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AUTOMATION OF A WAREHOUSE BY MEANS OF A ROBOTIC ARM

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ABSTRACT: The paper introduces a system of automating a vertical warehouse by means of a Lynxmotion robotic arm. The development of the solution was done using a model of the warehouse and by building the robotic arm that achieves the automation. The robotic arm is programmed in RIOS and it makes use of the SSC-32 controller of the power motors. Using RIOS, the robotic arm can be taught movement sequences, by means of a mouse or a joystick. This program uses digital and analogical inputs in order to control the robot movements in closed-loop projects.
KEYWORDS: robotic arm, automation, controller, warehouse

INTRODUCTION

Robotics represents at present the crossroads of edge studies in several domains: mechanics, automatics, computers and driving systems. The convergence of such various scientific and technological branches is explained by the complexity of the robot, both in terms of mechanical architecture and the control system [2], [3].

The automation of a warehouse consists on the one hand in the operation of vehicles without drivers and, on the other hand in the technical support of the processes that need manual operation in the warehouse [1].

The robotic arm is meant to transport the merchandise form the loading platform to the storage cells and vice-versa. Thus, there is no risk of accident for the operators in the warehouse.

The RIOS SSC-32 program allows the human operator to choose the position in the warehouse where the merchandise has to be deposited and, later on, where it has to be retrieved from, in order to get to the shops or to other smaller warehouses. Thus, the number of employees in the warehouse is reduced to a minimum, and so is the risk of accidents.

The advantages of vertical warehouse automation are: increased stocking capacity, less equipment, easy identification of each item, easy access to each item without displacing other articles, no equipment crossing, the use of just one transport device (the robotic arm), high performance control functions and PC interface, the control of the entire warehouse by means of a single program, the manual adjustment of the robotic arm, the merchandise can be retrieved from the warehouse according to demand and not the principle "first entered first removed" and three stocking cells for items having different shapes and are fragile, the movements of the robotic arm are not programmed, but manually controlled at the moment the products are brought [4], [5].

DESCRIPTION OF THE RIOS SSC-32 PROGRAM

RIOS (The Operation System of the Interactive Robotic Arm) Windows is a program for the control of robotic arms, using a SSC-32 controller. Using RIOS, the robotic arm can be taught movement sequences, by means of a mouse or a joystick. This program uses digital and analogical inputs in order to control the robot movements in closed-loop projects. For these inputs, the accepted loops are: if-then, for-next and do-while. The outputs can also be controlled. This is done by means of a serial cable connecting the SSC-32 controller to the serial port of the computer. For standard operations, the RIOS/SSC-32 program can create its own basic code in order to control the arm. Alternatively, the power motors can be controlled directly, from a micro-controller.

This robotic arm can perform three types of movements: along axes X, Y and Z; distance, axis Y and the base angle; mixed.

The SSC-32 Controller (serial servo controller) has a high resolution for the exact positioning and extremely light movements. The control of the movement can be done extremely fast. A sole movement group allows any combination of power motors, in order to start and stop the movement at the same time, and this is achievable even when it has to travel along various distances. This is a very important characteristic of robots.

Figure 1. The main window of the program

DESCRIPTION OF THE APPLICATION

The Lynx robotic arm offers a swift, accurate and repeatable movement. The characteristics of the basic robot in terms of rotation are: Shoulder, Elbow and Wrist movement, as well as Gripper.

Thus, using a computer connected to the SSC-32 controller, one can control the robot. The control program offers the user enough information to enable decisions related to the movement of the robot in the Cartesian space towards the next destination. The movement in space is done along the three coordinates X, Y, Z. This is probably one of the best examples of cinematic implementation.

The simple movement of the device along axes X, Y and Z is done by means of the power motors. When moved to the desired position, this position is added as a step. When moved into the position you'd like it to go to, add that position as a step. A group of Steps makes Sequences. A group of steps makes up a sequence. One project can contain one or several sequences. A Project can contain one or more Sequences. [6].

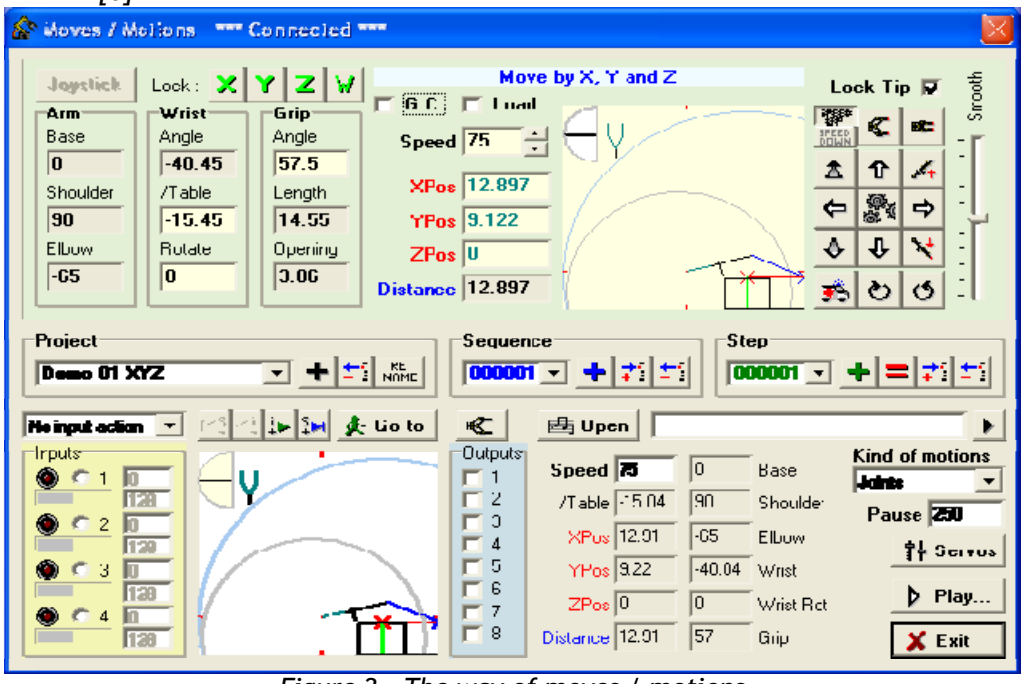

Figure 2. The way of moves / motions

The project pad - the project can be added, deleted or renamed. The sequence pad - the "plus" button will add this step into a new series to the actual project. Sequences can also be added or deleted. The step pad (colored green) - the "plus button" will add this step into the actual sequence and project. The step can be inserted, deleted or rewritten.

The application contains 9 programs for loading the merchandise cells and 9 programs for retrieving the merchandise from the cells, whereas for the rest of the cells the moves of the arm are performed manually (because of the various dimensions and fragile merchandise batches). One can set the rate, duration and delay of the outputs.

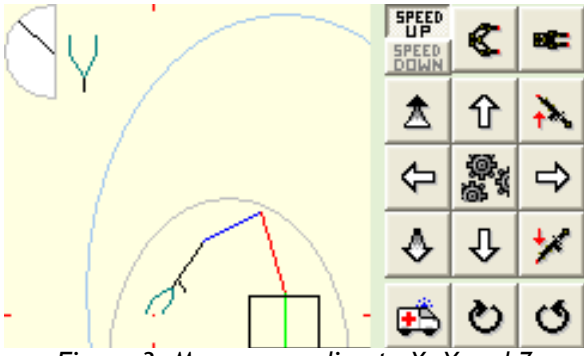

Figure 3. Moves according to X, Y and Z

Example program with sequences and steps for the first storage cell with a single merchandise batch (large volume).

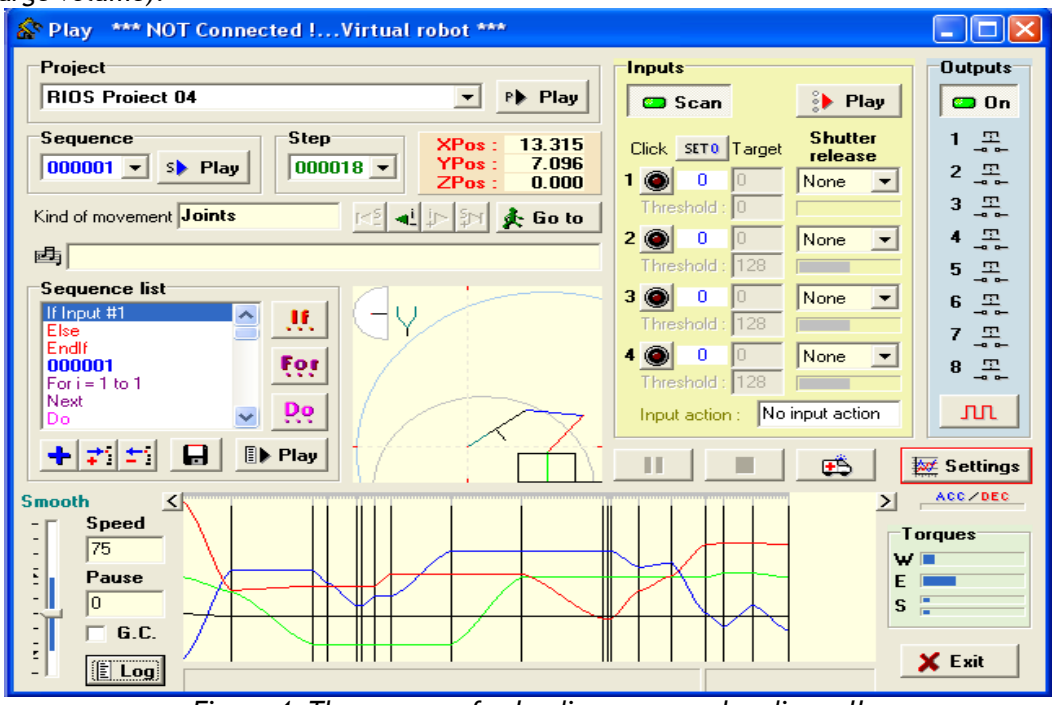

Figure 4. The program for loading one merchandise cell

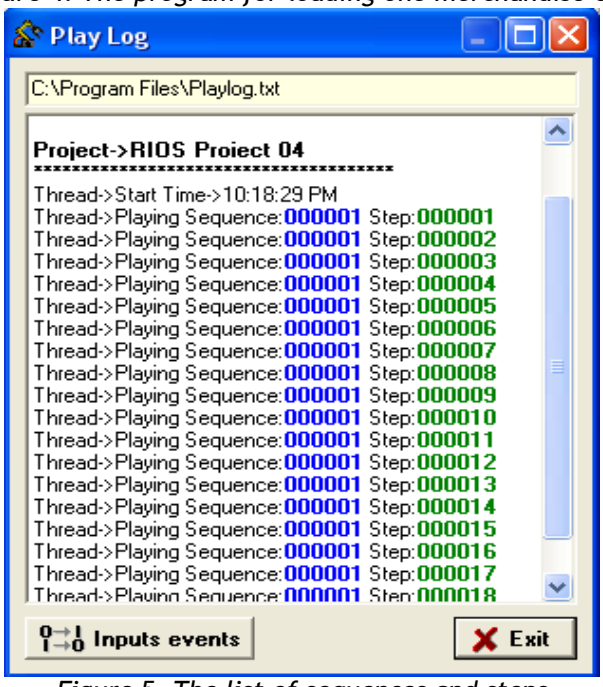

Figure 5. The list of sequences and steps

The logs are lists with everything going on. They show exactly what move of the arm is performed, which are the inputs and what program loops are being performed.

CONCLUSIONS

This work joins elements of electronics (the SSC-32 controller), mechanics (components: power motors, connecting cables, regulator, controller serial data cable etc.) and programming (RIOS SSC-32). The automation of the vertical merchandise warehouse using the Lynx robotic arm has several advantages.

Robots, by their structure and functions, represent a class of systems synthesizing high tech elements from several technical and scientific domains. In fact, through its attributions, the robot substitutes human locomotion, manipulation and intellectual functions. It is therefore obvious that the robot represents an extremely complex system, described by sophisticated mathematical models defined by non-linear differential equation systems, with variable determinist or stochastic parameters, comprising a large number of input and output variables.

The programming of the robotic arm is done by means of the RIOS SSC-32, while the controller actuates the power motors.

The paper can be implemented in any warehouse or in other domains, such as: the automotive industry, medicine, transport, constructions, assembly points, etc.

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