Proposal for master thesis in software engineering

Authors:
Patrik Kosowski, Olof Persson

Email:
patrik.kosowski@gmail.com, olof.82@gmail.com

Title:
Constructing dispatching strategies for the IPSI AGV system and evaluating them with Multi Agent Based Simulations.

Link to master project:
http://www.oponline.se/master-thesis

Size:
20x2 weeks of work

Advisor:
Lawrence Henesey

Start-and end date:
2006-06-12 → 2006-10-27

Thesis type:
Evaluation through Multi Agent Based Simulations.

Background:
Logistics is the world’s second largest industry, and the importance of refinement is increasing along with the growing amount of containers that port terminals are required to handle each day. The management of port terminals is searching for more efficient ways of handling containers. In addition to that, new ships that are built tend to be larger then previously built ships. This puts the ports on the edge of their limitations and to handle this rising problem the ports have started to look for different solutions to reduce costs and increase the efficiency.

To solve this problem some ports have started using Automated Guided Vehicles also known as AGVs, but to this day they are still being operated by humans to a certain extent. There are some companies that are using AGV systems to handle the transportation between the quay-crane and the stacking area (ECT in the Netherlands and CTA in Germany). However, the AGVs in those systems get containers loaded on to them directly. There is another AGV system that recently has been developed by the company TTS Port Equipment AB [7] called the IPSI AGV system, which is using cassettes to carry the containers. One of the benefits of using cassettes is that they can carry multiple containers at once. Another factor that makes the use of cassettes beneficial is that the quay-crane can drop off a container without the presence of an AGV. There have been some studies regarding AGVs using cassettes [3]. However, that study does not consider dispatching and selecting jobs very extensively, which will be the focus point in this paper.

Aims and objectives:
Our main aim with this thesis is to construct and evaluate dispatching methods for the IPSI AGV system. To the best of our knowledge, no study has been conducted yet on dispatching strategies for the IPSI AGV system. Therefore, already explored dispatching strategies [1, 2, 4, 5] will be investigate and re-evaluated with suitable modifications to suit the IPSI AGV system. Our findings i.e. MABS will be performed and evaluated in a created Multi Agent Based simulator that are using already existing packages from the open-source simulation framework Desmo-j [6]. The result from the simulations will then be evaluated from both a cost and a time standpoint, with the purpose of increasing the
understanding of how different dispatching policies perform in a live container terminal environment with the IPSI AGV system.

**Research question:**

RQ1. Which methods has been tested and proven successful for dispatching AGVs in earlier systems?

RQ2. Is it possible to reuse previously applied methods in order to dispatch IPSI AGVs?

RQ3. Can these methods be implemented and evaluated through MABS?

RQ4. How will these newly applied methods perform in the matter of efficiency compared to each other in MABS?

RQ5. How will the IPSI AGV technology perform against the other AGV systems that are not using cassettes in the matter of efficiency?

**Expected outcome:**

As most of the result from this study is dependent on the outcome of the simulations that will be preformed during this study, this makes the expected outcome much more uncertain. However, the results will indicate how different dispatching methods perform under various situations, and that the usage of cassettes will reduce the number of needed AGVs with a similar or an increased level of efficiency.

Already used algorithms which have shown some promising result for AGV systems without cassettes such as the Greedy algorithm [4] and Network Flow Method [5] will be re-evaluated with the consideration of the usage of cassettes. The results from MABS will show if these methods are applicable to the IPSI AGV system, and are in fact something to consider in the future when designing a container terminal system that is using the IPSI AGV system.

**Research methodology:**

Our proposed methodology is quite straightforward for this study, and consists of three main steps, which are connected to the intended structure of the entire thesis.

**Step 1:**

In order to investigate and answer the first research question, a quite extensive literature review will be preformed as a first point. The review's main purpose is to gather previous work that can be of value for this study, article such as [1, 2, 3, 4, 5] will be analysed and carefully considered. Further, previous used dispatching algorithms will be reviewed and explained, together with an extensive explanation and presentation of AGV systems and container terminals to inform the reader about the background. In addition to that, at least two case studies of container terminals will also be preformed; with the purpose of giving us better understanding of the different aspects revolving a container terminal. This will benefit us with an increased critical view, which will be beneficial when reviewing articles and other sources revolving this area.

**Step 2:**

The second step of this methodology aims to answer research questions 2 and 3, which is mainly connected to constructing and implementing IPSI AGV dispatching models. As much of the previous work related to this area have been directed to other systems than the IPSI, this study intends to use already existing algorithms such as the Greedy algorithm [4], Network Flow Method [5], when designing and constructing these dispatching strategies.

After this activity has been finalized, a multi agent based simulator will be created with purpose of evaluating these dispatching strategies. This simulator will be implemented with mapped entities from a container terminal, and use already existing packages from the open source simulation framework Desmo-J [6]. This study will also contribute with an additional package to this framework, that mainly consist of a GUI together with the mapped entities to support dispatching evaluation, which can be used for further studies revolving the IPSI AGV system. Obviously, one of the most critical validity
aspects that this study has is the creation of this simulator. Therefore, we intend to fully encounter for what is done during this stage.

**Step 3:**
The last and final step for this proposed methodology is analysing and presenting the result from the simulations with the purpose of answer research question 4 and 5. The result will be first and foremost compared against each other in order to find the most efficient strategy from different standpoints such as time and resources etc. This study will also consider the results obtained from other non cassette using AGV system by setting the number of used cassettes equal to the number of AGVs in the simulator. This will give us the differential performance of the two AGV systems. Altogether, as the main goal of the whole study is to investigate our previously stated research questions. The presented work that is obtained from these steps should all contribute to that, which enables us to conclude and answerer these questions. Suggestions for future work will also be considered during this stage, in order to inspire the reader to perform further studies revolving this area.

**References:**


[4] Ebru K. Bish, Frank Y. Chen, Yin Thin Leong, Barry L. Nelson, Jonathan Wing Cheong Ng, and David Simchi-Levi - *Dispatching vehicles in a mega container terminal*, 1 Virginia Polytechnic Institute and State University, Department of Industrial and Systems Engg., Blacksburg, VA 24061-0118, USA, 2 The Chinese University of Hong Kong, Department of System Engg. and Engg. Mgmt., NT, Hong Kong, China (e-mail: yhchen@se.cuhk.edu.hk), 3 Port of Singapore Authority (PSA), Singapore, Singapore, 4 Northwestern University, Department of Industrial Engg. and Management Sciences, Evanston, IL, USA, 5 University of Hong Kong, Department of Industrial and Manufacturing Systems Engg., Hong Kong, China, 6 Massachusetts Institute of Technology, Department of Civil and Environmental Engg., Cambridge, MA, USA.

