PROPOSAL MODULAR ROBOTIC SYSTEMS

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Abstract

The article describes how the arrangement of objects on pallets and determination programmable robot for palletizing points. It describes the basic structure for handling and palletizing selected types of components. To explain the principles of modular structures with designed workstation.

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1. THE BASIC STRUCTURE OF HANDLING OPERATIONS FOR PALLETIZATION

The palletizing cell may be palletized objects through the insertion into nests pallets or cartridges, or may be the pallet-stacking operation objects. In both cases, insertion of objects on pallets, almost always the handling operations lay in a vertical top-down and handling operations can be considered as the mounting system insertion pin into the hole. In most cases, the palletization for handling operations are analyzed only in terms of geometric characteristics, namely when considering uncertainties position pallets and repeated inaccuracies robots. [2]

The main handling operations for palletization in most cases:
- object snap (constant grid points)
- movement in a vertical position (fixed path),
- relocation in the horizontal plane (always another point)
- downward movement - insert (fixed path).

If a cell is designed for palletizing objects with a very tight fit then it is often necessary to equip robot passive or active end effector. In these cases, the handling operations of insertion are analyzed in terms of geometric dependencies and for the impact of friction in passive effector geometry and dynamic characteristics of the servo system for active effectors. Handling operations in these cases by the steps:
- contact between objects,
- positioning the secondary object using the micro-movements
- insertion
- Arrangement of objects at pallets

During the palletizing operations is one particular choice of surface layout of objects on a pallet. This is mainly dependent on:
- shape, dimensions and weight of the object,
- dimensions and load pallets,
- handling control ability palletizing robot
- method of gripping objects effectors
- direction sequence of their palletizing.

The used method network is advantageously when we select the arrangement. Network window size is determined according to floor plan of the projection for the outline shape of object increased by a certain value taking into account the uncertainty and conflict handling conditions effector during the storing objects to pallet. [2]

For regular arrangements of objects can be used networks:
- rectangular: rectangle, square,
- angle: triangular, hexagonal,
- square diagonally,
- polar.

Number of windows networks is mainly depended on dimensions of the pallet. Only in specific cases, such as the characteristics of the robot, number of steps in the program and so on. For example, calculating the number of square diagonally frames network or respectively number of objects on the pallet is:

![Fig. 1 Dependence of layout objects](image)

where: \( r \) - radius opening gripper, \( \Delta \) - max. uncertainty of positioning the gripper,

\[
I_{\text{min}} = r - \frac{D}{2} + \Delta
\]
in the x-direction in the first row
\[ M_1' = \frac{A-2'\alpha-D}{D+l_{\text{min}}} + 1 \]
in the x-direction in the second row
\[ M_2' = \frac{A-2\alpha-D-s\tan \alpha}{D+l_{\text{min}}} \]
in the y-direction (number of rows)
\[ N = \frac{B-2\alpha-D}{s} + 1 \]
If \( N \) is an even number then possible number of stored objects pallet:
\[ Q = \frac{N}{2}(M_1 + M_2) \]

An important condition compilation for palletizing program is a precisely defined handling points for palletizing. This is advantage to apply at robot wrist. Then you need to:
- determine the coordinates of wrist in coordinate system for object manipulation based on interaction,
- determine the coordinates for beginning of object in coordinate system palette. Coordinates \([xB]A\) a \([yB]A\) can be determined from deployment of objects on a pallet. Coordinates \(zB\) as possible, we choose a constant value for all palletizing objects through inserting objects were safe,
- transformation point \(C\) to coordinate system of palette,
- transformation of coordinates for point \(C\) at pallet to robot coordinate system.

In transformation \([C]B \rightarrow [C]A\) is the most common two cases:
1. axes of two coordinate systems are parallel, then
\[ [C]^A = \begin{bmatrix} x_C^A \\ y_C^A \\ z_C^A \end{bmatrix} = \begin{bmatrix} x_B^A \\ y_B^A \\ z_B^A \end{bmatrix} + \begin{bmatrix} x_C^B \\ y_C^B \\ z_C^B \end{bmatrix} \]
2. occurs to wrist rotations around the axis \(z\) by an angle then
\[ [C]^A = \begin{bmatrix} x_C^A \\ y_C^A \\ z_C^A \end{bmatrix} = \begin{bmatrix} \cos \varphi, & -\sin \varphi, & 0 \\ \sin \varphi, & \cos \varphi, & 0 \\ 0, & 0, & 1 \end{bmatrix} \begin{bmatrix} x_B^A \\ y_B^A \\ z_B^A \end{bmatrix} \]

Transformation of point \([C]A\) to coordinate system for robot depends on type of robot kinematics. [2]

2. PROPOSAL OF ASSEMBLY CELL WITH ROBOT SCARA

Recently, the emphasis is mainly on development for flexible modular structures that are composed for unitized modular components able to cover diverse of user requirements and implementing the latest construction technology. This goal can be met only through a system approach to design process, which in addition leads to design and construction activities that includes process of knowledge development trends at construction for modular devices. Flexibility is divided into the following two basic forms:

Static flexibility – configured installation remains stable when set of combination products and can be changed only when altered product interface will change and will require another type of system. Reconfiguration basis for exchange of specific tools, supplies, and accessories or overall reconstruction system is made separately and processing by new installation that can be performed during design of a new product.

Dynamic flexibility - in this case, flexibility is managed on - line: there exist possibilities to adapt different tasks, while system runs through predicting and preparing a scenario. This may enable a person or system can adapt itself control, which means that system has knowledge about their own options and decision algorithms that decides which modules can be used, how and in which case continue. Modular solution structure palette - assembly cell uses a variety of modular components that allows providing the required diversity of transported products, great variety of configurations and options. Flexible palette - assembly cell with a SCARA robot can be seen at Fig. 3.
The module is a unit in accordance with one or several parts, which performs one or more defined functions and provides an interface to other modules. This interface may be available in different ways. Catalogue variants can be created by an exchange of modules. Each module is optimized for the exercise of those functions. Individual modules must comply with its technical parameters and final assembly is created by combination of available modules to meet requirements of stability device as a whole and must meet safety requirements. Fig. 4 is shows a modular principle for construction palette - assembly workstations. [1],[3]

In the field of design so called flexible assemblies manipulation devices, that are constructed on basis of unified modular components is possible to find their application of complex CAD systems. Their application in the pre-production stages brings the following benefits:

- shortening of continuous time proposal,
- flexible adaptation to new conditions,
- variant way for solution proposals
- use of optimization methods,
- carrying out of engineering analyses,
- simulation capabilities.

In this structure palette - assembly workstation used a two-level conveyor, pallet lifts, vibrating tray components, SCARA robot. An example of installation of the object are used PCB to be fitted with one component part., Fig. 5.

In engineering practice, the process of designing an efficient modular system follows important information:

- Analysis device to determine groups of modules, which are important in terms of its diversity and flexibility,
- creating a platform of maximum number of modules that are common to typical representatives of production program to increase efficiency and productivity,
- identification modules based on relevant criteria,
- creation of size among to the various types of modules for required power equipment classes by using similarity theory and dimensional analysis,
- minimize the number of modules in final assembly (time saving),
• built a flexible system that suppliers a modules flexibly responding to the immediate production requirements.

Current of the complex CAD systems provides to users a wide range of useful tools, enabling improvement of the various stages for the proposal. Individual modules palette - assembly cells are arranged in type rows which can be entered to input parameters for selection the appropriate module. [4],[6][10]

Conclusion

We can observe a new trend forming palletizing - robotic assembly cells based on the use of modular components. The result is the ability to better adapt to the customer's needs without undue expansion of production of new components.

References


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