Design and Implementation of a Stacking Centre with Autonomous Vehicles

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Abstract

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The Intelligent Stacking Centre (ISC) is an automation logistics system with the main purpose to use autonomous vehicles (agents) to transport various goods from one place to another. In order to handle different requirements given by customers, a number of distributed components cooperate to achieve the requested solutions.

Developing this system rises a wide variety of engineering challenges ranging from mechanics via electronics to software. This thesis will discuss two software parts extensively: The so called Central Intelligent System which is the central server that coordinates all other components and the Agent System which is the software that controls agents.

The Central Intelligent System (CIS) combines functionality that can be found in traditional warehouse management systems (WMS) and warehouse control systems (WCS). It provides a number of software components such as a basic box management that keeps information about storage containers (so called boxes) and functionality to manage storage locations with its geo-code and information whether a box occupies the location or not. Another important part is the order management that provides mechanisms to deal with customer specific information, different kinds of orders to the system and customized interactions upon various order specific events. The gap between WMS and WCS is filled by the transport management which receives requests for boxes by the order management and offers it to the agent management that controls the agents and engages them with transports. The separation of the components through interfaces helps to make the system as flexible as possible and allows customer specific builds that chains components together as needed. Throughout the design phase of the system a lot of effort was put into keeping the system testable (with unit tests) to provide a very error prone and stable system.

The second important part is the Agent System (AS). It consists of a layered architecture that provides a central "decision" layer to react to various inputs and allows manual and automatic control, a "planning" layer that coordinates automated tasks to fulfill higher level jobs given by the CIS and an execution layer to gain hardware independence and increase testability. A well defined interface for automated tasks allows task developers to easily design new tasks, react to various errors and offer user friendly error handling. This was an important design aspect to support people without a lot of special knowledge to keep the system alive and clear various errors on their own. Another requirement which is a very common and essential part when developing for the automation industry influenced the development phase: It is essential to always keep control over the system. This means that the program may never terminate and as many errors as possible need to be handled in order to guarantee safety for people and hardware.

A core element of the whole system worth mentioning is a special developed graph. It is the base for each agent to navigate autonomous and as generic as possible through different warehouse systems. It offers a solution for agents to safely traverse the warehouse graph without dead-locking the system with other agents and interact with distributed components like an elevator to pass horizontal ways. The generation of the graph data for a custom installation is quite complex as well and a self-made SVG visualization of the graph helps during construction.

As this extract shows there are a lot of interesting technical topics that are covered within this project but still a lot of effort is needed to optimize the system to increase throughput and performance. This includes software specific parts like optimizing algorithms and approaches to solve different problems. Furthermore the logistics and process viewpoint like minimizing the distances agents have to travel and coordinate their behaviour at the best, is an essential part that is worth thinking about.