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AGENT TECHNOLOGY AT COMPUTING OPTION OF FLEXIBLE MANUFACTURE SYSTEM ELEMENT AND COMPOSED STRUCTURE

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Abstract. At present by investigation of the problems of computing design of flexible manufacture system (FMS), specialty on the beginning stages, it is necessary to do purpose-directly option of elements, informing data and parameters FMS. Computing option of FMS, as complex iteration process, is performed with much level organization of design procedures from design demands at first level to design solution of the demanded degree of detailing at the next levels. At computing option of FMS, for creation its informing, mathematical, program supports, the levels of logical and parametric designing application are demanded. In this connection, for designing process advancement of efficiency and accuracy, in the paper the problem of computing option and definition of FMS elements parameters on logical and parametric designing levels with agent's technology application [1, 4].

Keywords: CAD, agent technology, flexible manufacture system, knowledge.

AMS Subject Classification: 97M10.

1. Solution

As well as now FMS posses a great number of industrial robots, grippers and specials manipulators of different purpose, installed on manufacture islands, technological equipment, used in productions making, elements of control system. [2]. At logical sublevels of designing, criterions of efficiency variants of FMS and its elements option are heuristically and their levels – values successive corrected. On each logical sublevel by means of search models the set of rationale variants named partial and developed in future are chosen. Option on each sublevel is divided on complex of interacted designing problems (logical and mathematical procedures), which are suited aspects of designing.

Solution of individual sub problems of computing option of FMS elements demands knowledge's application, executed by agents (expert or software component), which are responsible for it decision. For formal description of subject's area of elements the expert knowledge defining them basis parameters, working out kinematical and dynamical schemes of active elements and manufacturing modules of FMS, defining commonly coordinates, speeds of industrial robots served technical units of manufacture modules, developing their control algorithm are applied (the structure of the expert knowledge exposing is represented on the figure 1). Process of FMS element option is excised by coordination use with traditional components of computing design and

intelligence systems, passing between agents, worked out units of informing support (knowledge and data bases of the designed objects).

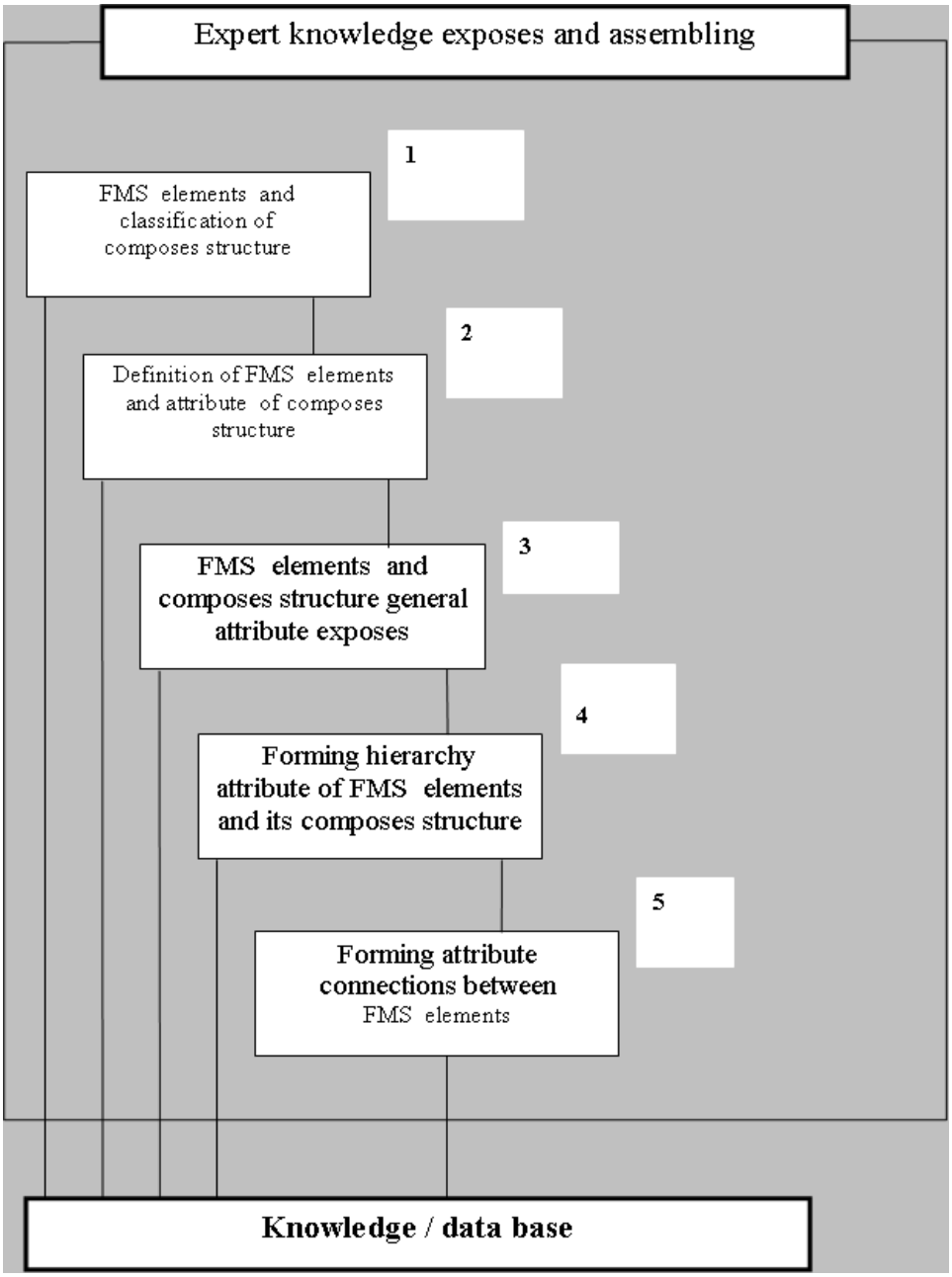

Fig. 1. The structure of subsystem of exposes and assembling expert knowledge

At elements and manufacturing modules of FMS manufacture appointment and technical characteristics (number of movement degree, load lifting, linear and revolving relocations, speed of linear and revolving relocations, and maximal radius of service are necessary to define. In this case, each agent suit by some knowledge of subject area, knowledge about limitation and local problems of

option an the base of common informing area of FMS active elements and composes structure, which is excised by means of the term conditions [1]:

" Area of FMS equipment relocation is minimal – $S^{FMS} \to min$ ",
" Active element's working zone is maximal – $R^{wz} \to max$ ",
" Active element's positioning error is minimal – $\Pi^{pe} \to min$ ",
" Productivity of active element is maximal – $\Pi^{p} \to max$ ".

For a support of processing designing information between FMS computing design subsystems the communication agents, where each agent execute logical conclusion in theirs internal terms and pass some information to another agents, are used [4]. The agents interact by use of exchange of designing area's knowledge.

On the stage of FMS computing design, agent's works – designers by its active elements and composes structure option are connected with solution of necessary part of basis technological equipment forming, successiveness of technological operations in manufacture modules, relocation of basis technological units between serving robots, definition of economical efficiency and productivity of the chosen FMS composes structure, development of program-algorithmic supports of robotic technical complex control process. At that, a great number of system variants of FMS compose structure is defined a great number of variations of variants:

$$V = \prod_{i=1}^{n} l_i \ , \tag{1}$$

where l_i – the parameters number in the i-th group; n – number of the parameter groups.

The agent problem – for option of best variants analyze of maximal number of FMS composes structure. FMS composes structure is chosen on the base of discrete parameters variation: the set of technological units; the set of technological units and industrial robot relocation structures; successiveness of technological operations; common time of technological operations executive [3].

In corresponding of the above presented discrete parameters, the agent-designer executes procedures of option, where the condition must perform [1]:

$$\forall\ MS_j \vee IS_j \vee PS_j \in OP_j \tag{2}$$

где MI_j , IS_j , PS_j – the developed by the agents mathematical, informing and programming supports (MS, IS, PS) of computing option of FMS composes structure, which suit the option procedures (OP_j).

The set of computing option supports of FMS composes structure, created by agents-experts (AE), can represented as block matrix:

$$S = \begin{pmatrix} MS_{11} & MS_{12} & \dots & MS_{1n} \\ IS_{21} & IS_{22} & \dots & IS_{2n} \\ PS_{31} & PS_{32} & \dots & PS_{3n} \end{pmatrix} \Rightarrow \begin{pmatrix} AE_{M\,j} \\ AE_{I\,j} \\ AE_{P\,j} \end{pmatrix} \Rightarrow \begin{pmatrix} OP_{1i} \\ OP_{2i} \\ OP_{3i} \end{pmatrix} \quad (3)$$

The option procedures $OP_{1j} \in \{OP_{11}, OP_{12}, .., OP_{1n}\}$, $OP_{2j} \in \{OP_{21}, OP_{22}, .., OP_{2k}\}$, created by agents of mathematical and informing supports in following stages of computing option are presented as the initial data for procedures by development of special software $OP_{3j} \in \{OP_{31}, OP_{32}, \dots\dots, OP_{3m}\}$.

Agents-experts connection, theirs created supports and the suited procedures of option can present as a logical model and graph-scheme (fig. 2):

$$\begin{aligned} &OP_{11}: MS_{11} \to AE_{M\,1};\ OP_{12}: \{MS_{12} \wedge MS_{13}\} \to AE_{M\,2};\ OP_{13}: MS_{14} \to AE_{M\,1};\\ &\quad OP_{14}: MS_{15} \to AE_{M\,3};\ OP_{21}: IS_{21} \to AE_{И\,1};\ OP_{22}: IS_{22} \to AE_{I\,1}; \\ &OP_{23}: IS_{23} \wedge IS_{24} \to AE_{I\,2};\ OP_{31}: PS_{31} \to AE_{P\,1};\ PS_{32}: PS_{32} \to AE_{П\,2};\\ &OP_{33}: PS_{33} \wedge PS_{34} \to AE_{P\,3}, \end{aligned} \quad (4)$$

where MS_{11} – mathematical model of calculation of industrial robots work zones in FMS; $MS_{12} \wedge MS_{13}$ – mathematical model of structural and functional analyze; MS_{14} – mathematical model of calculation of industrial robots positioning error for their composes in FMS; MS_{15} – mathematical model of calculation of FMS economical efficiency; IS_{21} – informing model (data base) of mathematical units complex (MUC), that is, the principal calculated parameters, made by $AE_{M\,i}$; IS_{22} – informing model of active elements, FMS composes structures and their basis standard technical characteristics; IS_{23} – informing – search model for searching and option of demanded industrial robots, technological equipment, technical units of FMS control system, automation scheme in suitable of the manufacture demands; IS_{24} – informing – search model for searching and option of FMS composes structure by the above presented term conditions of the mathematical model; PS_{31} – a program unit, worked out on the base of MUC and informing unit complex (IUC) of the mathematical models $МИ_{1i}$; PS_{32} – a program unit, worked out on the base of informing models of FMS active elements and composes structures; PS_{33} – a program unit, worked out on the base of the informing-search model for search and option of demanded industrial robots, technological equipment, technical devices of FMS control system and automation scheme; PS_{34} – a program unit, worked out on the base of the informing-search model for search and option of FMS composes structure.

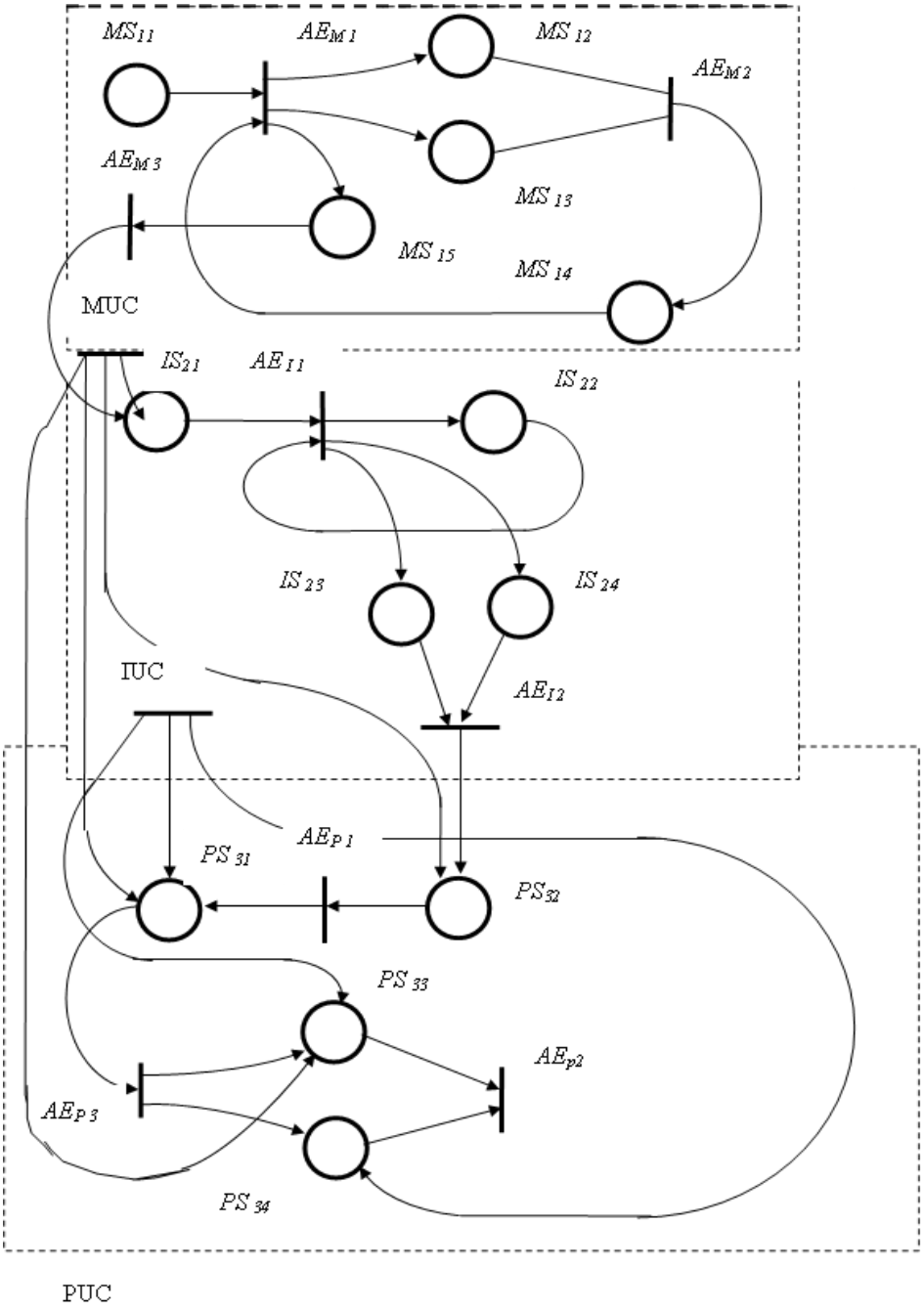

Fig. 2.

In corresponding of the above presented parameters – criterions the members of the purpose function for FMS composes structure are defined [1, 2]:

$$W_{FMS} = \min \left\{ f_1(X),\ f_2(X), \ldots,\ f_n(X) \right\}, \tag{5}$$

where

$$f_1(X) \in \left\{ S_i \to CS^{j}{}_{FMS} \right\},$$

$$f_2(X) = \left\{[T_i \to TE\ , T_j \to IR] \in \left\lfloor CS^1_{FMS} \vee CS^2_{FMS} \vee CS^3_{FMS} \right\rfloor\right\},$$

$$[CS^1_{FMS} \to FMS\ of\ \ circular\ \ structure \vee$$

$$CS^2_{FMS} \to FMS\ of\ \ parallel\ \ structure \vee$$

$$CS^3_{FMS} \to FMS\ of\ \ successive\ \ structure\ ]$$

$$f_3(X) = R_{\max} \int_0^{\varphi} \cos^2 \varphi d\varphi \quad + \sum_{i=1}^{5} S_i\ ,$$

$$f_4(X) = \sum_{i=1}^{n} t_l + \sum_{i=1}^{m} t_\varphi + \sum_{i=1}^{n} t_z\ ,$$

where $\frac{2\pi}{3} \le \varphi \le \frac{4\pi}{3}$ - corner of the technological equipment relocation and an industrial robot servicing in dependence of FMS structure (at $2\pi/3$ – FMS structure is circular; at π - FMS structure is parallel; $4\pi/3$ – FMS structure is corner; *Rmax* – maximal an industrial robot length together with a detail; t_l – the common time of linear transference by an industrial robot at FMS technological equipment service; t_φ – the common time of rolling transference by an industrial robot at FMS technological equipment service; t_z – the common time of closing and opening operations executive of an industrial robot at FMS technological equipment service; S_i – the area of FMS manufacture modules relocation.

Option of a demand composes of FMS is existed also by minimal error of positioning of transference.

$$\Delta = \begin{cases} \dfrac{l_z K_\Delta}{D_n}, \textit{ if a transference of Z axle paralell} \\ \dfrac{l_y K_\Delta}{D_n}, \textit{ if a transference of Y axle paralell} \\ \dfrac{\varphi_z K_\Delta}{D_n}, \textit{ if a transference of Z axle round} \end{cases} \tag{6}$$

where $D\,n$ – the number of a sensor discrete, $K\Delta = 1.5,\ldots..,\ 3$ – the quality factor of measuring chain of control system.

The common scheme of organization of informing support, computing search and option of FMS technological equipment and composes structure exists as the following algorithm:

< informing supports of computing option > : : =

- < Data base of the principal parameters of FMS active elements and composes structure > &
- < The data base of principal standard characteristics and composes structure of FMS > &
- < Informing search and option >
- < The data base of principal computed parameters > : : = < the results of mathematical calculation by definition of positioning error, working zone of active elements, structural and functional analyze, productivity of FMS >

< The data base of principal standard characteristics > : : =
< technical characteristics of principal equipment of FMS >
< Informing search and option > : : = < search conditions >
< search conditions > : : = < purpose limiting for FMS active elements option >
< purpose limiting for FMS active elements option > : : =
< lift-loading → FMS demands > &
< speediness → max > &
< movement degree → FMS demands > &
< positioning error → min > &
< working zone → max > &
< FMS productivity → max >.

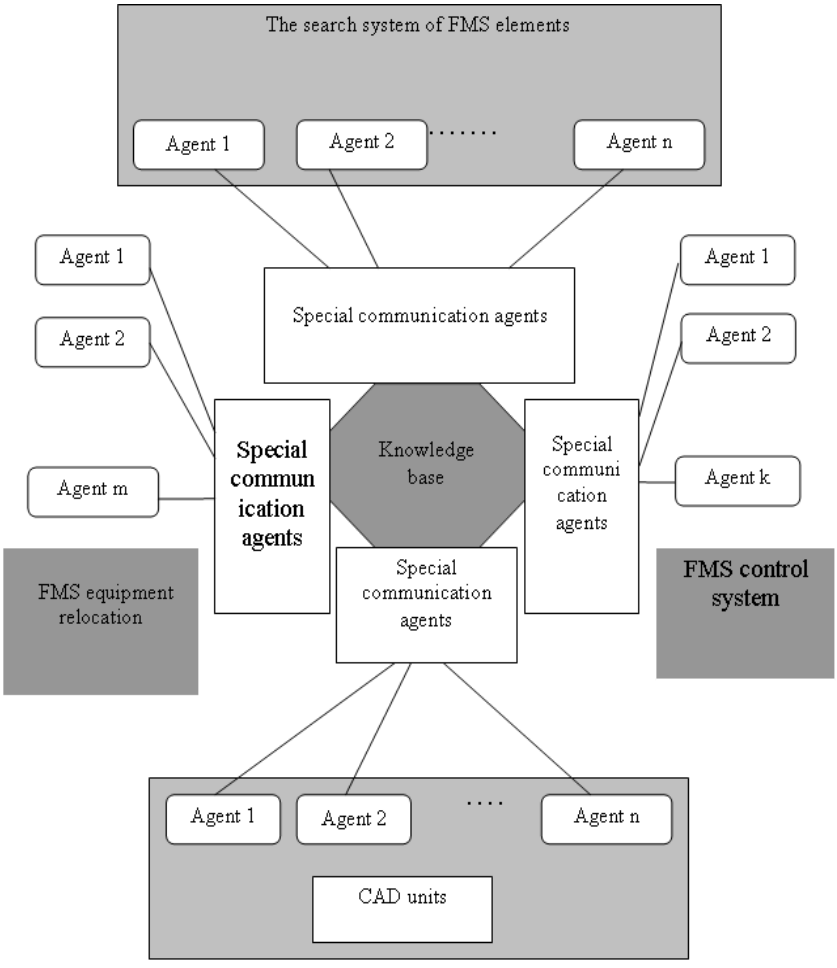

Fig.3. CAD architecture with application of agent technology

As see from the above presented model of computing option of FMS active elements and composes structure the important dynamical informing model is data base for computing documenting the project and description of the project's

documents and their interaction with another documents. Search conditions shorten search area, what heighten search efficiency.

2. Conclusion

Using agent technology at development of computing option units (Fig.3) shown the agents interacted on the knowledge level is perspective development technology of complex designing systems and support flexibility of component integration and use of the existed software systems.

References

1. Mammadov J.F., Akhmedova S.M., Mirzayeva I, Zulfigarov R. Agent technology of computer design of flexible manufacturing system, The Fourth International Conference "Internet-Education–Science", Baku-Vinnytsia-Veliko-Turnovo, 2004, pp.587-590.
2. Mammadov J.F., Huseynov A.H., Akhmedov M.A. Informing knowledge control of computing design of flexible manufacturing system, The Third International Conference "Problems of Cybernetics and Informatics", Baku, September 6-8, 2010, Vol.1, pp.235-238.
3. Akhmedov M.A., Mammadov J.F. Huseynov A.H., The kinematical model of computing design of the technical vision system for an industrial robot, III Congress of the Turkic World Mathematical Society, Almaty, 30 June-4 July, 2009, Vol.2, pp.234-236.
4. Intelligent Agents - Theories, Architectures, and Languages, Eds. M. Wooldridge, N.R. Jennings, Springer-Verlag, 1995, Lecture Notes in Artificial Intelligence, Vol.890, 289 p.
5. Mamedov J.F., Huseynov A.H. Application of agent technology at computing option of flexible manufacture system element and composes structure, Intenational Research and Practice Conference "Science, Technology and Higher Education Materials", Westwood, Canada, 2012, Vol.II, pp.454-460.
6. Huseynov A.H. Modeling of agent technology at computing option of flexible manufacture system element and composes structure, Life Sci. J., 11, 2014, pp.341-344.