Control System for Pneumatic Robot

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Abstract: The paper deals with a control system built for a pneumatic robot with 5 mobility ranks. The robot is controlled using a USB-6009 USB board connected to a PC, along with circuitry needed to adapt the signals. The paper shows how the difference between the number of available DIO lines on the DAQ board and the number of signals needed to control the system is resolved using regularly available integrated circuits and the program developed in LabVIEW to control the robot.

Keywords: pneutronic, precision pneumatics, microcontroller, data acquisition

1. INTRODUCTION

The structure and the control system of a 5 mobility ranks pneumatic robot were presented in a previous paper Avram et al (2010). Several examples of such systems have been attempted and discussed in other papers Zeller et al (1997), Todorov et. al (2009). A programmable automaton was used to control the robot. The automaton features a limited number of digital input and output lines and so the robot can be used only for average complexity applications. The aim of the actual paper is to optimize the control structure of the robot and to develop a working program in order to use the robot in more complex applications.

2. THE CONTROL SYSTEM STRUCTURE

The developed control system is based on a NI USB-6009 data acquisition board connected to a PC. This acquisition board was chosen due to its low price an to the fact that the planed applications do not need a very high sampling rate. The features of the data acquisition board are the following:

- 8 simple analog inputs, 4 differential analog inputs respectively, allowing the following voltage ranges: ±20V, ±10V, ±5V, ±4V, ±2.5V, ±2V, ±1,25V, ±1V; the maximum sampling rate: 48000 samples/s; 14 bits A/D converter;
- 2 digital outputs in the range of 0-5V; sampling rate: 150 samples/s; 12 bits A/D converter;
- 12 digital I/O channels, configurable according to the application;
- 32 bit counter;
- USB bus connection;
- power supply: 2,5V and 5V;
- software driver: NI-DAQ;
- compatible software: LabVIEW, C, Visual Studio;
- platforms: Windows, Mac, Linux.

An analysis of the mechanical system of the robot to be controlled [1] shows the following necessary:

- 8 output lines and 4 digital input lines for the Ox axis;
- 8 output lines and 4 digital input lines for the Oy axis;
- 2 output lines and 2 digital input lines for the Oz axis;
- 1 output line and 2 digital output lines for the rotation around the Oz axis;
- 1 output line and 1 digital input for the gripper.

The control system must have 20 input lines and 13 digital output lines. This is the reason why an electronic block was inserted between the data acquisition board and the robot system in order to perform the serial data transfer from the PC to the pneumatic robot system. This block also protects the PC and it is an adapter for the transferred signals. The principle scheme of the developed system is shown in figure 1.

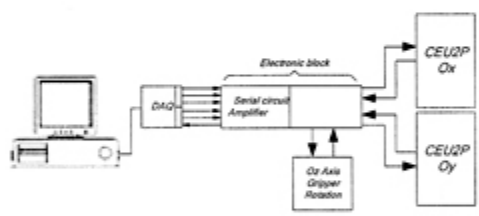

Fig. 1. The principle scheme of the system

3. THE ELECTRONIC BLOCK

The serial processing circuit, as shown in figure 2, consists of two 74HC165 type integrated circuits used for the serial processing of the signals coming from the robot and of four 74HC595 type circuits used to transfer the command signals to the system. Every circuit works with 8 bits data. So, the electronic block has 32 output command lines and 16 digital input lines. The maximum I/O signals can be increased by adding more circuits on the board.The command signals transmitted to the system must be amplified according to the electronic schemes of the controllers and distributors used within the robot system.

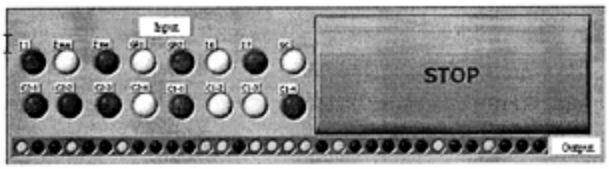

Fig. 6. The front panel of the program

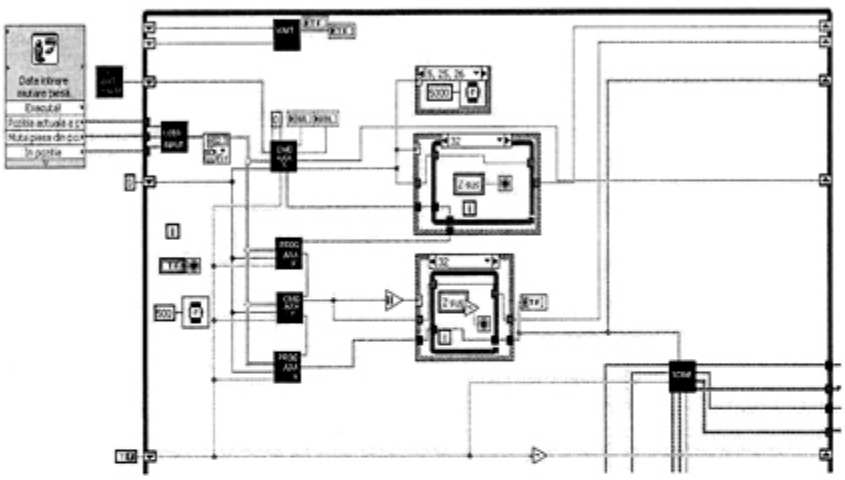

Fig. 7. The block diagram of the program

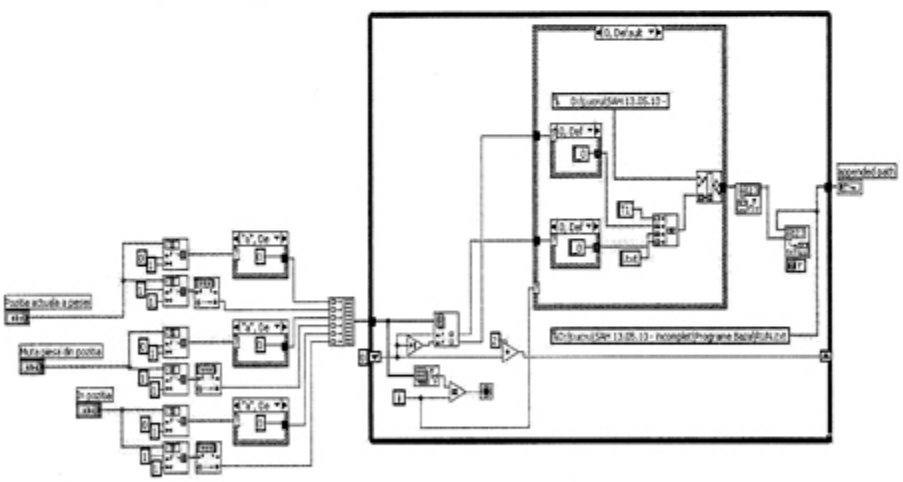

Fig. 8. The block diagram of the User input vi

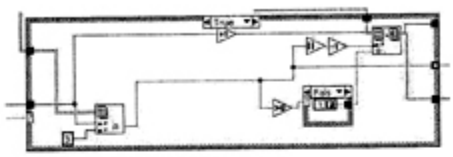

Fig. 9. The block diagram of the x/y axis command vi

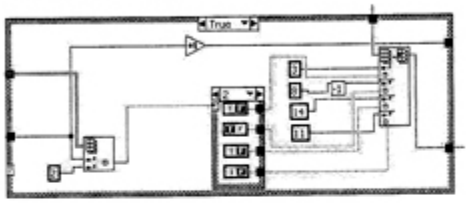

Fig. 10. The block diagram of the x/y axis program vi

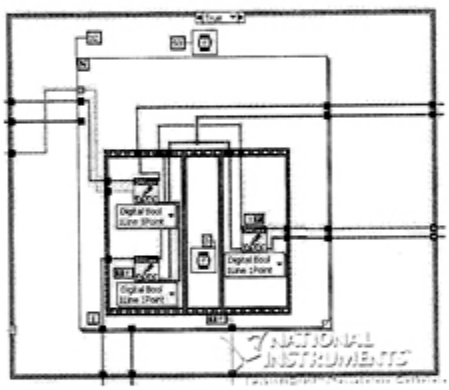

Fig. 11. The block diagram of the Command Writer vi

The input data is read using a "while" loop including the vi-s which generate the Load_IN and Clock_IN signals necessary to synchronize the data input through the Data_IN channel. The obtained vector values are read using the Index Array vi and the data are displayed in parallel mode. The block diagram of this vi is shown in figure 12.

5. CONCLUSIONS

The command system designed and built by the authors is functional. The cost of the system is low due to the use of current electronic components and a very simple DAQ board. The number of input and output lines of the system can be easily increased adding more integrated circuits on the board and so it can be used for more complex applicatrions. The working program has a modular structure and can be easily adapted for other similar applications.

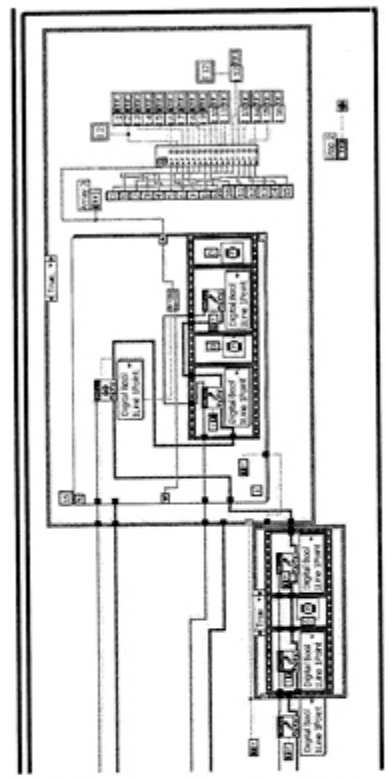

Fig. 12. The block diagram of the Index Array vi

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