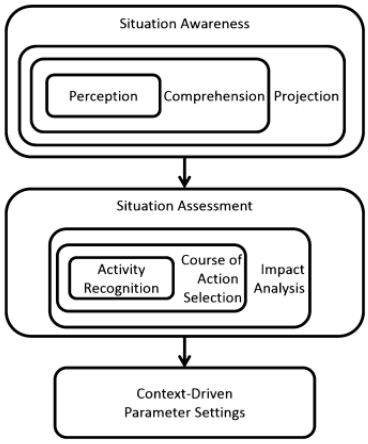
Raw data→features→flock-based state info→estimation

Situation assessment: activity recognition, course of action selection, and impact analysis

produce activity information of sheepdog shepherd→a course of strategies to achieve goals→assess the impact of the selected course of action on the mission

Context-driven parameter settings: parameterise the force vectors based on the context

Fig. 1.4 A contextual awareness architecture spanning sensing, perception and context-driven parameter setting



1.6.3 Smart Shepherds and Sheepdogs Overall Architecture

The architectures from 1.6.1 and 1.6.2 use modualism:

- Neat, efficient and easy to maintain

Need bridges between modules to pass essential information, bridges should :

- Minimised to reduce system complexity
- Cannot be removed without have negative consequence on the performance of the system
- Provide feedback loops which enables modules to make informed decisions

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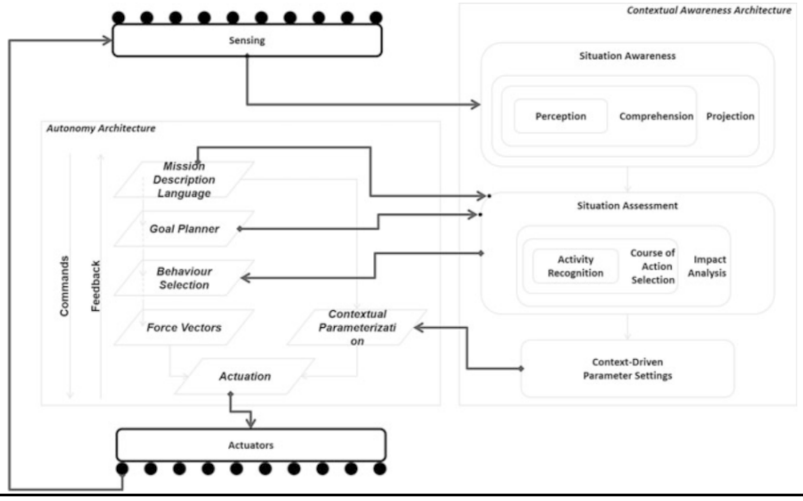

1.6.3 Smart Shepherds and Sheepdogs Overall Architecture

Links between autonomy and conceptual awareness architecture:

- 7 links in total added, 2 of them are links to sensors and actuators

The interdependency between a module in the autonomy architecture and a module in the contextual awareness architecture is necessary for the agent to function as a smart agent, while maintaining a well-designed modular cognitive architecture

1.6.3 Smart Shepherds and Sheepdogs Overall Architecture

The links between some of the actuators and sensors allow for direct interaction with sensors:

- E.g. situation assessment may lead to actions to actively direct sensors to a specific regions in the environment to collect data

Active sensing let agents to independently control its own orientation and its sensors' orientation:

- E.g. orienting a gimbal mounted camera on a robot sheepdog towards the furthest sheep location without changing the orientation of the robot itself

Allow for a dynamic configuration of its sensors:

- E.g. Adjust camera zoom in and out

1.6.3 Smart Shepherds and Sheepdogs Overall Architecture

Radio receivers may be represented as sensors and radio transmitters may be represented as actuators:

- Agent-to-agent communication is possible
- Communication is not a mere exchange of information:
  - Improve another agent's situation awareness
  - Delegate the execution of sub-goal to another agent

Conclusion

Cognitive is needed to enable effective swarm control

Complexity lies in providing the right information at the right time

Artificial sheepdog only needs to archive the same objective as a real sheepdog but not need to be an exact replica

The artificial incarnation requires AI algorithms ranging from those analysing data such as clustering, classification, and point prediction to those making plans and decisions

Artificial sheepdog further enhance shepherding capability