

## Design for Material Handling Systems using Co-evolution (Prof. J. OTA)

Recently, manufacturing systems must have high flexibility to cope with dynamic changes of their environments. In this background, we have researched several subjects concerned with the material handling systems as follows,

1. Integrated design for Automated Guided Vehicle (AGV) system in a factory
2. Material arrangement in a warehouse
3. Design for AGV systems in a port of delivery

In the 1st subject, we should solve 3 design problems, (1) flow path network design so as to guide AGVs, (2) transporter routing design so as to complete the transportation and (3) integration design of these both (1) and (2) problems. We propose the methods for these problems as follows, (1) flow path network design using Genetic Algorithm (GA), (2) transporter routing design with parameterization of multi-agent motion planning, (3) to design both using cooperative co-evolution. An appropriate AGV system can be designed by this method (see Fig.1).

In the 2nd subject, 3 problems should be solved, (1) to decide transferred items so as to arrange the warehouse, (2) to plan paths of forklifts and (3) to re-plan the paths due to the errors of forklifts controlled by workers. We propose the methods for these problems, (1) decision of moved items with Simulated Annealing (SA), (2) to plan paths of forklifts using Greedy Algorithm as a k-stacker crane problem (k-SCP), (3) re-planning the paths by solving k-SCP with less information in order to be solved within short time. We can arrange a warehouse by this method (see Fig.2).

In the 3rd subject, 3 problems should be solved, (1) to design a motion controller for an efficient transportation, (2) to assign tasks effectively and (3) to design a layout of ground slots. We propose the methods for these problems as follows, (1) to design a motion controller to decide the speed with the distance from the car in front dynamically, (2) to assign the tasks that are designed on offline in advance, (3) to design a layout of ground slots using GA. Efficient AGV system in a port of delivery is designed with above methods (see Fig.3).

*Keywords:* Automated Guided Vehicle, Co-evolution, Material Handling System

### References

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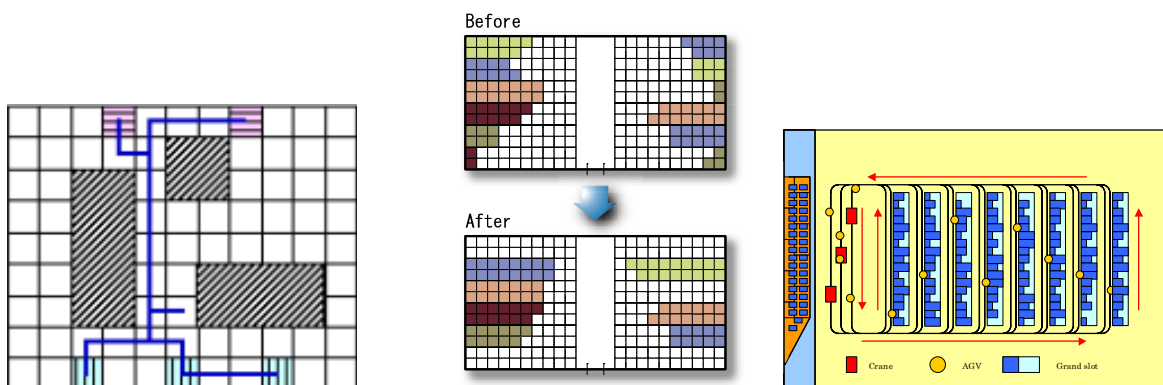


Fig. 1 AGV transportation system in a factory

Fig. 2 Arrangement in a warehouse

Fig.3 AGV system in a Port