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FUZZY MODELS OF ACTIVE ELEMENTS WORKING IN THE FLEXIBLE MANUFACTURE SYSTEM

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It is considered a problem of fuzzy model working out for investigation of flexible manufacture module (FMM), where its active elements have the next basis specifics: every active elements work in a fuzzy area of positions and at limited conditions (time and resource); working actives elements of FMM are not personal and have complex structural and functional relations between them; the characteristics of active elements are not defined by quantity and can be represented only by linguistically method; working some active elements is executed asynchrony, and their rules of connection are represented by fuzzy logical relation as «condition-execution». For simulation of above presented dynamical contrary functioned process which work at condition of not definition. By that the mathematical apparatus as fuzzy Petri net (PN) and its modifications use at all.

As known the fuzzy PN is defined as $N=(P,T,I,O,\mu)$, where $p=\{p_1,p_2,...,p_n\}, n>o$ - final not empty multiplex of positions; $T=\{t_1,t_2,...,t_m\}$, $m>0$ - final not empty of transfers; $I: P\times T\to(0,1,...)$, $O: T\times P\to(0,1...)$ - corresponding to functions of internal and external incidents; at presentation of $\mu: P\to[0,1]$ - for every position p_i vector of degree allocation of belonging markers to the positions $\mu(p_i)$.

Rules of transfers and changes executing for fuzzy PN are defined as [1]: if vector of degree allocation of belonging every internal position $p_i\in P$ is being a component corresponded to not zero, with number, corresponded to or more then number of arc which connect the date position with the transfer $t_j\in T$, then the transfer t_j is activated; after activation of the transfer a process of relocation of markers in the positions; quantity of fiches in the positions defines the net form.

At solution of practical problems can use matrix presentation of fuzzy PN structure. The elements of a matrix of internal, external incidents define in a view:

$$f_{ij}=\begin{cases}1, if\ \ p_i\in I(t_j);\\ 0, if\ \ p_i\notin O(t_j);\end{cases}\quad h_{ij}=\begin{cases}1, if\ \ p_i\in O(t_j);\\ 0, if\ \ p_i\notin O(t_j);\end{cases}\quad d_{ij}=\begin{cases}-1, if\ \ p_i\in I(t_j) \text{ and } p_i\notin O(t_j);\\ 1, if\ \ p_i\notin I(t_j) \text{ and } p_i\in O(t_j);\\ 0, if\ \ p_i\notin I(t_j) \text{ and } p_i\notin O(t_j);\end{cases}$$

It is considered working FMM of cleaning aluminum cards. FMM includes the cleaning technological unit (CTU) for executive of cleaning upper area of cards, internal and external holding for saving cards before and after cleaning operation, the equipment of technical vision (ETV) for definition of quality of cleaning upper area of cards, an industrial robot (IR) for executive of loading operation of holding defects cards, corrected cards, cleaned cards.

FMM works as following: by having a card at the internal holder the pusher is actived and a card is passed into the work zone of CTU, where technological operation of cleaning is executed, a beginning and a finale status of the pusher is fixed, at finishing operation cleaned cards are relocated to a position of the external holder. By having a card at the external holder ETV executives an operation of control of quality of cleaning upper area of cards, by the end of quality control the cleaned cards is loaded in the corresponded holder, in depended on a control result bellowing function is defined: (0; 0,5) is interval of normal limit; (0,5; 0,8) is corrected interval; (0,8; 1)- not corrected interval.

Fuzzy model of FMM active elements working for cleaning upper area of cards is represented as fuzzy Petri net. There was defined structure of fuzzy Petri net and worked out graph-scheme of functioning FMM for cards cleaning (fig. 1).

Multitude of position: p_1 – having a card at the internal holder of the cleaning unit; p_2 – having not a card at the internal holder of the cleaning unit; p_3 – of the cleaning unit executes an operation of cleaning; p_4 – having a card at the external holder of the cleaning unit; p_5 – having not a card at the external holder of the cleaning unit; p_6 – ETV is at the beginning position; p_7 – ETV executes operation of quality control of upper area of a card; p_8 – ETV is at a finale status; p_9 – is not defect on upper area of a card in the external holder of the cleaning unit; p_{10} – is found a corrected defect on upper area of a card in the external holder of the cleaning unit; p_{11} – is found a not corrected defect on upper area of a card in the external holder of the cleaning unit; p_{12} – is the beginning status; p_{13} – is loading the holder of cleaned cards; p_{14} – is loading the holder of cards with corrected defects; p_{15} – is loading the holder of cards with not corrected defects.

The Multitude of transformations: t_1 – cards are given for cleaning operation; t_2 – is loading the internal holder of the cleaning unit; t_3 – the cleaning unit is over cleaning operation; t_4 – is activated ETV; t_5 – ETV is finished operation of quality control of cleaning upper area of a card; t_6 – is activated off ETV; t_7 – activated IR; t_8 – activated off.

Function of internal and external incidents are represented in corresponding to matrix F and H:

$$F = \begin{bmatrix} 1&0&0&0&0&0&0&0 \\ 0&1&0&0&0&0&0&0 \\ 0&0&1&0&0&0&0&0 \\ 0&0&0&1&0&0&0&0 \\ 0&0&0&0&0&0&0&0 \\ 0&0&0&1&0&0&0&0 \\ 0&0&0&0&1&0&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&0&1 \\ 0&0&0&0&0&0&0&1 \\ 0&0&0&0&0&0&0&1 \end{bmatrix}, \quad H = \begin{bmatrix} 0&1&0&0&0&0&0&0 \\ 1&0&0&0&0&0&0&0 \\ 1&0&0&0&0&0&0&0 \\ 0&0&1&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&1&0&0&0&0 \\ 0&0&0&0&1&0&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&0&1 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&1&0 \end{bmatrix}.$$

The matrix elements of incidents define by formula: $d_{ij} = h_{ij} - f_{ij}$, $i = \overline{1,15}$; $j = \overline{1,8}$.

The initial marking μ_0 is represented as:

$\mu(0,1) = (1.000, 0.000)$; $\mu(0,9) = (0.200, 0.600, 0.100, 0.100)$;

$\mu(0,2) = (1.000, 0.000)$;
$\mu(0,3) = (1.000, 0.000)$;
$\mu(0,4) = (1.000, 0.000)$;
$\mu(0,5) = (1.000, 0.000)$;
$\mu(0,6) = (1.000, 0.000)$;
$\mu(0,7) = (0.200, 0.300, 0.500)$;
$\mu(0,8) = (0.000, 0.400, 0.600)$;
$\mu(0,10) = (0.100, 0.500, 0.400, 0.000)$;
$\mu(0,11) = (0.100, 0.400, 0.500, 0.000)$;
$\mu(0,12) = (0.000, 0.000, 0.000, 1.000)$;
$\mu(0,13) = (0.000, 0.400, 0.600, 0.000)$;
$\mu(0,14) = (0.000, 0.200, 0.000, 0.800)$;
$\mu(0,15) = (0.000, 0.300, 0.500, 0.200)$;

On the base of worked out algorithm [2] is calculated Gram matrix elements and a vector of diagonal case of fuzzy Petri net. By a result of computer experiment successiveness of transformation activating $\sigma = (t_1\, t_3\, t_2\ t_4\, t_5\, t_6\, t_7\ t_8)$ from beginning marker μ_0.

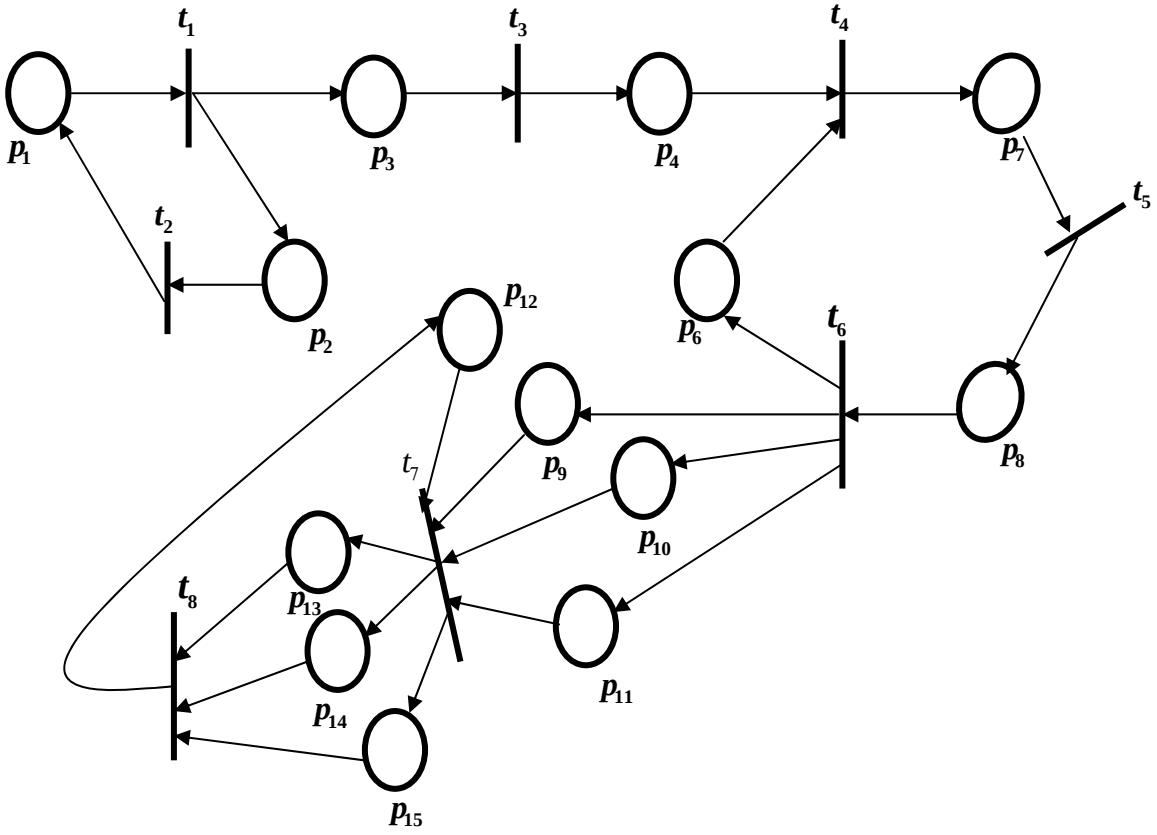

Fig. 1. Graph-scheme of functioning FMM for cleaning cards

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