







AUTOMATIC STORAGE AND RETRIEVAL SYSTEM (AS/RS) BASED ON CARTESIAN ROBOT FOR LIQUID FOOD INDUSTRY



A. Fenercioğlu, M. Soyaslan, C. Közkurt
 Gaziosmanpaşa University, Department of
 Mechatronics Engineering

REM 2011, Kocaeli

- Automatic Storage and Retrieval System (AS/RS)
- AS/RS Components
- AS/RS Storage Process
- AS/RS Retrieval Process
- AS/RS Automation Technics



Page 2

Incubation Periods

- Why are the liquid foods must be stored about one week?
- Pasteurized products, such as fruit juice and milk must be kept for one week in storage due to food safety because of the incubation periods.
- All pallets have to stay in the warehouse along incubation, so warehouse capacity is particularly important for pasteurized liquid foods.


Page 3

Before AS/RS

- When we look at Turkey's practices in general, we see a system of six and nine meters of standard heights, by lifts and forklifts based on human operation.
- When the given forklift operation range is considered, the width of the aisle between two racks should be minimum of 3-3.5 meters.
- In warehouses established with AS/RS, it is enough that pallet handling widths are within aisle widths. In other words, the handling process can be done in an area of 1.5 meters wide.

Page 4



Before AS/RS



Back to Back
Warehouse System

Page 5

Before AS/RS

REM

- The resulting difference in two meters will provide 42% more storage capacity with 20 meters gain in a 10 aisles warehouse.
- But the important thing is not only to increase the storage volume, also to operate the system quickly and smoothly with the right algorithms in system requirements [1-5].
- Therefore, the AS/RS is required, which can be controlled with computer software, work interactive with connected other systems, provide complete control with product identification and tracking operation.

Page 6

AS/RS

REM

- AS/RS has got two main components. First one is the shuttle robot that takes the pallet (the product stack) on and carries it to the transfer points (aisle robot) and rails. The other one is the aisle robot that works as depth and height in two axes between the racks along the aisle and carries the pallet to the assigned rail starting point.
- AS/RS starts working after pallets are transferred to the warehouse.
- The pallets are placed on the rails with a three axes Cartesian robot by moving onto the racks.

Page 7

AS/RS

REM

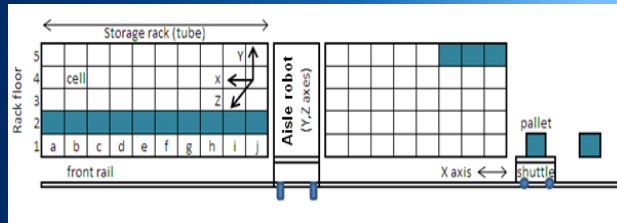


Multiple-Deep
AS/RS [6]

Page 8

AS/RS

REM



Basic AS/RS

Page 9

AS/RS

REM

➤ When the product pallet is ready, the shuttle robot takes it on, then the cell address and the aisle robot are determined according to pallet's barcode information and designed algorithm.

➤ After that, the aisle robot takes the shuttle robot to the desired rack (tube) entry by moving between the rails. The shuttle robot enters the tube and leaves the pallets at the specified cell addresses.

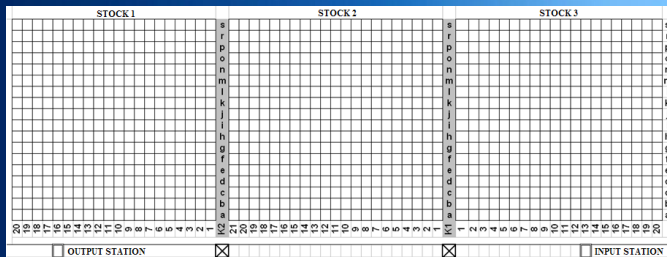
➤ The shuttle robot places the pallets from the deepest cells because all the products will be placed the same way in the tube.

Page 10

AS/RS

REM

➤ AS/RS (Automated Storage and Retrieval System) general working principle:



Warehouse Rack System (top view)

Page 11

AS/RS

REM

➤ According to delivery data and the first in first output (FIFO) rule, the algorithm decides at which rack the product will be retrieved and the Cartesian robot takes the product to the output station, repeating the storage actions [1-3].

➤ For unusual circumstances, general algorithm can be disabled and the system can be controlled manually. The AS/RS's units' communication is wireless.

➤ All movements in the system are recorded in the database. Stock data can be viewed remotely and reported.

Page 12

AS/RS

60 m.

30 m

STOCK1

STOCK2

STOCK3

Robot 1

Robot 2

ROBOT1:

- Storage to STOCK1 area,
- Retrieval from STOCK1 and STOCK2

ROBOT2:

- Storage to STOCK2 and STOCK3,
- Retrieval from STOCK3

➤The middle stock area (Stock2) will be stored from one side and will be retrieved from the other side. As a result, 2 robot will be work equally.

Page 13

AS/RS Components

- Automatic Storage and Retrieval System (AS/RS)
- AS/RS Components
- AS/RS Storage Process
- AS/RS Retrieval Process
- AS/RS Automation Technics

Page 14

AS/RS Components

lifting gear unit

driving gear unit

Shuttle Robot

➔ Aisle Robot


Page 15


AS/RS Components

3-D Model of Rack System


Page 16

AS/RS Components







Servo Motor



Fotoelectric Sensor





Encoder




Page 17


AS/RS Components








Wlan Adaptor





Aisle and Shuttle robot PLC examples




Page 18

AS/RS Components






Aisle Robot Motor and Gear Group




Page 19

AS/RS Storage Process



- Automatic Storage and Retrieval System (AS/RS)
- AS/RS Components
- AS/RS Storage Process
- AS/RS Retrieval Process
- AS/RS Automation Technics



Page 20

AS/RS Storage Process

REM

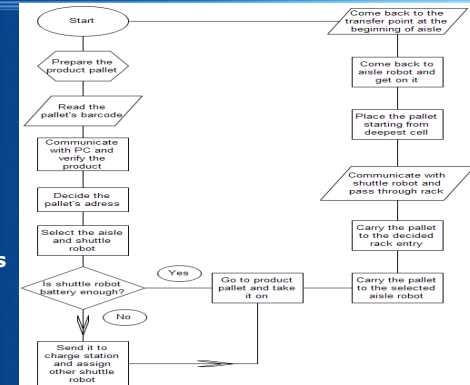
- The beginning of the storage place is the conveyor line which is the intersection point of the palletizer robot and AS/RS.
- At the end of this conveyor line, the packed products on the pallets are arranged on the rail. The defined barcode product information of the pallets is transferred to the database during the palletizer process.
- Pallets are taken on to the shuttle robot and carried to the aisle robot. The aisle robot comes to the tube entry/exit of the cell address, which is determined by the algorithm, and awaits the transfer of the shuttle robot to the tube rail. Thus, the storage process is completed.

Page 21

AS/RS Storage Process

REM

Storage Process Algorithm Flowchart



Page 22

AS/RS Retrieval Process

REM

- Automatic Storage and Retrieval System (AS/RS)
- AS/RS Components
- AS/RS Storage Process
- AS/RS Retrieval Process
- AS/RS Automation Technics

Page 23

AS/RS Retrieval Process

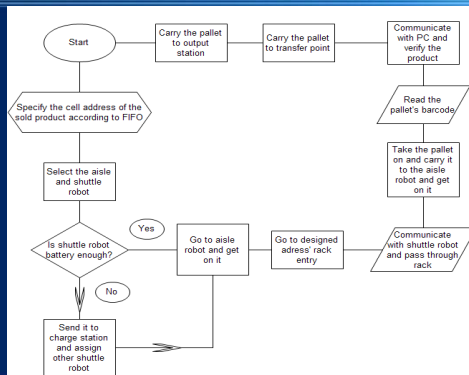
REM

- The shuttle robot selected in the retrieval process goes to the related aisle robot and gets on it.
- The aisle robot goes to the pallet's address entry and waits for the shuttle robot to pass the tube's rail.
- The shuttle robot takes the pallet from the cell and gets on the back of the aisle robot with the pallet.
- The aisle robot carries the loaded shuttle to the rack system's front rail and waits for it to pass through. The loaded shuttle robot goes to the shipping (output) station and leaves the pallet. Thus, the retrieval process is completed.

Page 24

AS/RS Retrieval Process

REM



Retrieval Process
Algorithm
Flowchart

Page 25

AS/RS Retrieval Process

REM

➤ At the shipment of the products which are waiting in the warehouse, the incubation periods must be considered due to FIFO rules while retrieving.

➤ For reducing retrieval times, the operation must be started from the nearest addresses to the output station according to the algorithm.

Page 26

AS/RS Retrieval Process

REM

- Automatic Storage and Retrieval System (AS/RS)
- AS/RS Components
- AS/RS Storage Process
- AS/RS Retrieval Process
- AS/RS Automation Technics

Page 27

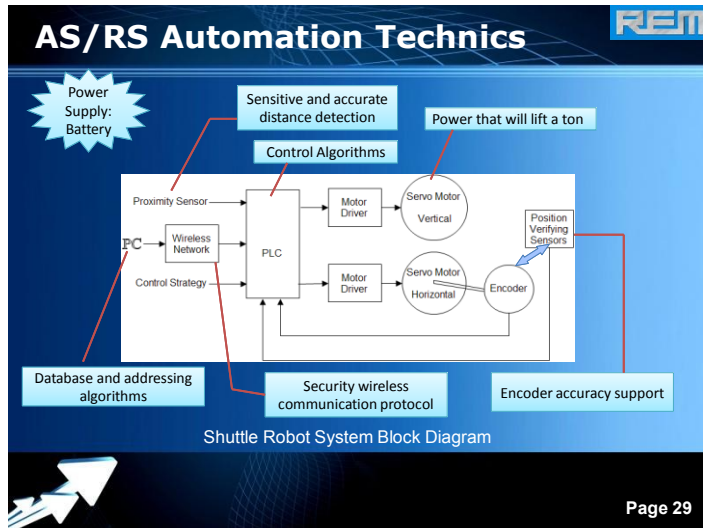
AS/RS Automation Technics

REM

➤ According to the specified algorithm, automation control of the system will be done with PLC. According to given work order of the central computer and robots' positions, the Cartesian robot motors' control will be done with their drivers with PLC.

➤ Flexible controlled, high torque AC servo motors are supposed to be used for AS/RS. PLC will take the position data which is necessary for motors control from the sensors on the rails and encoders.

Page 28



AS/RS Automation Technics

- Motors will take the product to correct addresses according to information that received from sensors on the rails and encoders. The spin, slide or blocking situation of the motor can occur the encoder position data error, so the position data will be confirmed with the sensors on the rails.
- Aisle robot, shuttle robot and central PC PLC systems will communicate with wireless network and profiBUS.
- The WLAN adapters will be set up to the suitable points at the warehouse.

Page 30

REFERENCES

- [1] K.Y.Hu, T.S.Chang, An innovative automated storage and retrieval system for B2C e-commerce, logistics, Int J Adv Manuf Technol 48:297–305, 2010.
- [2] J.,Peng, Optimal Allocation in Automatic Storage & Retrieval System Based on Flexsim Simulation, International Conference on Internet Technology and Appl. ITAP, 2010.
- [3] D. Bargiotas, A. Ktena, C. Manasis, and, O. Ladoukakis, A Scalable Low-cost Automated Storage & Retrieval System, 16th International Conference on Systems, Signals and Image Processing, IWSSIP, 2009.
- [4] F.Amato, F.Basile, C.Carbone, P.Chiacchio, An Approach to Control Automated Warehouse Systems, Cont. Eng. Prac., 2005.
- [5] L.Zhou, G.Zhou, X.Xie, An Optimal Storage Assignment Policy for Automated Storage and Retrieval Systems, Second International Workshop on Education Technology and Computer Science, 2010.
- [6] <http://www.ssi-schaefer.com.au/Pallet-Racking.20672.0.html>

Page 31

