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Increasing of the Efficiency of Flexible Manufacturing System

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Abstract

Management of universal shelf stacker process many varied operations, whose are different in difficulty of solved problems, time of reaction of controller and next parameters. Usually is used one controller with all functions, which have many external input-output modules and have to solve parallel many tasks together. The control application have to be very complicated and blind with risk of collisions control processes and needed of solving control process priority. If the processes are separated to the groups, every group of processes solved with separate control automat. For simple processes, whose needs immediate reaction can be used simple and easy controller, complex control processes have to been solved with controller with sufficient performance, mathematical performance and adequate memory.

1. Introduction

Universal shelf stacker (USS), is device, that store shelves, so the residual space was minimized and the store space in USS is very effectively employed (see Fig. 1).

The device is contained from two towers, between them there is vertically moving device, which is manipulating with shelves (extractor). Extractor puts the shelf into tower on any position and removes the shelf from tower. Extractor can manipulate on time with only one shelf. The shelf can be placed in tower in any position, so don't make collision with other shelf or shelves or other item of mechanical construction of USS [1]. In tower (usually front) is situated dispensing slot, in which operating personal can handle with shelf content or a shelf. When shelf is putting into USS from dispensing slot, the maximum high of shelf is measured. This entry is very important for establishing of space for positioning of shelf. When the shelf is moved on extractor from dispensing space, the weight of shelf content is measured by special method. When weight limit is overrun, the USS does not put shelf into tower, but put it back into dispensing slot. Move of moving parts of USS is performed by actuators – three phase asynchronous motor, of which only one is connected to output of inverter. This solution is sufficient for moving, because from principle of USS results, that it is not possible moving vertical and horizontal direction together.

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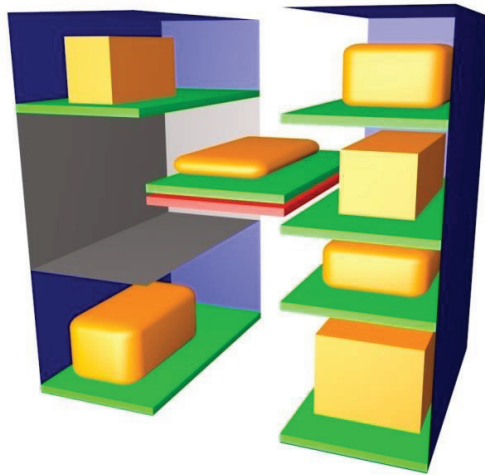*E-mail address:* kai@istu.ru

Fig. 1. Scheme of USS.

blue – towers of USS, gray – dispensing slot, green – shelves, red – extractor, yellow – items on the shelve

2. Objectives and methodology

Control system of USS is complicated set of electronic components, sensors, actuators, safety elements and so on. Control system must perform:

- synchronous performing more tasks with various priority of processing
- synchronous performing more tasks with various time of reaction
- performing input data from sensors, measuring components, back-coupling components, etc
- controlling many types of actuators
- communication with outer system
- communication interface for operating personal and servicemen

Process of management of USS must handle many various processes, whose are different their difficulty and time reaction [4]. Usually is done, that the process which need shorter time for reactions is simpler. The simplest processes need the shortest reaction time (e.g. emergency stop) and processes, whose we have to control on base of difficult algorithm, usually don't need immediate reaction (e.g. establish the best position on positioning shelf into tower USS).

The control system for an easy processes needs usually the different hardware as control system for a difficult processes, therefore is control system of USS divided to 4 layers with vertical hierarchy. These layers are linked by communication channels (see Picture 2). Each of control layer can be realized on different hardware platform, but this fact not exclude joining any layers, with the same hardware platform, on one unit.

On hardware design, the layers can be make on next hardware platforms:

8-bit microprocessor (for example from Intel, Atmel, PIC, Fairchild, Motorola and others companies)

32-bit microprocessor from Atmel, ARM, Intel, Motorola or others companies

Many types of PLC (Programmable Logic Controller) from many companies (B&R, Siemens, Unitronics, Panasonic, Rockwell Automation, ...)

Industrial PC, for hard industrial environs.

Layers of control USS are divided by time of reaction and by functioning to 4 independent parts, whose are in vertical hierarchy structure.

2.1. Layer zero of control system of USS

 collect data from sensors of position, sensors of end of position, sensors of presence of shelf on extractor and dispensing slot, synchronize and safety sensors. Layer zero too operate with actuators this way, that by its outputs manage connecting elements for enabling move and switch the power from frequency inverter between motors of moving parts. This layer is the quickest and its reaction time is the shortest in control process of moving parts USS. Together the processes whose the layer zero control are