APPLICATION OF INTELLIGENCE MODELS FOR FUNCTIONAL ANALYZE OF TECHNOLOGICAL UNITS

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Introduction.

One of the hard way influenced on speeding and efficiency automation design of flexible manufacturing enterprises and its elements is creation of its informing support with application intelligence system. As complicated technical system for design informing support of technological equipments of flexible manufacturing system is demand its structural, technical and functional analyze. At creation of knowledge and data base been basis informing support, semantically and logical models are used often. These models allow to describe complicated technological equipments of manufacturing systems more exactly and reliability, guarantee its high productivity and efficiency [1].

Solution.

One of the principal active element of the flexible manufacturing system (FMS) of aluminum evaporator making for home refrigerator is the hydro-press of evaporator canal making. At design the hydro-press of evaporator canal making the problem of its automation scheme, informing area of automation scheme elements, functional analyze are considered [2]. The hydro-press included not-moving (a matrix, a foundation, a prop) and moving (puncheon) units works as follows: after installing by an industrial robot an aluminum sheet on the matrix of hydro-press, puncheon is relocated down on the matrix and fixed. On beginning position of the hydro-press variable of contact less monometer pressure is 0. As soon as the puncheon of hydro-press is switched, water from the hydro-syringe by pressure enters canals of an evaporator. Contact less monometer pressure begins to rise until 4 atm. At completion of water entering canals of an evaporator, contact less monometer is switched off. As soon as water is not entering canals of an evaporator, puncheon is relocated up to high position (initial position), an industrial robot grips an aluminum evaporator from the matrix of hydro-press.

Relations between the hydro-press automation scheme's active elements and a service element-industrial robot are presented as set

$$R_j = \{ R_1, R_2, \ldots , R_m \}.$$

The scheme of relations is presented as intentional and extensional knowledge base:

$$INT (R_j)=\{ \ldots, [A_I, DOM (A_I)], \ldots \},$$

$$EXT (R_j)=\{ F_1 , F_2, \ldots, F_k \},$$

where F_k – facts of semantically net. Facts are suited of technological operations of the hydro-press and an industrial robot in the manufacturing module.

F_1- if an industrial (IR) robot loads an aluminum evaporator (AE) into a matrix of the hydro-press (MHP), then an aluminum evaporator is fixed on a matrix of the hydro-press ;

F_2- if an aluminum evaporator is fixed on a matrix of the hydro-press, then puncheon of the hydro-press (PHP) is mowed down ;

F_3 – if puncheon of the hydro-press is fixed on a matrix of the hydro-press, then hydro-syringe (HS) is mowed forward and the hydro-press monometer pressure (HPMP) is begun to change ;

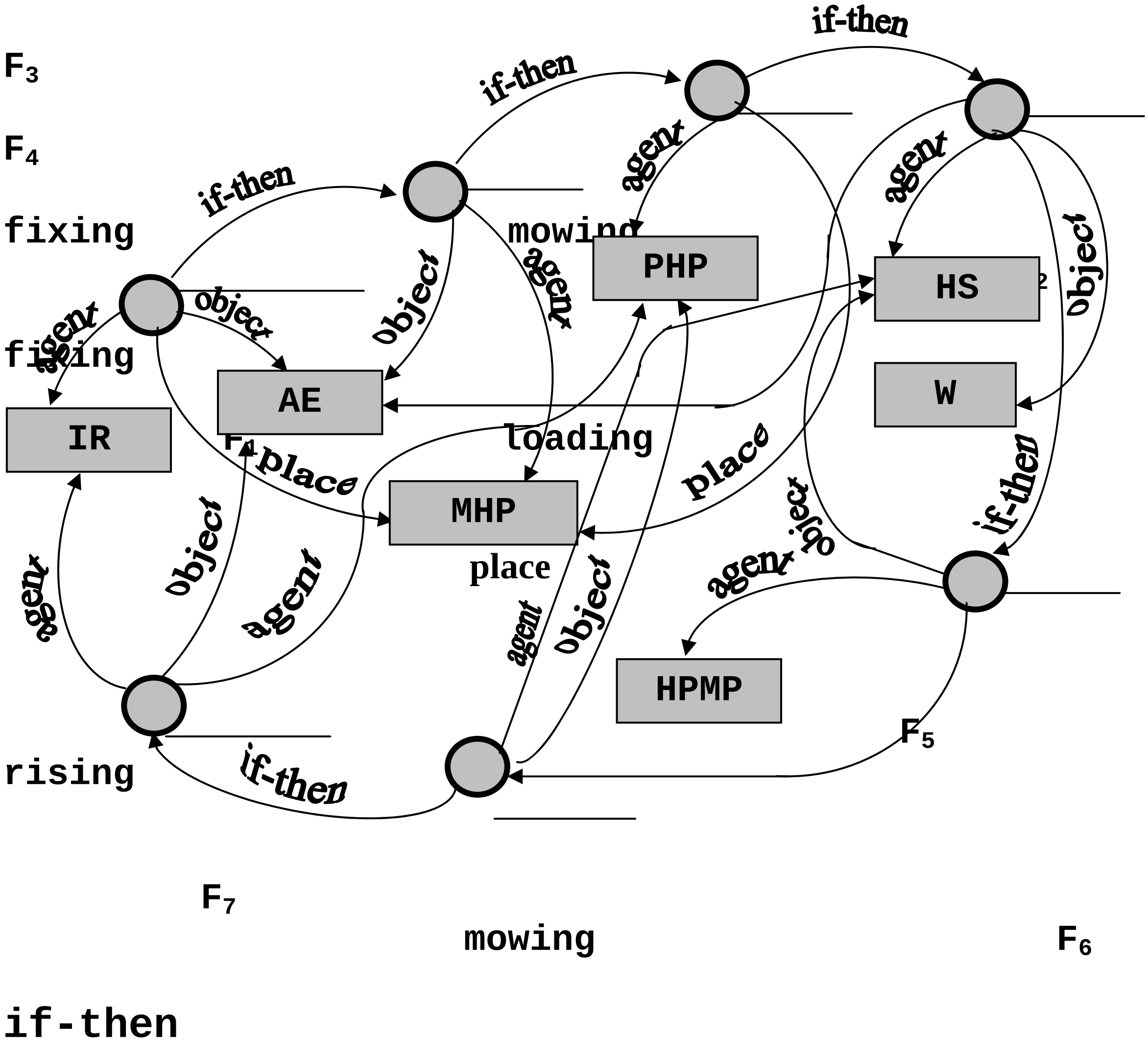
F_4 – if the hydro-syringe is mowed forward and some water (W) pass across the hydro-syringe into canals of an aluminum evaporator, hydro-press monometer pressure is begun to rise till norm (4 atm) ;

F_5 – if hydro-press monometer pressure is raised till norm, then the hydro-syringe is mowed back ;

F_6 – if the hydro-syringe is mowed back and hydro-press monometer (HPM) pressure parameter is zero, then puncheon of the hydro-press is mowed up ;

F_7– if the puncheon of hydro-press is mowed up, then an industrial robot grips a ready aluminum evaporator from a matrix of the hydro-press.

In accordance to the facts for intentional knowledge description graph-scheme of semantically relations is drawn (figure 1).



By means of facts worked out graph-scheme of technological process semantically relation of the hydro-press and an industrial robot, **"agent"** is active functioning element and **"object"** is passive functioning element.

Extensional data base of the semantically net includes functional representation of the hydro-press and an industrial robot and its technical characteristics.

F_1 : (if an industrial robot loads an aluminum evaporator into a matrix of the hydro-press, then an aluminum evaporator is fixed on a matrix of the hydro-press, D1, D2, D3) ;

($\forall$ $D1_I \in$ an industrial robot technical characteristics) ,

($D1_1 \rightarrow$ moving degree of an industrial robot) &
($D1_2 \rightarrow$ positioning error of an industrial robot) &
($D1_3 \rightarrow$ load lifting of an industrial robot) &
($D1_4 \rightarrow$ maximal line straight relocation along Z axis of an industrial robot) &
($D1_5 \rightarrow$ maximal line straight relocation along Y or X axis of an industrial robot) &
($D1_6 \rightarrow$ speed of line straight relocation along Z axis of an industrial robot) &
($D1_7 \rightarrow$ speed of line straight relocation along Y or X axis of an industrial robot) &
($D1_8 \rightarrow$ maximal turning relocation round Z axis of an industrial robot) &
($D1_9 \rightarrow$ maximal turning relocation round Y or X axis of an industrial robot) &

($D1_{10} \rightarrow$ speed of turning relocation round Z axis of an industrial robot) &
($D1_{11} \rightarrow$ speed of turning relocation round Y or X axis of an industrial robot).

($\forall$ $D2_J$ $\in$ an aluminum evaporator technical characteristics),

($D2_1 \rightarrow$ maximal length of an aluminum evaporator) &
($D2_2 \rightarrow$ maximal width of an aluminum evaporator) &
($D2_3 \rightarrow$ maximal weight of an aluminum evaporator).

($\forall$ $D3_J$ $\in$ a matrix of the hydro-press technical characteristics),

($D3_1 \rightarrow$ maximal load lifting of a matrix of the hydro-press) &
($D3_2 \rightarrow$ maximal length of a matrix of the hydro-press) &
($D3_3 \rightarrow$ maximal width of a matrix of the hydro-press).

F_2 : (if an aluminum evaporator is fixed on a matrix of the hydro-press, then puncheon of the hydro-press is mowed down, D2, D3, D4)

($\forall$ $D4_J$ $\in$ a puncheon of the hydro-press technical characteristics),

($D4_1 \rightarrow$ maximal length of a puncheon of the hydro-press) &
($D4_2 \rightarrow$ maximal width of a puncheon of the hydro-press) &
($D4_2 \rightarrow$ maximal weight of a puncheon of the hydro-press).

F_3 : (if puncheon of the hydro-press is fixed on a matrix of the hydro-press, then hydro-syringe is mowed forward and the hydro-press monometer pressure is begun to change, D4, D3, D5, D6)

($\forall$ $D5_R$ $\in$ hydro-syringe of the hydro-press technical characteristics),

($D5_1 \rightarrow$ hydro-syringe diameter of the hydro-press) &
($D5_2 \rightarrow$ hydro-syringe length of the hydro-press).

($\forall$ $D6_R$ $\in$ hydro-press monometer of the hydro-press technical characteristics),

($D6_1 \rightarrow$ pressure diapason of hydro-press monometer of the hydro-press) &
($D6_2 \rightarrow$ diameter of hydro-press monometer of the hydro-press).

F_4 : (if the hydro-syringe is mowed forward and some water pass across the hydro-syringe into canals of an aluminum evaporator, hydro-press monometer pressure is begun to rise till norm, D5, D2, D6) ;

F_5 : (if hydro-press monometer pressure is raised till norm, then the hydro-syringe is mowed back, D6, D5);

F_6 : (if the hydro-syringe is mowed back and hydro-press monometer pressure parameter is zero, then puncheon of the hydro-press is mowed up, D5, D6, D4) ;

F_7 : (if the puncheon of hydro-press is mowed up, then an industrial robot grips a ready aluminum evaporator from a matrix of the hydro-press, D4, D1, D2, D3).

For addition knowledge base the flexible manufacturing module is analyzed by means of deductive logical system – timing logical relations. In timing logic conceptions are organized of time and event net [3].

Time moments include elements set shown below :

$$t_j = \{ t_0, t_2, \ldots\ldots, t_7 \}$$

The events include situation elements set, which is shown below :

$$p_j = \{p_0, p_2, \ldots\ldots, p_{16} \}$$

where p_j events situation is suited of the facts F_i. In event situation elements time relations are presented in not-metrical form (r_0 – an event happened at the same time moment; r_1- an event happened before a time moment; r_2- an event happened after a time moment); in metrical form ($r^{n,L}_3$ –an event happened on **n** time before by **L** scale (n =1, 2, 3,….), - r^L_4 **t** – an event happened at **t** time by **L** scale).

In timing logical relations model is written as combination **(p_i R p_j)**

where $p_i , p_j \in P$, $R \in \{ r_0, r_1, \ldots\ldots, r_4 \}$

In timing logic axioms scheme are represented as follows :

$$(p_i\ r^{n,L}_3\ p_j) (p_j\ r^{m,L}_3\ p_к) \Rightarrow (p_i\ r^{n+m,L}_3\ p_к) \quad (1)$$

$$(p_i\ r^L_4\ t) (p_i\ r^{n,L}_3\ p_j) \Rightarrow p_j\ r^L_4\ (t \oplus n) \quad (2)$$

where $\oplus$ symbol is plus sing operations of times by scale

Of analyze of the flexible manufacturing module technological process it was defined that it has some stages and controlling situations. In this connection, that complex technological process actions are analyzed in depend on time.

Functional control events of IR and the hydro-press are represented as follows :

($\forall\ p_i \in$ functional control events of IR and the hydro-press)

(p_0 = AE is fixed on a fixing manipulator) $\wedge$ (p_1 = IR hand is relocated down) $\wedge$
(p_2 = IR hand gripper is gripped AE from a fixing manipulator) $\wedge$
(p_3 = IR hand is relocated back and up at same time by ellipse trajectory) $\wedge$
(p_4 = IR hand is turned 90^0) $\wedge$
(p_5 = IR hand is relocated forward and down at same time by ellipse trajectory) $\wedge$ (p_6 = IR hand gripper is opened) $\wedge$ (p_7 = AE is fixed on the MHP) $\wedge$
(p_8 = IR hand is relocated back and up at same time by ellipse trajectory) $\wedge$
(p_9 = PHP is relocated down) $\wedge$ (p_{10} = HS is relocated forward) $\wedge$
(p_{11} = water blowing AE canals) $\wedge$ (p_{12} = HS is relocated back) $\wedge$ (p_{13} = PHP is relocated up) $\wedge$ (p_{14} = IR hand is relocated forward and down at same time by ellipse trajectory) $\wedge$
(p_{15} = IR hand gripper is gripped AE from the hydro-press) $\wedge$
(p_{16} = IR hand is relocated back and up at same time by ellipse trajectory).

The intervals t_j between technological operations of the flexible manufacturing module are chosen in accordance to p_i events:

($\forall\ t_j \in$ intervals between technological operations)

(t_0 = interval of AE fixing on a fixing manipulator or MHP) $\vee$
(t_1 = interval of IR hand relocating down) $\vee$
(t_2 = interval of IR hand relocating back and up or forward and down at same time by ellipse trajectory) $\vee$ (t_3 = interval of IR hand turning on 90^0) $\vee$
(t_4 = interval of PHP relocating down or up)$\vee$(t_5 = interval of HS relocating forward or back) $\vee$ (t_6 = interval of water blowing AE canals)$\vee$(t_7 = interval of IR hand gripper opening or closing).

In accordance to (1) and (2) expressions IR and the hydro-press functional control situations can write the following expression :

$$TS = (p_0\, r_4\ t_0) \wedge (p_0\, r_3^{n1,L}\ p_1) \wedge (p_1\, r_3^{n7,L}\ p_2) \wedge (p_2\, r_3^{n2,L}\ p_3) \wedge$$
$$(p_3\, r_3^{n3,L}\ p_4) \wedge (p_4\, r_3^{n2,L}\ p_5) \wedge (p_5\, r_3^{n7,L}\ p_6) \wedge (p_6\, r_3^{n0,L}\ p_7) \wedge (p_7\, r_3^{n2,L}\ p_8) \wedge$$
$$(p_8\, r_3^{n4,L}\ p_9) \wedge (p_9\, r_3^{n5,L}\ p_{10}) \wedge (p_{10}\, r_3^{n6,L}\ p_{11}) \wedge (p_{11}\, r_3^{n5,L}\ p_{12}) \wedge$$
$$(p_{12}\, r_3^{n4,L}\ p_{13}) \wedge (p_{13}\, r_3^{n2,L}\ p_{14}) \wedge (p_{14}\, r_3^{n7,L}\ p_{15}) \wedge (p_{15}\, r_3^{n2,L}\ p_{16}) \Rightarrow (p_0\ r^{2n0+ n1+ 5n2+ n3+ 2n4+ 2n5+ n6+ 3n7,\ L}_3\ p_{16}) \Rightarrow \Rightarrow p_0\ r^L_4\ (t_0 \oplus 2n_0 ; n_1 ; 5n_2 ; n_3 ; 2n_4 ; 2\, n_5 ; n_6 ; 3n_7)$$

where in L scale each t_i time is suited n_i.

Conclusion.

The worked out model of semantically and timing relation of a hydro-press, an industrial robot serving a hydro-press allows to do detailed functional analyze, create more broad informing support about flexible manufacturing module. A like methodic can use at work out manufacture control system.

Reference

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