SC42050 Literature Assignment

The role of cooperative agents in a modern warehouse concept

Robert Babuska

This assignment pertains a novel concept of a warehouse which is based on a large number of cooperative autonomous robots. The system has been developed by Kiva Systems and its basic features are described in the attached article. During the first reading of this article, many question pop up to which no clear answer may be given in the paper (Wurman et al., 2008):

- The title mentions cooperative, autonomous vehicles. What is meant by 'autonomous' in this application? Clearly, for the operation of the warehouse to be safe and cost-effective, collisions, deadlocks, waiting queues and similar problems have to prevented by coordinating the robotic agents. To what degree can they still be autonomous?
- The authors also name a number of quite diverse commercially available autonomous vehicles – are they all very similar in terms of the requirements on their operation, and in terms of the underlying technologies and control mechanisms? What are their common features and where are the differences?
- The authors mention that the Kiva system is highly influenced by AI. What are the particular AI techniques used? Do the methods and algorithms applied give guarantees of fail-safe and optimal operation?
- What is the difference between the multi-agent solution used in this application and a more conventional centralized solution? It should be possible to control say up to several hundred robots from a single computer, so why the multi-agent solution?
- *Swarm intelligence* methods may offer an alternative approach. Have these methods been considered by the authors? In the literature, are there any similar or related applications of swarm intelligence?

An engineer considering an application of this concept in a different environment or country (e.g., in the Netherlands), would probable ask many other questions, too. Such as – how is the performance measured? Can I make sure beforehand that the Kiva system will outperform our current solution? And so on. You may take these issues into account as well, especially if you are familiar with (some of) the warehouse solutions applied in the Netherlands.

References

Wurman, P. R., D'Andrea, R., and Mountz, M. (2008). Coordinating hundreds of cooperative, autonomous vehicles in warehouses. *AI magazine*, 29(1):9.