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Production Model of Cassette Conveyor Motion Control in Mechanical Processing

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PRODUCTION MODEL OF CASSETTE CONVEYOR MOTION CONTROL IN MECHANICAL PROCESSING

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***Abstract*- A fuzzy inference mechanism is presented for cassette conveyor motion control in mechanical processing. In the MATLAB environment, fuzzification of input and output linguistic variables is implemented using the Fuzzy Logic Toolbox package. As a result of fuzzification of input and output linguistic variables for cassette conveyor motion control in mechanical processing, bases of fuzzy production rules were formed. The degrees of validity of conditions in the fuzzy production rules are calculated. The activation and accumulation procedures were performed and all the values of the degrees of validity of the conclusions for each rule were found. Using the Mamdani algorithm via the application of the center of gravity method, quantitative estimates of the output linguistic variable were obtained. An interactive window of all input and output linguistic variables by means of trapezoidal membership functions is put forward.**

Keywords- fuzzy inference, production rules, fuzzification, cassette conveyor, membership function

I. INTRODUCTION

To create modern methods of managing complex processes, it is necessary to develop and refine models that describe various processes in an uncertain environment [1,2]. At the same time, the process of information accumulation takes place, expert models should be supplemented and refined as new experimental data are accumulated, obtained in model and experimental conditions.

In this regard, the development of a decision-making model for the control of a cassette conveyor in mechanical processing based on modern methods of artificial intelligence is an urgent scientific and technical task.

II. BASE OF PRODUCTION RULES FOR CASSETTE CONVEYOR MOTION CONTROL

To form the rule base of fuzzy production systems, input and output linguistic variables are determined. The following should be formally used as an input linguistic variable: "load factor of the input drive", "speed of the cassette conveyor".

A trapezoidal membership function was used to fuzzify the input and output variables "load factor of the input storage processing device", "cassette conveyor speed" and "air motor valve of cassette conveyor" [3,4].

The following sets are used as term-sets of input linguistic variables:

$$TX_1 = (zero;\ close\ to\ zero;\ negative\ close\ to\ normal);$$

$$TX_2 = (minimum, average, maximum).$$

As a result of fuzzification of input and output linguistic variables, the base of fuzzy productions for cassette conveyor motion control in machining production consists of the following rules:

RULE 1: IF the processing unit's input storage load factor is zero; is close to zero [0.8, 1, 1.2, 1.4], And the speed of movement of the cassette conveyor is minimal [2.5, 10.13], THEN turn the valve of the air motor of the cassette conveyor at a large angle to the right [69.74, 80.85];

RULE 2: IF the load factor of the input accumulator of the processing device is zero, close to zero [1.1, 1.3, 1.5, 1.7], AND the speed of the cassette conveyor is medium [8, 11, 16, 19], THEN turn the air motor valve of cassette conveyor at a large angle to the right [65, 70, 76, 81];

RULE 3: IF the load factor of the input accumulator of the processing device is zero, close to zero [1.4, 1.6, 1.8, 2.0], AND the speed of the cassette conveyor is maximum [14, 17, 22, 25], THEN turn the air motor valve of cassette conveyor a small angle to the right [60, 65,71,76];

RULE 4: IF the load factor of the input accumulator of the processing device is negatively close to normal [1.7, 1.9 2.1, 2.3], AND the cassette conveyor speed is minimum [14, 17, 22, 25], THEN turn the air motor valve of cassette conveyor at a small angle to the right [30, 35,41,46];

RULE 5: IF the load factor of the input accumulator of the processing device is negatively close to normal [1.8, 2.0, 2.4, 2.6], AND the cassette conveyor speed is average [26, 29, 34, 37], THEN leave the air motor valve of cassette conveyor unchanged [33, 38, 43,48];

RULE 6: IF the load factor of the input accumulator of the processing device is negatively close to normal [2.3, 2.5, 2.7, 2.9], AND the cassette conveyor speed is maximum [32, 35, 41, 44], THEN turn the air motor valve of cassette conveyor at a small angle to the left [38, 42, 45, 50];

RULE 7: IF the load factor of the input accumulator of the processing device is positively close to normal [2.6, 2.8, 3.0, 3.2], AND the cassette conveyor speed is minimum [39, 42,46,49], THEN turn the air motor valve of cassette conveyor at a small angle to the left [25, 30, 34, 39];

RULE 8: IF the processing unit's input accumulator load factor is positively close to normal [2.9, 3.1, 3.4, 3.6] AND the cassette conveyor speed is medium [45, 48, 55, 58], THEN turn the air motor valve of cassette conveyor at a large angle to the left [20, 25, 31, 36];

RULE 9: IF the load factor of the input accumulator of the processing device is positively close to normal [3.1, 3.5, 3.7, 3.9], AND the speed of the cassette conveyor is maximum [47, 50, 56, 59], THEN turn the air motor valve of cassette conveyor at a large angle to the left [15, 20, 24, 29].

Figure 1 shows an interactive window through which 9 terms of the linguistic variable "load factor of the input accumulator of the processing device" are fuzzified by means of trapezoidal membership functions on the universe [0, 4].

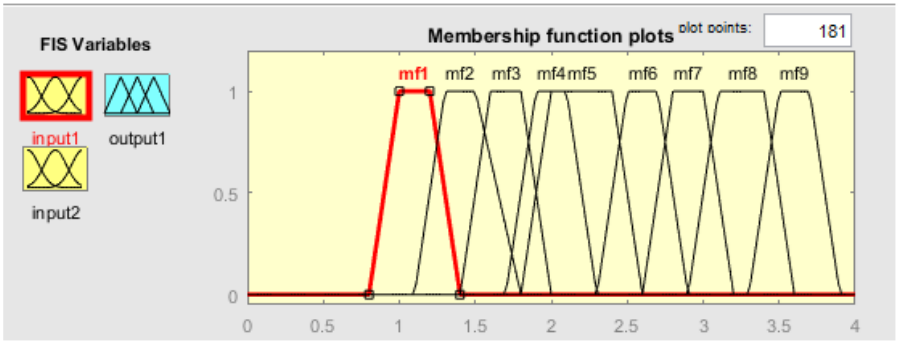

Fig 1. Trapezoidal membership functions of fuzzy sets, depicting the terms of the input linguistic variable "load factor of the input storage of the processing device"

Figure 2 shows an interactive window through which 9 terms of the linguistic variable "cassette conveyor speed" are fuzzified using trapezoidal membership functions in the universum[0,60].

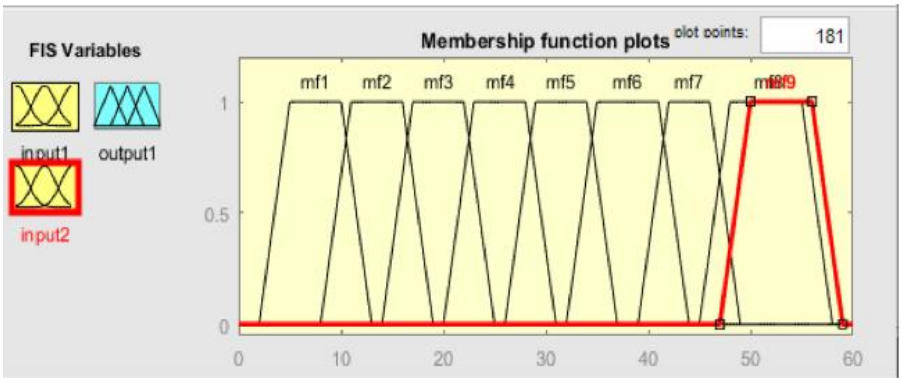

Fig 2. Trapezoidal membership functions of fuzzy sets, depicting the terms of the input linguistic variable "the speed of the cassette conveyor"

Fuzzy sets of input linguistic variables are defined as:

$$X_1(input\ storage\ load\ factor) = 0.100/x_1 + 0.300/x_2 + 0.400/x_3 + 0.600/x_4 +$$

$$+0.800/x_5 + 1.000/x_6 + 0.700/x_7 + 0.200/x_8 + 0.090/x_9;$$

$$X_2(cassette\ conveyor\ speed) = 0.125/x_1 + 0.255/x_2 + 0.335/x_3 +$$

$$+ 0.625/x_4 + 0.721/x_5 + 1.000/x_6 + 0.475/x_7 + 0.265/x_8 + 0.097/x_9.$$

Figure 3 shows an interactive window through which 9 terms of the linguistic variable "starting the valve of air motor regulator of the cassette conveyor" are fuzzified using trapezoidal membership functions in the universum [0,90].

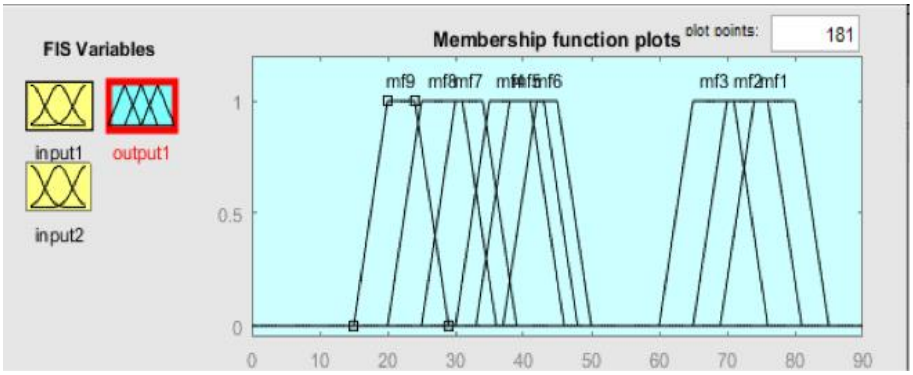

Fig. 3. Trapezoidal membership functions of fuzzy sets, depicting the terms of the output linguistic variable "starting the valve of air motor of the cassette conveyor"

As term-sets of output linguistic variables, we will use the set:

$$TX_3 = (a\ small\ angle\ to\ the\ right;\ a\ small\ angle\ to\ the\ right;\ unchanged, at\ a\ slight\ angle\ to\ the\ left;\ wide\ angle\ to\ the\ left).$$

The fuzzy set of output linguistic variables is defined as follows:

$$X_3(cassette\ conveyor\ air\ motor\ valve) = 0.097/x_1 + 0.180/x_2 + 0.253/x_3 + +0.397/x_4 + 0.607/x_5 + 1.000/x_6 + 0.720/x_7 + 0.295/x_8 + 0.125/x_9.$$

Defuzzification in fuzzy inference systems is a procedure for finding a non-fuzzy value for each of the output linguistic variables. The purpose of defuzzification is to use the results of the accumulation of all output linguistic variables to obtain the usual quantitative value of each of the output variables, which can be used by special devices external to the fuzzy inference system.

The defuzzification procedure is considered complete when the final quantitative values in the form of some real number are determined for each of the output linguistic variables.

A three-dimensional image of the result of defuzzification of the output variables of the “valve of air motor of the cassette conveyor” is shown in Fig.4.

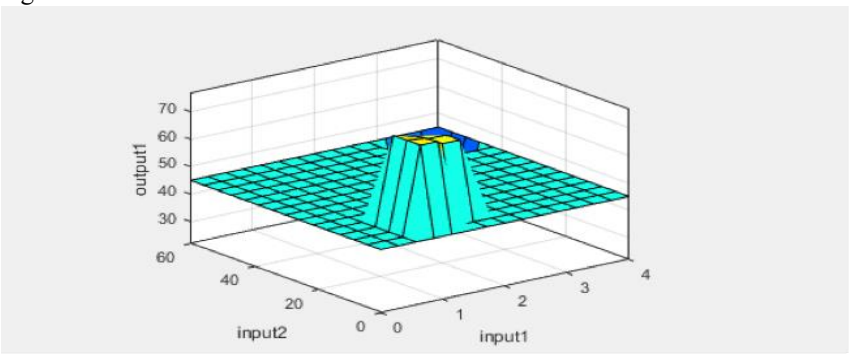

Fig. 4 Three-dimensional image of the result of defuzzification of the output variables of the “valve of air motor of the cassette conveyor”

III. CONCLUSION

A model for controlling the movement of a cassette conveyor during machining with fuzzy conclusions has been developed. The structure and rules for launching network transitions are defined. The base of rules is formed. On the basis of a computer experiment, fuzzification of all terms of input variables was carried out. The degrees of fulfillment of conditions in fuzzy production rules are calculated. The activation and accumulation procedures were performed and all the values of the degrees of reliability of the subconclusions for each rule were found. The defuzzification procedure is implemented in three-dimensional space in the Matlab environment using the fuzzy logic Toolbox extension package. An interactive window of all input and output linguistic variables is presented using trapezoidal membership functions.

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