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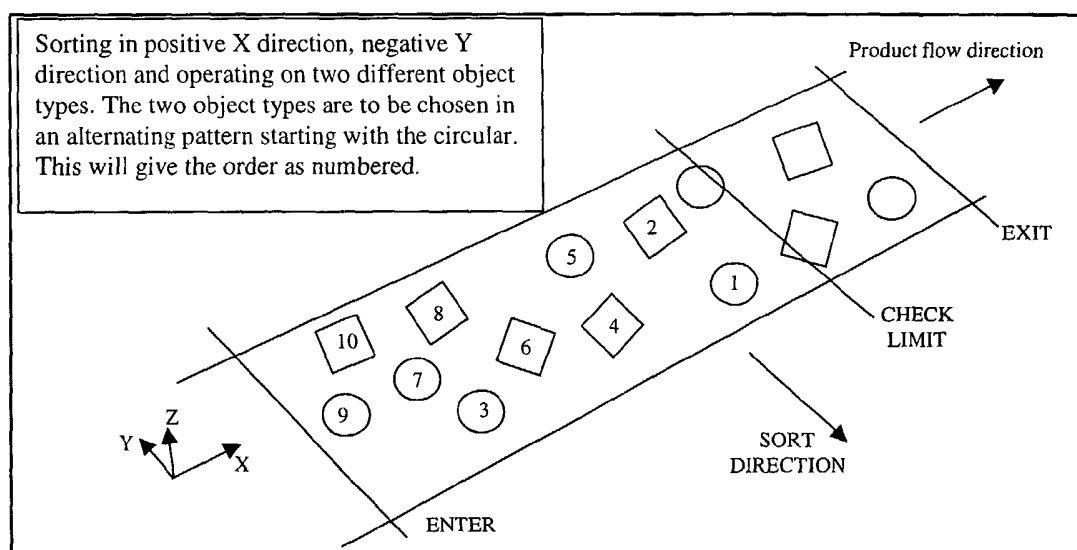
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- Published:**
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- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: AUTOMATED PRODUCTION SYSTEM FOR OBJECT IDENTIFICATION, SELECTION AND TRANSPORT



(57) Abstract: System for selection and transport of an object out of a plurality of objects in an operation area comprising a system for detection of objects present in the operation area and an industrial robot including a manipulator and an operating system having a computer memory for storing information on the objects present in the operation area.

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Automated production system for object identification, selection and transport

TECHNICAL FIELD

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The present invention relates to a production system including an industrial robot and a detection system for localization of objects. More precisely the invention relates to a method and system including an industrial robot and a vision system for extracting an object out of a plurality of objects in a continuous production flow. With objects in this context should be understood both objects which are identical as well as object or groups of objects that are different in shape, color softness and such. The objects arrive into the robot working range in a continuous stream on a conveyor, a rotating plate or the like, or they arrive in layers of a pallet.

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BACKGROUND OF THE INVENTION

It is known a system for sorting articles on a conveyor belt where the articles pass a detection area before entering a robot operation area. In the detection area the articles are identified by order of sort, position and orientation. This information is stored in a memory of the robot operating system. By this information the articles are picked, lifted and oriented by the robot and placed at a specified position in a reception area. A typical application of this system is picketing of chocolate pralines or cookies.

25 When working with heavier articles the picking process decreases due to acceleration forces. The risk of dropping the article also increases. When working with articles, which have an uneven or rough surface the technique of lifting with vacuum gripper become more difficult. A mechanical gripper is heavier, more complicated and more expensive. A mechanical gripper is also less flexible.

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From US 6,401,936 a divert apparatus for a conveyor system is previously known. This is a sorting system for processing a disordered stream of items including three-dimensional non-flat articles. The apparatus regulates the flow of articles through the system by

singulating a disordered stream. There is also means for mechanically increasing the spacing between the items and a gate for discharging articles from the stream. The known system is designed for one type of articles only. When changing production the apparatus has to be re-adjusted.

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Thus there is a need in the industry for flexible handling arbitrary articles in a continuous production flow.

10 SUMMARY OF THE INVENTION

A primary object of the present invention is to devise ways to find a solution to select an object from a plurality of objects present in an operation area for transport to a predefined position. A secondary object of the invention is to select an object in a flow of continuous products for transport in a direction at an angle to the direction of product flow.

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This object is achieved according to the invention according to the features in the characterizing part of the independent claim 1 and according to a method as claimed in the independent claim 2. Preferred embodiments are described in the dependent claims.

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In a first aspect of the invention these objects are achieved by a system for selection and transport of an object out of a plurality of objects in an operation area comprising a system for detection of objects present in the operation area and an industrial robot including a manipulator and an operating system having a computer memory for storing information on the objects present in the operation area, wherein the operating system comprises means for defining a transport direction of each object in the operation area, means for defining a passageway along the transport direction of each of said object, and means for calculating the presence of other objects penetrating into each of said passageways.

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According to the invention an algorithms is described for a selection of objects in a continuous production flow according to given sorting rules. A continuous production flow, which feeds objects into a robot working area is defined by the positive flow

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direction, hereafter named "X" and it's perpendicular direction in the horizontal plane of a right-hand coordinate system, named "Y".

5 All objects information, such as position, orientation, type and size, are stored in a buffer in an industrial robot controller. A new object is requested from the buffer when the robot is about to use the object as a target. The robot operation can only be performed when the object is within an entry and an exit limit of the X-direction. The robot controller supervises this. Within this work area it shall be possible to choose the object with respect to the priority rules in X- and Y- or/and Z-direction.

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Preferred information for sorting:

- **Sort direction:**
From which direction the sorting will be done. Given in object request command.
- **Safety distance:**
15 The clearance area for sorting. Given in object request command.
- **Enter limit:**
The limit where the robot can start operate on an object. Given when defining a new object buffer.
- **Exit limit:**
20 The limit where the robot can't operate on an object. The objects will be erased from the buffer when they enter this limit. Given when defining a new object buffer.
- **Check limit:**
25 Optional limit where the robot can't operate on the object. The objects will not be erased from the buffer when they enter this. Given in object request command.

The sorting algorithm chooses the object, which is the closest to the exit limit in X-direction and depending on the non-presence of other objects in direction of the sorting, the first object in the sort direction will be selected. A safety distance defines the required
30 clearance area around an object. The algorithm will check both upwards and downwards the production flow for presence of other objects.

When a new object is requested from the object buffer, the sort direction and safety distance is given as parameters in the request command. The sorting algorithm will then choose which object the robot shall operate with.

- 5 By using a check limit, in the X-direction, as a parameter to the request command, it is possible to define the starting point from where the first object shall be extracted. The command will try to extract the first object between the check- and enter limit. This will have the effect that the sorting algorithm also takes all objects between the check limit and the exit limit into consideration when checking the safety distance for the nearest objects.

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By this invention the objects can be extracted from the flow without touching surrounding objects. The objects can be shuffled sideways without any risk of bumping into other objects in the production flow.

- 15 It is possible to combine the directional sorting with type request. The first object of a certain type in the production flow will then be selected according to previous described algorithm.

20 Normally the production flow is in the horizontal plane. However there is no limitation to what direction the production flows. As an example the production flow can be vertical. This situation arises when the products arrive into the operation area on a pallet where the articles are piled individually or in layers. The detection information is then achieved from package pattern or by having the pallet moved between the detecting area and the operation area.

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In a second aspect of the invention these objects are achieved by a method of selecting an object out of a plurality of objects in an operation area for transport to a predetermined location comprising, detection of the objects present in the operation area, storing object and location information in a computer memory, selecting an object to be picked, wherein
30 the selecting step comprises, defining a transport direction for each of the objects present in the operation area, defining a passageway along the transport direction of each of said objects, calculating for each passageway the presence of penetration of any other of said present objects, selecting an object which passageway is free from penetration.

The following problems are solved with this invention:

- Shuffling objects off a conveyor without touching surrounding objects.
- Optimize production cycle performance by choosing products with shortest
5 displacements.
- Sorted 3D picking of objects in order of their vertical positions. This can be used
for efficient palletizing and de-palletizing while preserving the layers without the
need for predefined layer schemes.

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BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will become more apparent to a
person skilled in the art from the following detailed description in conjunction with the
15 appended drawings in which:

FIG is an operation area with a plurality of objects for selection,

DETAILED DESCRIPTION OF THE INVENTION

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The operating area in the embodiment showed in the fig is defined by the edges of a con-
veyor belt, a check limit line and a entry line. The transport direction is in the embodiment
shown perpendicular to the flow direction. Normally a flow of products for picking arrive
into a detection area (not shown) before entering the operation area. In the detection area
25 all information of the articles are defined. This information contain type of article, size,
position, orientation and other desirable information. At a predetermined time calculated
from the flow speed and the distance between the detection area and the operation area the
articles arrive into the operation area.

30 During this time the system calculated the transport direction for each of the articles to a
predetermined position when the articles have reached the operation area. Before reaching
the operation area the system also determine a passageway for each of the articles, along
which the article must be transported. The passageway can be seen as a tunnel. Prior to

arrival into the operation area the system also determine if any of the other objects present penetrates these tunnels. Thus each of those articles which has a clear tunnel can be chosen. An optimization program, having information on the speed of the flow, the performance of the manipulator and other information then chooses the optimal article for transport.

In an embodiment of the invention the detection system is a vision system. By a camera or a plurality of cameras the position and orientation information is achieved for each article. All such information is stored in a computer memory. The vision system gets continuous information of the articles passing the detection area. Thus the same article may appear on a plurality of detection areas that are overlapping each other. This results in the operating area being adjusted and thus always contain actual information.

The information received in the detection area may be used to direct a plurality of manipulators along the conveyor line. In a vision system that detect the articles prior to arrival into the operation area it is essential that the articles remaining on the conveyor remains at the same position and in the same orientation. This means that when an article is picked up or shuffled sideways the remaining articles must not be moved or even touched. If one of the articles are moved in one robot station its position will not be recognized in the next station.

The invention is not be limited by the embodiments presented above. Thus the production flow can be circular, as when the articles are placed on a rotating plate. The conveyor can also be continuous, such that the articles are passing several times through the detection area. The predetermined target position can be on either side of the conveyor belt and there can be a plurality of target locations at the same operation area.

CLAIMS

1. System for selection and transport of an object out of a plurality of objects in an operation area comprising a system for detection of objects present in the operation area and an industrial robot including a manipulator and an operating system having a computer memory for storing information on the objects present in the operation area, **characterized in** that the operating system comprises means for defining a transport direction of each object in the operation area, means for defining a passageway along the transport direction of each of said object, and means for calculating the presence of other objects penetrating into each of said passageways.
2. Method of selecting an object out of a plurality of objects in an operation area for transport to a predetermined location comprising, detection of the objects present in the operation area, storing object and location information in a computer memory, selecting an object to be picked, **characterized in** that the selecting step comprises; defining a transport direction for each of the objects present in the operation area, defining a passageway along the transport direction of each of said objects, calculating for each passageway the presence of penetration of any other of said present objects, selecting an object which passageway is free from penetration.

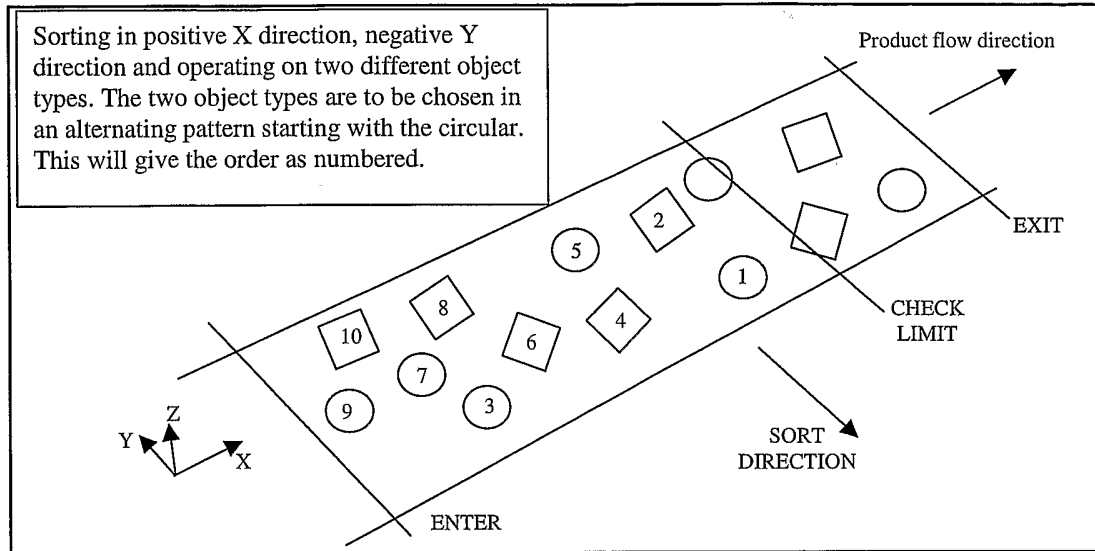


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 03/01221

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B65G 47/48, G06F 19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B65G, G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 62218314 A (ISHIDA SCALE MFG CO LTD), 25 Sept 1987 (25.09.87), figures 1-9, abstract --	1
A	US 5379229 A (PARSONS ET AL), 3 January 1995 (03.01.95), column 2, line 26 - line 60; column 5, line 43 - column 10, line 40, figures 1-3,5-8, claims 1-5,7,12-17 -- -----	1,2

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

06/09/03

International application No.

PCT/SE 03/01221

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 62218314 A	25/09/87	NONE	
US 5379229 A	03/01/95	NONE	