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Research on the general system of multi robot based onembedded computer

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ABSTRACT

The 21st century is an information age, the highly developed network technology and computer technology has given birth to the application of the embedded computer, which is very extensive and plays an important role in many areas of people's social production, life style as well as the national industrial. Robots, as the new production tools, have increasingly appeared into the social production, but the coordination between multi-robot need to be controlled by computer system, embedded computer system has a unique advantage which is able to make general multi-robot systems become a reality. In this paper, we can establish the related hierarchy structure and construct mathematical analysis on how to construct the general computer system on the basis of multi-robot system, which helps to provide the reference of the embedded computer system research of multi-robot.

KEYWORDS

Analytic hierarchy; Multi-robot system; Embedded; The computer system.

INTRODUCTION

The continuous development of computer technology, information technology, and the huge progress that people made in the electronic ways make human have the ability to study and develop the large-scale integrated circuits, which drives the research and application of the embedded computer. What is more, the wide application of embedded system is becoming more and more important for the development of the society. And at the same time, Worldwide robot research and study developed thoroughly, which moves to a higher intelligent from the simple mechanization, and moves to the multi-robot coordination from single robot operation. The robots are on the road to the development of intelligent and the optimization in the 21st century. The combination of the multi-robot control system research and embedded computer system research makes embedded general computer system research of multi-robot become the key to the future multi-robot cooperation system. So this article will carry on a preliminary study of embedded computer system of multi-robot.

MULTI-ROBOT SYSTEM AND EMBEDDED COMPUTER

The embedded computer system in actual application of multi-robot can make the writing of the whole system achieve its optimum. Excellent characteristic of multi-robot system is the reasonable structure, good awareness and optimization mathematics control model and efficient operation of the system. At present the principle of Multi-robot anti-war trend are 1 establish a compact and efficient system structure; 2 improve the communication and coordination skills of software and hardware; 3 the flexible configuration of robot clustering and partial; 4 improve the ability of analysis and transmission of external information.

The core component of embedded computer system is the different type of CPU. Embedded systems, combined the Reference program, the operating system and computer hardware system into an instrument of whole system. This embedded system has the characteristics of high automation, small software code, the fast corresponding speed and low cost, etc. Embedded computer system is very suitable for multi-robot system; it can control the robots to be the integrated miniature model. The development of embedded computer system provides the path of the building of multi- robot system. The systems of different groups of robots are different, and the constructions of the control system are different too, which have brought some barriers in the development of multi-robot. The research of general embedded system plays an important role in the control of multi-robot. the index of the aspect of system design is that 1, System transition time and speed ratio; 2, The code size; 3, The power consumption of the system;4, The number of cycles in the operation of the system executes instructions.

MULTI-ROBOT HIERARCHIES

Based on the characteristics of the robot control system, and the performance of embedded computer system, we build the hierarchical structure of the general system through the relevant indicators such as TABLE 1.

TABLE 1 : Hierarchy table

Destination Layer	criterion layer B	index level C
Embedded computer system (A)	Establish a compact and efficient system structure (B_1)	System transition time and speed ratio (C_1)
	Improve coordination of software and hardware (B_2)	The code size (C_2)
	The flexible configuration of clustering and partial of robot (B_3)	The consumption of the system (C_3)
	Improve the ability of analysis and transmission of external information (B_4)	The number of cycles in the operation of the system executes instructions. (C_4)

Establish a hierarchy structure

In the optimize the decision algorithm of analytic hierarchy process, the hierarchical structure mainly has three layers, 1, The target layer (A), 2, Quasi side layer (B_m), 3, Scheme layer (C_n). We calculate the weights of scheme according to the Limiting conditions of rule layer scheme among various Schemes, and determine the scheme priority on the basis of weighted order. such as Figure 1.

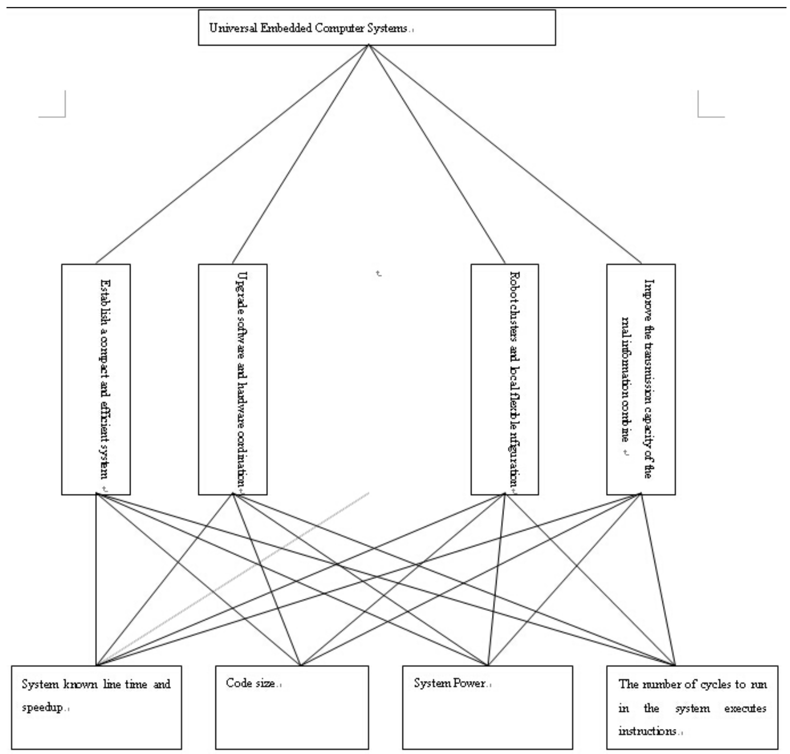

Figure 1: Hierarchical structure

Judgment matrix

The Rule layer has 4 conditions $B=\left(B_1, \quad B_2, \quad \cdots \quad B_4\right)$, which has the restriction role to the completion of the target. By comparing to the importance of the rule, we use 1-9 or its reciprocal to represent the result of the comparison. We carry on Comparing the importance structure of B_i, B_j and use a_{ij} to represent, the Judgment matrix A is made by all the comparison result. It can be saw in the following.

$$A=\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} \end{pmatrix}$$

Among them, Saaty thinks that it is in accordance with people's judgment to use 1~9scale to represent the comparing structure after some researches. Then using number 1~9 to represent the value of a_{ij} . the meaning of the numbers are in the following TABLE 2.

TABLE 2: The meaning of the scale1~9

scale	meaning
1	Two factors of the target are equally important
3	The former factor is slightly important than the next one
5	The former factor is important than the next one
7	The former factor is more important than the next one
9	The former factor is much more important than the next one
even number	represent the importance between the two Odd numbers
reciprocal	Represent the order of the front-to-back ratio of the factors

The calculation of the Weight vector and the Maximum eigenvalue.

First, we can get Matrix D after normalizing All the vectors of columns A.

$$D=\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \bullet \begin{pmatrix} 1/\sum_{i=1}^{n} a_{i1} & 0 & \cdots & 0 \\ 0 & 1/\sum_{i=1}^{n} a_{i2} & \cdots & 0 \\ 0 & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1/\sum_{i=1}^{n} a_{in} \end{pmatrix}$$

Then summing according to the line in the matrix.

$$E = D \bullet (1 \quad 1 \quad \cdots \quad 1)_{1\times n}^{T}$$

$$E = (e_{11} \quad e_{12} \quad \cdots \quad e_{1n})^{T}$$

The results of The normalized matrix E are the Weight vector

$$W = (w_1 \quad w_2 \quad \cdots \quad w_n)^T = \left(e_{11} / \sum_{i=1}^{n} e_{i1} \quad e_{12} / \sum_{i=1}^{n} e_{i1} \quad \cdots \quad e_{1n} / \sum_{i=1}^{n} e_{i1} \right)^T$$

The Maximum eigenvalue, if the Weight vector corresponds with the Maximum eigenvalue, then:

$$AW = \lambda_{\max} W$$

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{w_i}$$

Consistency check

CI represents the Consistency index of the matrix, CR represents The consistency ratio of the matrix, we can check out consistency of the matrix according to the calculations of two indicators.

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

Among then n represents the Number of factors in the layers of the Judgment matrix and the order of it.

$$CR = \frac{CI}{RI}$$

Among them RI represents the value of Random Consistency Index, showing in the following TABLE 3.

TABLE 3 : The value of RI

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

Assuming that in the layer B, the results of m factors are α_m after calculation, the corresponding values of Consistency index are CI_m, in the next layer C, The calculated weights of n factors of the layer A are β_{nm}, so The total ordering weights of the factors in all layers are:

$$w_i = \sum_{j=1}^{m} \alpha_i \beta_{ij}$$

The combination of consistency check consistency ratio is

$$CR = \frac{\sum_{j=1}^{m} \alpha_j CI_j}{\sum_{j=1}^{m} \alpha_j RI_j}$$

Whether the matrix meet the Consistency criterion or not depends on the value of *CR:* when $CR \geq 0.1$, it is reasonable when $CR < 0.1$, it is unreasonable.

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The calculated Weight vector of Rule layer and Scheme layer

According to the Embedded computer system hierarchy of TABLE 1, we can respectively get the matrix and Weight vector in the following TABLE 4-8:

TABLE 4 : The importance weights of factor B for target A

A	B_1	B_2	B_3	B_4	W
B_1	1	2	5	3	0.483
B_2	1/2	1	3	1	0.229
B_3	1/5	1/3	1	1/3	0.080
B_4	1/3	1	3	1	0.208

TABLE 5 : The importance weights of scheme C for target B_1

B_1	C_1	C_2	C_3	C_4	W
C_1	1	3	7	8	0.576
C_2	1/3	1	5	5	0.276
C_3	1/7	1/5	1	3	0.097
C_4	1/8	1/5	1/3	1	0.052

TABLE 6 : The importance weights of scheme C for target B_2

B_2	C_1	C_2	C_3	C_4	W
C_1	1	2	3	1/5	0.166
C_2	1/2	1	3	1/7	0.114
C_3	1/3	1/3	1	1/9	0.055
C_4	5	7	9	1	0.665

TABLE 7 : The importance weights of scheme C for target B_3

B_3	C_1	C_2	C_3	C_4	W
C_1	1	3	7	5	0.598
C_2	1/3	1	2	1	0.170
C_3	1/7	1/2	1	1/2	0.082
C_4	1/5	1	2	1	0.150

TABLE 8 : The importance weights of scheme C for target B_4

B_4	C_1	C_2	C_3	C_4	W
C_1	1	1	1/5	3	0.148
C_2	1	1	1/5	3	0.148
C_3	5	5	1	9	0.647
C_4	1/3	1/3	1/9	1	0.057

The calculation results, the consistency check

We can make the weight vector calculation, eigenvalue of maximum, and consistency check of the above five judgment matrix to carry on a combination consistency check, like TABLE 9, TABLE 10.

TABLE 9:Weights of alternatives and test index

B W C	B_1	B_2	B_3	B_4
	0.483	**0.299**	**0.080**	**0.208**
C_1	0.576	0.166	0.598	0.148
C_2	0.276	0.114	0.170	0.148
C_3	0.097	0.055	0.082	0.647
C_4	0.052	0.665	0.150	0.057
λ_j	4.206	4.108	4.026	4.032
CR_j	0.076	0.038	0.0096	0.012

TABLE 10 : The weight table of total sorts of scheme layer

Destination Layer	Index layer	weight
Embedded computer system (A)	System transition time and speed ratio (C_1)	0.37
	The code size (C_2)	0.25
	The consumption of the system (C_3)	0.37
	The number of cycles in the operation of the system executes instructions. (C_4)	0.17

CONCLUSIONS

In the design of embedded general computer system research, we can get the "System transition time and speed ratio"、the largest scheme of"System Consumption"according to the calculation of analytic hierarchy process. Therefore the optimal system of universal design should focus on the research of the two measures. In the study of embedded computer system designed for multi-robot, we should research for the task of multi-robot and its control system. Then we emphasize on the research of the system orderly, through the four indicators of different weights.

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