PRODUCTION LOGISTICS IN THE INDUSTRY 4.0 ERA

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AGENDA

PRODUCTION LOGISTICS AND INDUSTRY 4.0

MACRO-LAYOUT & MATERIAL HANDLING SYSTEMS

MICRO-LAYOUT & HUMAN-CENTERED WORKSTATIONS

CONCLUSION & FUTURE RESEARCH
Requirements of production and logistics systems 4.0

- Interconnection of production modules
- Routing flexibility of material handling systems
- Integration of production and logistics systems
- Dynamic reconfiguration
- Scalable automation
- Human-centered workstation
- Human-robot collaboration
- Real time access to production and materials info
- Simulation based on real time data
- ...

MACRO LAYOUT LEVEL

SMART MATERIAL HANDLING SYSTEMS
1. Introduction

Some of the most influential management concepts assemble systems from Henry Ford’s assembly line to the more recent Toyota Production System and 5S. Currently, assembly systems experience dramatic changes in terms of flexible,customized,fast and automated workflows. Modern markets demand features, e.g., short product life cycles, short time to market, the ability to offer customized products at prices or define as mass customization). It is clear that the design and management of assembly systems has become essential on several fronts. The need for customization can be summarized in the following:

Dimensioning of a Rail Guided Vehicles system with real throughput estimation

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Abstract: An automated parts-to-picker picking system consists of an automated warehouse with Automatic Storage and Retrieval Systems (AS/RS) that store the Stock Keeping Units (SKUs) of the various needed products, from their working location, and of a picking area, with linear manipulators or robots that pick the needed items in order to convey a mixed picking unit. The automated warehouse and the picking area are connected by an automated transportation system, which includes the AS/RS. The transport vehicles consist of a rail guided vehicles (RGV), which are guided by a magnetic code, with an integrated two-tier pneumatic conveyor system which transports the picked items to the picking area. By integrating the RGV system, a two-tier pneumatic conveyor system, and a building information model, a mixed picking system was built which can be used for small and medium-sized companies. The building information model, together with the rail guided vehicle, can be used to estimate the throughput of the picking system. Moreover, the picking system was designed to be flexible, thus being able to accommodate various picking operations.

Keywords: warehouse picking, parts-to-picker, rail guided vehicles, picking throughput
FLEXIBLE MHS = FLEXIBLE PRODUCTION SYSTEMS

SMALL MOBILE ROBOTS FOR PRODUCTION SYSTEM

Stevanato Group
ENGINEERING SYSTEMS
Ultra Wide Band Indoor Positioning System: analysis and testing of an IPS technology

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Abstract: Due to their current operating context, all logistics processes, from the simplest to the most complex ones, are facing always more interesting challenges in terms of management of a huge variety of products and, at the same time, strict lead times. In such a framework, it turns out that logistics inevitably has to rely on rotating or, at least, reducing, all the possible inefficiencies that could emerge during the execution of the various activities that are needed to deliver a required product to a customer. These inefficiencies could be, among others, delays in the searching of the needed product code within a warehouse, errors in the retrieval or in the picking of an item, waste of time for carts or for operators’ travelling activity, lack of availability of warehouse facilities and devices due to failures and breakdowns. Of course, the overcoming of the inefficiencies has to pass through the retrieval of the information that can be useful to increase the awareness of such existing jacks. For example, it would be important to have the data related to the movements of resources and to objects handling. In this paper, an innovative indoor positioning system is presented. Based on a real-time indoor location technology using Ultra Wide Band, it can be used for having an effective overview of a logistic system. After an introduction of the possible technologies for indoor positioning and tracking, the configuration of the system is showed, together with a description of a simple test and of an industrial application. The reported examples highlight some preliminary insights about the system accuracy and its applicability.

Keywords: indoor positioning, Ultra Wide Band, system test
MICRO LAYOUT LEVEL

HUMAN CENTERED WORKSTATION
WEARABLE DEVICES FOR ERGONOMICS EVALUATION
WEARABLE DEVICES FOR ERGONOMICS EVALUATION

A device to monitor fatigue level in order-picking
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A model for rest allowance estimation to improve tasks assignment to operators
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(Received 13 May 2017; accepted 18 June 2018)

Ergonomics in assembly line balancing based on energy expenditure: a multi-objective model
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(Received 27 December 2014; accepted 15 July 2015)

In many assembly systems, ergonomics can have great impact on productivity and human safety. Traditional assembly systems optimisation approaches consider only time and cost variables, while few studies include also ergonomics aspects. In this study, a new multi-objective model for solving assembly line balancing problem is developed and discussed in order to include also the ergonomics aspect. First, based on main feature of assembly workstations, the energy expenditure concept is used in order to estimate the ergonomics level, thanks to a new technique, called Preadetermined Motion Energy System, which helps accurately estimate the energy expenditure values. Then, a multi-objective approach, based on four different objective functions, is introduced in order to define the efficient frontiers of optimal solutions. To complete the study, a simple numerical example for a real case is presented to analyze the behaviour of Pareto frontiers varying several parameters linked to the energy and time value.

Keywords: assembly line balancing; ergonomics; multi-criteria decision-making; optimisation

Heart rate trend

Trend of energy expenditure
WEARABLE DEVICES FOR IMPROVING KNOWLEDGE AND ASSIST OPERATOR

Ergo-Log – IMMERSIVE REALITY

Abstract: The paper presents the VII-Ergo Log system, an inertial motion capture system integrated with immersive reality and extended with a head iron monitoring. By using immersive reality, the operator will be able to move and interact within a virtual workplace environment, in order to perform a fast and efficient ergonomic assessment of future workplace solutions and to avoid all cost-consuming activities related to the remote operation of virtual reality. The head iron monitoring system is able to evaluate in advance the time-based and ergo-based indexes which can help practitioners in understanding how to design the workplace and the devices to be used by operators. In addition, the use of the head iron monitoring permits to have a real-time feedback regarding the fatigue the operator is experiencing. The use of such a system will help to make easier the early design phases of an industrial workplace, by also considering the impact of human diversity and avoiding non-ergonomic solutions especially when on spring workload will be applied in the system.

Keywords: motion capture system, virtual reality, ergonomic, human-centered workplace, aging workers

A comparative analysis of different paperless picking systems

Abstract

Purpose: Warehouse picking is often referred to as the most labor-intensive, expensive and time-consuming operation in manual warehouses. These factors are becoming even more critical due to recent trends in manufacturing and warehousing requiring the processing of orders that are always smaller and limited to a single item. For this reason, in recent years many efforts and better solutions for picking have been proposed. The picking process has moved from picking systems (i.e. high-level picking,推荐阅读：), various picking techniques and systems (i.e. RFID tagging system, voice picking, traditional picking, paperless picking)

Different paperless picking systems

1. RFID system
2. Voice system
3. Vision system
4. Barcode system
5. Mixed system

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2018 IMHRC, Savannah, Georgia USA, July 23-26, 2018
CONCLUSION & FUTURE RESEARCHES

…to make production and logistics systems smarter, more flexible, more adaptable, more scalable, more interconnected, in the industry 4.0 era it is necessary to:

FLEXIBLE MHS = FLEXIBLE PROD. SYST.

- New MHS (small mobile robots)
- Interconnection of prod. & log. syst.
- New models to design them
- New models to manage them
- Impact of real-time info
- New models for buffer design
- Impact of automation
- ...

HUMAN-CENTERED WORKSTATIONS

- Wearable systems for HF analysis
- Integration of assistive technologies
- New models for workstation design
- New models for operator mng
- Materials Exposure and Mng
- Human-Robot Collaboration
- Ageing workforce
- ...

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2018 IMHRC, Savannah, Georgia USA, July 23-26, 2018
THANKS FOR YOUR ATTENTION

ANY QUESTIONS FOR MY ANSWERS?

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A Decade of the Physical Internet: Informing Future Initiatives
Development timeline

- A worldwide initiative

2007:
- SCs collaborations

2009:
- The name is found...
- Projects in Fr & USA

2011:
- Dissemination, industry and awards

2013:
- European dimension

2015:
- Academic recognition
- 1st IPC

2018:
- Start-ups
- Chaire
An opportunity and responsibility

How to build coordination and trust in a new system?

- Collaborative design of 5 roadmaps towards physical internet components and guidelines
- At European level only...

alice: Alliance for Logistics Innovation through Collaboration in Europe

http://www.etp-logistics.eu
Physical Internet works when it exists!

- If we have a reconfigured network, the right cost function, the goodwill of the players then it works...

How?

Do we have an evidence it could exists somewhere?

Interconnection platforms: typical solutions

How to interconnect?

- Fragmentation
  - "Silo effect"

- International treaty
  - "UN bureaucracy"

- Interconnection
  - "Decentralization & trust"

- Dominant position
  - "The winner takes all"
An example with ecommerce deliveries

When consignees are not part of the system: missed deliveries, multiple deliveries per day...

Eric.ballot@MR Pasha
What we have not been able to solve yet

The reallocation problem: an example

Red carrier:
- 3 v.d
- 5 u.d
Blue carrier:
- 2 v.d
- 3 u.d
Total: 5 v.d and 8 u.d

2 transport requests for each carrier
Reallocation?

Red carrier:
3 v.d
5 u.d
Blue carrier:
2 v.d
3 u.d
Total: 5 v.d and 8 u.d

2 transport requests for each carrier

Red carrier:
2 v.d
3 u.d
Blue carrier:
1 v.d
2 u.d
Total: 3 v.d and 5 u.d

2 transport requests for each but reallocated
Our latest research tool
## The methodology

### Current market

<table>
<thead>
<tr>
<th>Optimal solution</th>
<th>PI approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>No reallocation</td>
<td>Reallocation is possible</td>
</tr>
<tr>
<td>Computer optimization</td>
<td>Computer optimization</td>
</tr>
<tr>
<td>Proposed Reference Rate Structure</td>
<td>Proposed Reference Rate Structure</td>
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</tbody>
</table>

### Solution with players

<table>
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</tr>
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<tr>
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<td>Reallocation is possible</td>
</tr>
<tr>
<td>Players playing the game</td>
<td>Players playing the game</td>
</tr>
<tr>
<td>Players offer their own rates</td>
<td>Players offer their own rates</td>
</tr>
</tbody>
</table>

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- **No reallocation**
- **Computer optimization**
- **Proposed Reference Rate Structure**

- **Reallocation is possible**
- **Computer optimization**
- **Proposed Reference Rate Structure**

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- **Study the performance of the players comparing to the optimal solution**
- **Analysis of player behavior with new mechanisms**

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**Analysis of the performance of the PI approach**

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- **E. Ballot**
- **2018**
In action

Player interface - Truck Game

You are the player 2
You are in the round 1
Which road do you choose ? (ex : 1-4-5)
Which request do you choose ? (ex : 8-14-9)
Which margin ? (percentage between 0 and 100)

Send the file

If you do not want to submit a price for this round, go to the next round and wait click here

Summary :
You chose the road 1-5-8
You chose the request {2-3}
You chose the margin 13 %

If you want to add a new offer in this round : click here
If you want to go to the next round click here
Data has been correctly added !
Warehousing 4.0

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Agenda

→ Intralogistics 4.0 and warehousing
→ Smart bins, containers, storage rack
→ Robotized storage and picking systems
→ Conclusions
Intralogaistics 4.0 and warehousing

FEM Statistics – Order Intake Intralogistics Systems

Source: https://www.fem-eur.com/
Würth Industrie Service was the first C-Parts supplier (January 2013) to introduce an optical ordering system that will revolutionize materials management for a long time to come.

The quantity, number and ordering information for the item can be obtained at bin level via the built-in camera; this is then transmitted to the ERP system automatically.

Smart Containers

The first real intelligent bin communicates with people and machines, takes decisions independently, supervises its environmental conditions and controls logistics processes. The charge carrier transforms itself into a »co-thinker«.

→ self supported
→ graphic display
→ 256 bit µProcessor
→ energy storage
→ communication
The classic "human-machine-interface" is changing.

Before: Operator enters a terminal / machine.

Afterwards: An operator is permanently connected to the "social networks" of an Industry 4.0 via an "Assistant Device". Operator communicates with other people as well as with cyber-physical systems.

Source: Michael ten Hompel, Logistik 4.0, Auswirkungen von Industrie 4.0 in Logistik und SCM.
Source: https://www.doag.org/formes/pubfiles/5817351/2014-Logistik-IND40-Michael_ten_Hompel-Keynote__Logistik_4_0_Auswirkungen_von_Industrie_4_0_in_Logistik___SCM-Presentation.pdf
Robotized storage and picking systems

→ AVS/RS

→ Movable racks with robots

→ AGV based picking

Source: SSI Schäfer

Source: Amazon Robotics

Source: Bastian Solutions, Kuka, Dematic
Autonomous vehicle storage/retrieval systems

→ Shuttle carrier horizontal movement, only
  - SSI Schaefer
  - Knapp
  - Vanderlande
  - Dematic
  - others...

Source: Knapp

→ Shuttle carrier horizontal and vertical movement
  - Swisslog (Autostore)

Source: Swisslog

→ Shuttle carrier horizontal and diagonal movement
  - Rack Racer (Fraunhofer IML)

Source: Fraunhofer IML
Autonomous vehicle storage/retrieval systems

Shuttle-Based Storage and Retrieval Systems
(tier-captive shuttle carriers).

Shuttle-Based Storage and Retrieval Systems
(non-tier-captive shuttle carriers)

Shuttle-Based Storage and Retrieval Systems
(multi-tier-captive shuttle carriers)

Shuttle-Based Storage and Retrieval Systems
(3D-level-captive shuttle carriers)
Shuttle-based systems

Source: SSI Schäfer (http://www.ssi-schaefer.de/lagertechnik/shuttle-systeme/cuby-einebenen-shuttle.html)
Movable racks with robots

→ Amazon Robotics
→ Grey Orange
→ Grenzebach
→ Scalog
→ and others...

Source: Kaveh Azadeh, René de Koster and Debjit Roy, Robotized Warehouse Systems: Developments and Research Opportunities
AGV based picking

→ Manual picking

¬ Works with any forklift brand
¬ Easy to integrate with your Warehouse Management System
¬ Removes unproductive steps
¬ 60-100% higher picking productivity
¬ Safer and more accurate handling
¬ Forklifts use less energy and last longer

Source: Kollmorgen

→ Automatic picking

Source: Bastian Solutions, Kuka, Dematic
Conclusions and further research

→ Robotic Mobile Fulfilment System
  - is an automated, parts-to-picker storage system where robots bring pods with products to a workstation.

→ Manual order picking with AGVs
  - routing, control, assignment

→ Interaction Man - Robot
  - operator 4.0
Thank you for your attention

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