Development and evaluation of dispatching strategies for the IPSI AGV system

by Patrik Kosowski and Olof Persson
Container Terminal Issues:
• Increasing overall throughput (1984-2004, 39 million to 356 million TEU)
• Space restrictions
• Provide as fast ship turnaround time as possible ($180 000 operating cost)
• Automated technology
e.g. Automated Guided Vehicles (AGV)

Automated Guided Vehicles (AGV):
• IPSI (Improved Port Ship Interface) AGV:
a cassette-based AGV system
• Problem Areas: Dispatching, Routing, Navigation,…
• No studies on dispatching IPSI AGVs: Greedy, Look ahead, Inventory and Hybrid.
Equipment found at a CT

- Quay-Crane
- Trucks
- Straddle Carrier
- AGV
- Stacking-Crane
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Visualization of CT

CT Simulation

IPSI AGV 1

IPSI AGV 2

IPSI AGV 3
Investigated Dispatching Strategies

- **Greedy**
  - Lowest cost based on distance
  - FIFO (First In First Out)

- **Greedy Look-Ahead**
  - Lowest combination cost based on distance
  - Using due times for job selection

- **Inventory**
  - Highest crane inventory level
  - FCFS (First Come First Served)

- **Hybrid**
  - Combination of Greedy and Inventory
Simulation Model

Active entities
- Quay-Crane
- AGV
- Stacking-Crane

Non-active entities
- Ship (Job list)
- Cassette
- Yard
The AGV Simulator

- DESMO-J / JAVA
- Process oriented implementation
  - Own lifecycles and data structures
- Verification
  - Basic scenarios without interruptions was calculated
  - Quay-Crane Service time
  - AGV traveled distance
### Simulation Experiment

#### Yard parameters:
- Number of jobs: 6960
- Number of containers: 12480
- Yard width: 50 meters
- Buffer width: 20 meters

#### QC parameters:
- Number of Quay-Cranes: 6
- Quay-Crane throughput: 40 / h
- Quay-Crane buffer size: 6

#### AGV parameters:
- AGV speed without any load: 12.5 m/s
- AGV speed with half full load: 11.1 m/s
- AGV speed with maximum load: 8.3 m/s
- AGV raising and lowering delay: 15 seconds

#### SC parameters:
- Number of Stacking-Cranes: 12
- Stacking-Crane throughput: 40 / h
- Stacking-Crane buffer size: 8

#### Simulations:
- Pre-Runs without interruptions: 112
- Number of AGVs: 6 10 14 18
  - Number of Cassettes: 42 42 42 42
- Number of Runs: 10*4*12
Results – Unloading time

GREEDY
GREEDY LOOK AHEAD
INVENTORY
HYBRID

AGV - Cassette

Seconds

0 50000 100000 150000 200000 250000 300000 350000

Results – Unloading cost

Observations:
• High cost = low amount of cassettes
• IPSI AGV specifications

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<th>Hybrid</th>
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Epilogue

Conclusions:
• Performance dependent on cassettes
• One AGV per QC (when using 6 QCs)
• Cost est. more suited than inventory based

Future Work:
• Find solutions for the job due time problem (Look Ahead)
• More investigation on the Hybrid algorithm
• Increase the number of runs with other scenarios

Questions:
Thank You!

THE END