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THE ELECTROPNEUMATIC SYSTEM SYNTHESIS OF CONTROL THROUGH MATRIX METHOD AND SIMULATION

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ABSTRACT

In this paper the matrix method for synthesis of sequential automated is shown.
The application of the matrix method is very important in synthesis of automated for discovering and eliminating of shut off signals (signals which are in contradiction), which signals stop the system to be developed continually (without continuity disorder). To see the rationality of solution the problem, the pour pneumatic system and electro pneumatic is taken, also the solution with PLC has been developed. The characteristics of this model are that the process development is realized through double sensors of first actuator, whereas the operation of the second sensors of the actuators is operating in indirect manner of the process.

Key words: matrix method, sensors, PLC.

1. INTRODUCTION

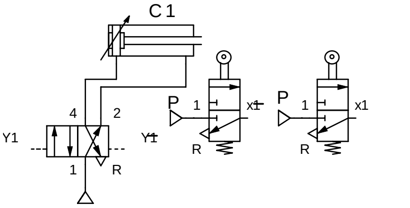
This method is suitable for determined synthesized systems and stochastic systems. The complete synthesis is done in common platform called “Matrixes of Conditions” [1]. Big similarity exists with total signal method, when dealing with determined problems especially.
The synthesis with matrix method is begotten from logical supposition that exits from system are related with entrances and preliminary condition of system.
Mathematical representation of the method:

$$[Y] = [M] \cdot [X] \qquad \dots (1)$$

where:

- [Y] - Vector of output systems
- [X] - Vector of input systems
- [M] - State matrix that includes information about output signals and memory elements

The method is developed in automates with assistance of electro pneumatic elements. Informative/energetic subsystem is shown in figure 1.
To illustrate the way of representation of matrix method we take the supposed system in general form, with executed n-output variables (relation 2).
To solve this method we need to know the algorithm and multiplication between matrix and vector.
The example which will be treated with this method contains inert state also (persistent state). Inert state is result of long term action of input signal. This state is occurred only if contradictions are shown between input signals (primary variables). In this example will be discovered the real causes and the method of elimination of inert states. Therefore, the synthesis with matrix method is suitable enough for finding as well as eliminating contradictory states which in meantime are the potential threat of continuity of remote systems.



$$\begin{bmatrix} Y_1 \\ \overline{Y}_1 \\ \vdots \\ Y_n \\ \overline{Y}_n \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & \cdots & m_{1n} \\ \vdots & \vdots & \vdots & \vdots \\ \cdots & \cdots & m_{ij} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ m_{n1} & m_{n2} & \cdots & m_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ \overline{x}_1 \\ \vdots \\ x_n \\ \overline{x}_n \end{bmatrix} \quad \ldots (2)$$

Figure 1. Informative/energetic subsystem

2. DISCRIPTION OF PROCESS

Function diagram

The sequence of motions of an electropneumatic control system is illustrated in graphical form by means of a Function diagram. A sheet – metal bending device (position sketch: Figure 2) has two double-acting pneumatic cylinder drives that are actuated with spring-return 5/2- way valves.

- Cylinder 1A is used to clamp the work piece. Proximity switches 1B2 (forward end position) and 1B1 (retracted end position) and a 5/2- way valve with solenoid coil 1Y1 are assigned to this cylinder.
- Cylinder 2A (forward end position: proximity switch 2B2, rear end position: proximity switch 2B1, 5/2 – way valve with solenoid coil 2Y1) executes the bending process.

Four steps are required for the bending operation:

- Step 1: Advance piston rod of cylinder 1A (clamp work piece)
- Step 2: Advance piston rod of cylinder 2A (bend metal sheet)
- Step 3: Retract piston rod of cylinder 2A (retract bending fixture)
- Step 4: Retract piston rod of cylinder 1A(release work piece)

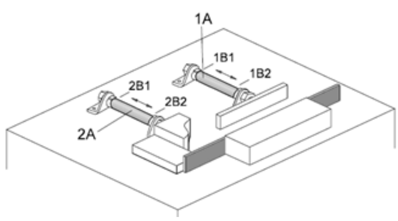


Figure 2. Positional sketch of a sheet-metal bending device

Sensor 1B1 create force 1Y1 and activate the cylinder 1A for clamping the metal sheet. When piston rod of cylinder 1A clamps the metal sheet, it activates the sensor 2A for bending metal sheet. At the end of action 2Y1 switches off and the spring in 5/2 – way directional control valve returns the piston rod of cylinder 2A in starting position. When the piston rod of cylinder 2A return in the starting position he activate the sensor 2B1 which sensor deactivates the force 1Y1 from the action, then the spring in **distributor** 5/2 takes the charge and returns the valve 1A at the starting position, and the work cycle ends with this operation.

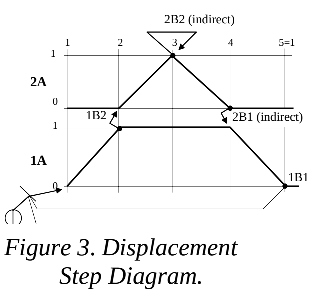


Figure 3. Displacement Step Diagram.

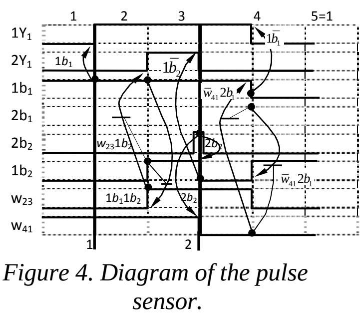


Figure 4. Diagram of the pulse sensor.

$$\begin{bmatrix} 1Y1 \\ 1\overline{Y}1 \\ 2Y1 \\ 2\overline{Y}1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 4 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 3 \end{bmatrix} \sim \begin{bmatrix} 1b1 \\ 1\overline{b}1 \\ 1b2 \\ 1\overline{b}2 \end{bmatrix}$$

Where we gain the matrix

In figure 1 are shown the signal relationship of independent variables $1b_1$, $1b_2$. The cylinder variable B_1, $1b_1$ independently accomplish the determined function, where the variable $1b_2$ its function accomplishes with independent memory element w_{23}. Two other independent variables of cylinder B_2, $2B_1$ and $2B_2$, activates and deactivates the supplementary memory elements, $2B_1$ even if the variable $1B_1$ is active, it makes deactivated and the variable $2B_2$ makes deactivated $1B_1$ variable. All that we said above is illustrated through arrow, reciprocal actions of the sensor signals in figure 4.

Therefore the supplementary memory elements w_{23} and w_{41} are doing the function of elimination of contradicted states, which are shown in the fig. 4 with whole vertical 1 and 2 in the figure 4.

3. SYNTHESIS

While in the remote system appears total signals in two places, which interfere the continuity of sequences, then these total signals should be eliminated [2].

The total signal appears in step 23 and 41. Therefore in the middle of the step 23 the bistable valve is placed 3/2 W_{23} and in the middle of step 41 bistable valve 4/2 W_{41} where active condition will be blocked and inactive condition will be in the service.

While mono stabile memory distributors 5/2 are suppliers, are activated only in one side, whereas the springs are making the return to the normal closed position. Therefore relating to these issue magnetic distributors (sensors) 2B1 and 2B2 will be in hand in processing and directing parts of information.

$$\begin{bmatrix} 1Y1 \\ 1\bar{Y}1 \\ 2Y1 \\ 2\bar{Y}1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \bar{W}_{41} & 0 & 0 \\ 0 & 0 & W_{23} & 0 \\ 0 & 0 & 0 & 3 \end{bmatrix} \sim \begin{bmatrix} 1b1 \\ 1\bar{b}1 \\ 1b2 \\ 1\bar{b}2 \end{bmatrix}$$

Four active conditions will be coded with binary number 1.

$$\begin{bmatrix} 1Y1 \\ 1\bar{Y}1 \\ 2Y1 \\ 2\bar{Y}1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \bar{W}_{41} & 0 & 0 \\ 0 & 0 & W_{23} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \sim \begin{bmatrix} 1b1 \\ 1\bar{b}1 \\ 1b2 \\ 1\bar{b}2 \end{bmatrix}$$

Complementary memory valves will be shown in table below $\bar{W}_{41}$ dhe W_{23} and magnetic distributors $1\bar{b}1$ dhe $1\bar{b}2$.

Table 1. Complementary memory valves.

Independent distributors: $1\bar{b}1$ and $1\bar{b}2$ and complementary valves: $\bar{W}_{41}$ and W_{23}	SET	RESET
$1\bar{b}1$	Piston rod in cyl. 1A in starting position	$2b1 \cdot \bar{W}_{41}$
$1\bar{b}2$	Piston rod in cyl. 1A in working position	$2b2$
W_{23}	$1b1$	$1\bar{b}1 \cdot 2b2$
W_{41}	$1\bar{b}1 \cdot 2b2$	$2b2$

According to gained results in table 1 and the data from coded matrix, we receive the equations of output functions:

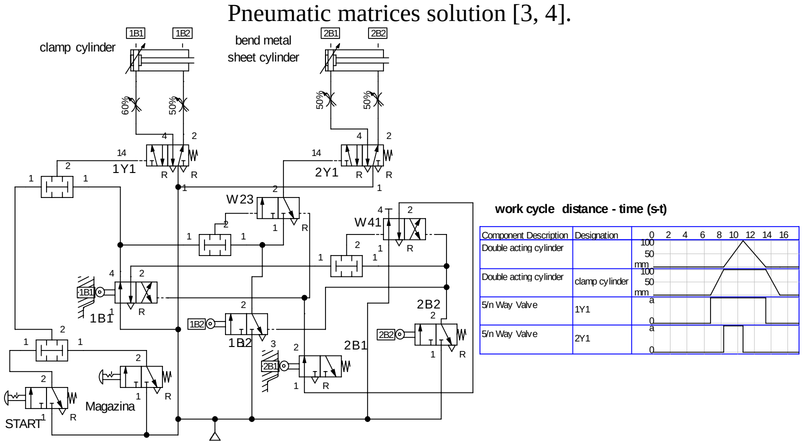
$$1Y1 = \text{START} \cdot \text{detali në magazinë} \cdot 1b1; \qquad 1\bar{Y}1 = \bar{W}_{41} \cdot 2b1$$

$$2Y1 = 1b2 \cdot W_{23}; \qquad 2\bar{Y}1 = 1\bar{b}2$$

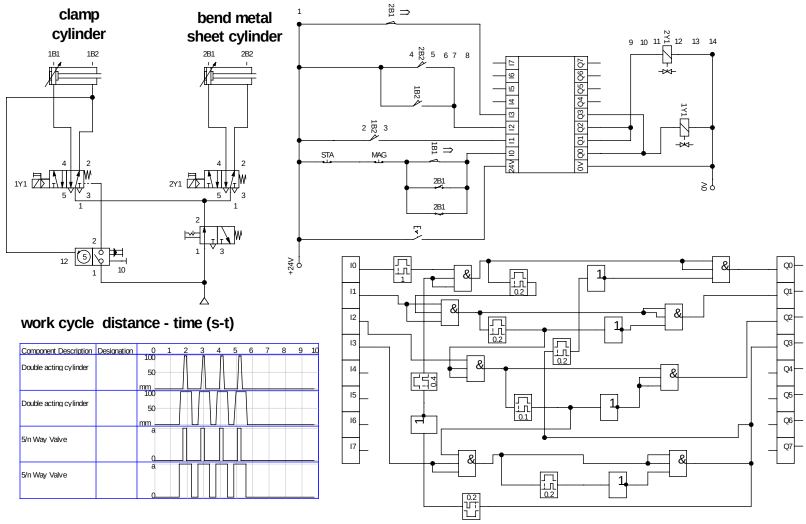
According to equations of output functions 1Y1 and 2Y1, independent variables 1B1; 1B2; 2B1 and 2B2 and complementary memory elements W_{23} dhe W_{41} provides solutions for some variables:

4. SIMULATION

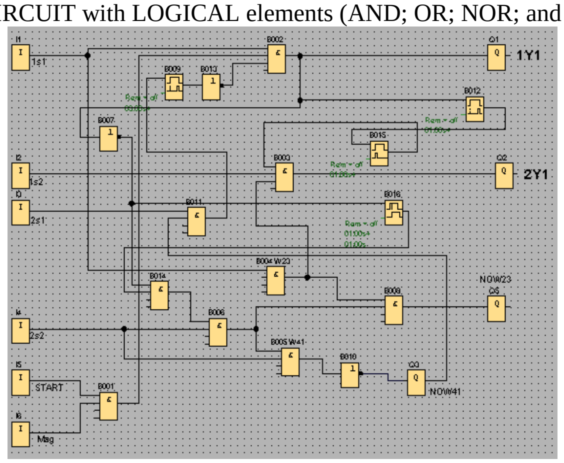
Pneumatic matrices solution [3, 4].



Electro-pneumatic solution with PLC [5].



DIGITAL CIRCUIT with LOGICAL elements (AND; OR; NOR; and TIMER) [6].



5. CONCLUSION

This method is applied for determined automates and stochastic synthesis and can be designed through computer. The synthesis is developed in matrix format. The procedure of synthesis is very rigorous, with the solution close to the minimum value in the context of component number for system execution. At the synthesis with hand of complex systems can remain a lot of errors, therefore it is preferred that this job should be done through PLC controller and Soft Comfort V6.1.

6. REFERENCES

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