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## The research on algorithms of embedded process control system

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### ABSTRACT

The embedded process control system is a new type of control system. In our daily life, it exists in each aspect regardless of food, clothing, live or transportation. However, the algorithm is the most important part that can't be neglected in the research on embedded process control system. This paper introduced the formation of ideas, structure principle and the basic algorithm of the embedded process control system. Firstly, it introduced the theoretical basis of the embedded process control system; Secondly, put forward the open loop embedded process control system and embedded process control of closed-loop system after making further analysis of its basic structure. Then it analyzed the difference between the two principles. Finally, C language, C ++ language, Java, Java Scrip, LOGO several programming languages were introduced on the basis of the study above. In addition, it evaluated them by fuzzy algorithm. Thus put forward that the embedded process control system combines the advantages of embedded systems and process control systems, in open and closed loop process control systems embedded in two, part of the operating system is the main difference lies. C and C ++ language is the basic algorithm, for different embedded process control systems, they need to create a different language its program implementation.

### KEYWORDS

Embedded; Process control; Basic algorithm; C language; Mathematical model.



## INDUCTION

With the development of computer technology, a lot of programming terms and procedures can be realized on scene. The scene can be simulated on a computer through simulation of hard problems in daily life on the basis of programming language and programming implementation, so as to study the problems and the corresponding countermeasures.

The embedded process control system took the dual advantages of embedded system and process control system as a whole. It is widely used in the areas of overall industrial production, such as medical, transportation, military and other fields. Many scholars associated with it have made discussion about the embedded process control system and obtained a series of results. For example, Zhao Wenguang studied the principle of process control system structure and design problems in his courseware. He noted that the courseware development is a complete process. The control process can be applied to process to design the control system over the year. That includes the implementation, the subject and the topic. Then form the computer network courseware running mechanism through the process control system form. For another example, in the paper of "The design and implementation of motor vehicle exhaust testing process control system", Che Tong researched the design of the process control system by testing stimulation through the embedded process control system. Therefore, the problem in motor vehicle exhaust testing mechanism was founded. So did the solution.

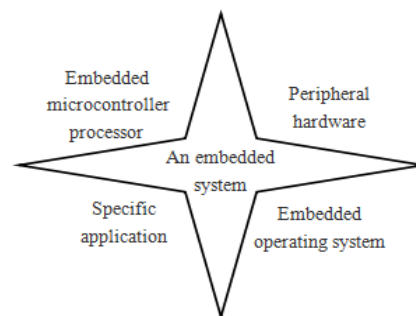
In addition, Process control systems embedded is also very common in every aspect of daily life. Wang Lirong studied about the application of process control system. In her article "The research and application of express business process control and tracking based on process optimization", the business problems in express were solved by the process control system. The purpose of the paper is the process optimization; the research object is express business process control. The problem occurred during express delivery has been resolved. For another example, in the paper "The study of CAID theoretical model on the basis of the design process control", Liu Shangcheng studied the design issues on the basis of CAID theoretical model and the concept of process control, and made the design more simple and the process more clear.

In this paper, the embedded process control system was studied on the basis of previous research results combined with the present stage our country development prospect of the embedded process control system. This paper introduced the formation of ideas, structure principle and the basic algorithm of the embedded process control system; made a deep analysis on the application of the embedded process control system; Provided a theoretical orientation for the study of embedded process control theory.

## EMBEDDED PROCESS CONTROL SYSTEM

### Embedded systems

Firstly, introduce the concept of embedded system. It's abbreviation is *ES*, *IEEE* made an accurate description and definition of *ES*, *ES* is an apparatus, It control, monitor or assist certain devices, machines and equipment operation through its own system.

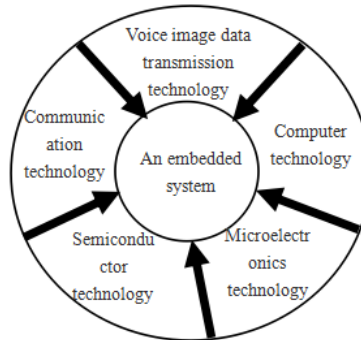


**Figure 1 : An embedded system structure**

As Figure 1, through the understanding of embedded system structure, we can see:

- (1) The embedded system is a compact device structure, it made centralized treatment to the basic structure of processors, peripherals, operating systems, programs, etc.;
- (2) Some specific components, such as embedded microcontroller processor, embedded operating system, etc. was integrated in the structure of the embedded system.

The unique structural parts of embedded system made widely application of embedded system. Whether it is a traditional computer technology or sensor technology today, were absorbed by the embedded system.



**Figure 2 : Embedded system technology**

As in Figure 2, the charts by the embedded system we can see that:

Embedded system brings together many advanced technologies,

- (1) In addition, *ES* also involves in the advanced technology such as voice and data transmission technology and sensor technology.
- (2) Therefore, *ES* have the characteristics of type utility, wide knowledge, continuous innovation, investment intensity, highly decentralized.

**Process control systems**

As the name suggests, process control is a process that control program execution. In the progress various control statements will be involved. Different control statements have different control principle. Therefore, in the control process, one should select the appropriate control statements based on different real situation. As shown in TABLE 1.

**TABLE 1 : Process control statements**

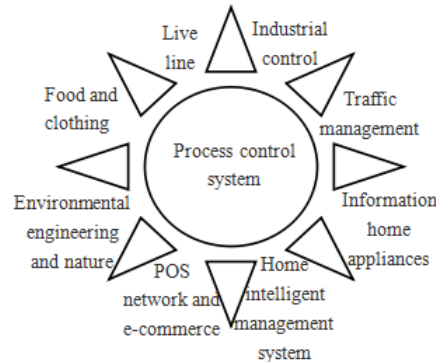
Process control statements	
C language	If, switch, for, while, do—while, continue, break, return
C++language	If, switch, for, while, do— while, continue, break, return
Java	for circulation, while circulation, do—while circulation, switch, break

Process control system is an automatic control system that used for grasping the parameters embodied in the development process and the features of the controlled amount. The characteristics and change of the process parameters can be observed through controlling the process. Thus one can better control the process development of things.

Process control system has been applied in every aspect of social life; the basic necessities of life are related to the process control. For example, industrial control, traffic management, information

appliances, network services, computer system building, etc. Therefore, the study of the process control system helps us to better improve the quality of life.

The application of process control systems is shown in Figure 3:



**Figure 3 : Application process control system**

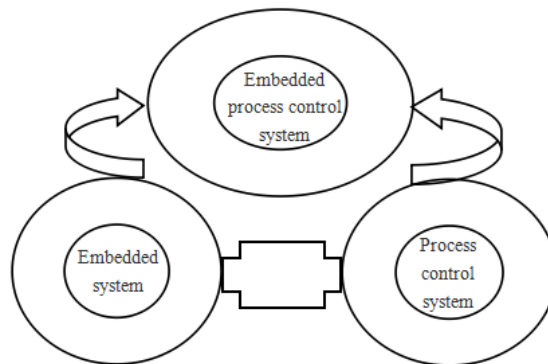
(1) The process control system is widely used in necessities of life and the production, purchase, use and recycling of small food.

(2)The wide application of process control system led our social life in order, and formed a process similar to the food chain

(3) As well as the food chain in biology, process control system has system source, process and the end. It has tight structure and wide application.

**Embedded process control system**

The embedded process control system is a kind of new control system that based on the theory of the embedded system and process control system. The system not only has the advantages of embedded system and process control system, but also avoided the disadvantages of them and can be said to be a perfect design of both the advantage.



**Figure 4 : Embedded process control system**

The formation of process control systems is shown in Figure 4:

(1) In simple terms, embedded process control system is the combined function of the embedded system and the process control system.

(2) In-depth look, embedded process control system combines the advantages of embedded system and process control system and had been made innovation on this basis.

## THE STRUCTURE OF EMBEDDED PROCESS CONTROL SYSTEM

As well as the embedded system, the embedded process control system including hardware, operating system and application software. There are Open loop control system and the closed loop control system in the control process. As shown in figure 5.

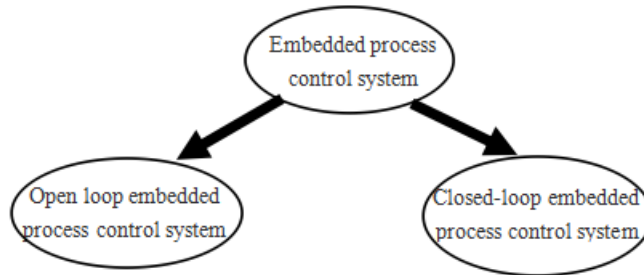


Figure 5 : Embedded process control system

As shown in the Figure 5 above, there are two forms of embedded process control system. That is open loop embedded process control system and the closed-loop embedded process control system. The difference between them is the operating system, one is a simple open loop form, the other is a simple closed form

### Loop embedded process control system

The main structure of open loop embedded process control system is the hardware device, operating system and application software. Wherein the operating system, there is a ring-opening process configuration.

The main workflow of open loop embedded process control system is: input into the controller through to reach the actuator, applied to the controlled object in the condition of the control amount to thereby output. This process is open, so it is also known as open loop process control system.

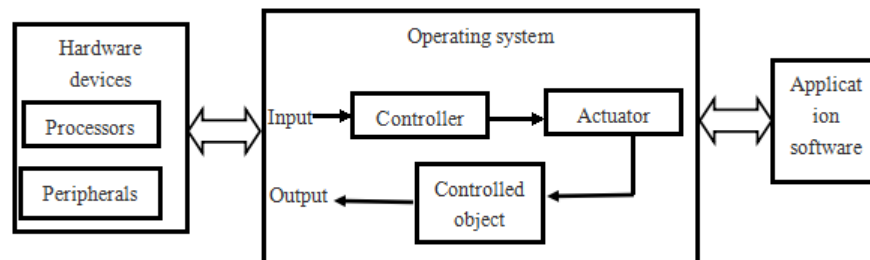


Figure 6 : Open loop embedded process control system

By Figure 6: Open loop embedded process control system above, you can get the following conclusions:

(1) Open loop embedded process control system formed the amount of input and output through operating system controller and actuator.

(2) The workflow of open loop embedded process control system is easy to understand and operate, and it's device is easy to tear down and clear.

### Closed-loop embedded process control system

The main structure of closed-loop embedded process control system is the same with that of open loop embedded process control system. Which is mainly the hardware device, operating system and application software. But the operating system is a closed-loop process structure that different from the open loop embedded process control system.

The main workflow of closed-loop embedded process control system is the same with that of open loop embedded process control system. That is reaches the operating system through a hardware device, finally to the application software.

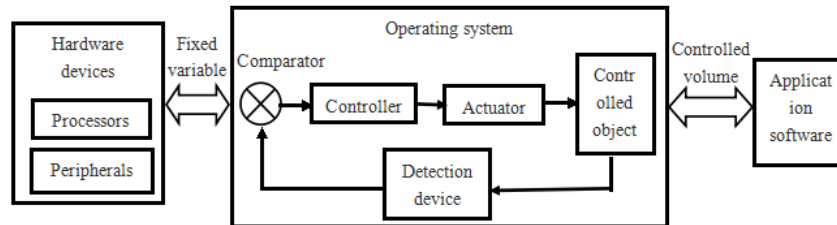


Figure 7 : Closed-loop embedded process control system

As shown in Figure 7, The main workflow of closed-loop embedded process control system is, quantified by comparing the device to reach the controller, and further through the actuator, under the control variable is the role of the amount charged by the output of the controlled object, while the charged object has returned to the comparator through a monitoring device, in order to achieve the circulation of the operation.

**The application of embedded process control system**

The application of embedded process control system has been applied to all aspects of our social life including intelligent equipment, production equipment, medical equipment, transportation equipment, audiovisual equipment, etc. Its basic function of process is shown in the figure below.

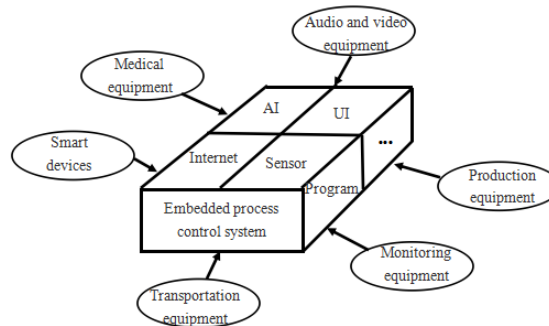


Figure 8 : The embedded application process control system

By above Figure 8: The embedded application process control system, we can get:

- (1)In the embedded application process control system, Internet, sensor, smart devices, user, program, etc., are the main function part.
- (2)The embedded application process control system) is widely used in necessities of life, such as in transportation, medical, industrial production, household equipment, etc.

**THE ALGORITHM OF EMBEDDED PROCESS CONTROL SYSTEMS**

The main part of the algorithm is the programming language. Among which, C language, C ++ language is mostly used. In addition, Java, Java Scrip, LOGO can also be used.

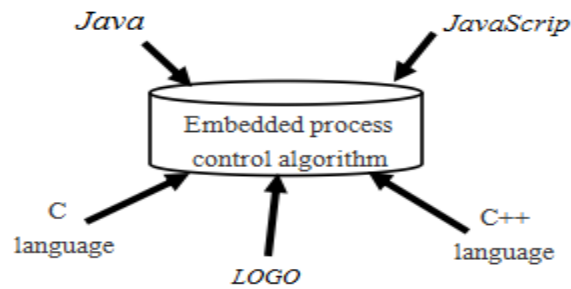


Figure 9 : Embedded process control algorithm

As shown in Figure 9. The last link in the algorithm of embedded process control systems is application software. So the program of application software can be achieved on the basis of the algorithm. Relative to the operating system and application, the software is also very important, so as to improve the low of the algorithm.

In order to evaluate the algorithm of embedded process control system, fuzzy algorithm was brought in. Fuzzy algorithm is a method that makes a comprehensive evaluation from the point of view of the amount of things. It is widely used in daily life.

Such as the evaluation about the academic level, medical effects of disease, quality of atmospheric environment. It is based on fuzzy math, fuzzy mathematics theory, establish targets set multiple influencing factors, fuzzy algorithm to calculate the weight of each index relatively small weight and significant power to determine the evaluation matrix, using the principle of maximum degree of membership to finalize important degree.

First of all, a fuzzy model of the algorithm of embedded process control system was constructed on the basis of the basic idea of fuzzy algorithm. The fuzzy model and its evaluation is shown in Figure 10.

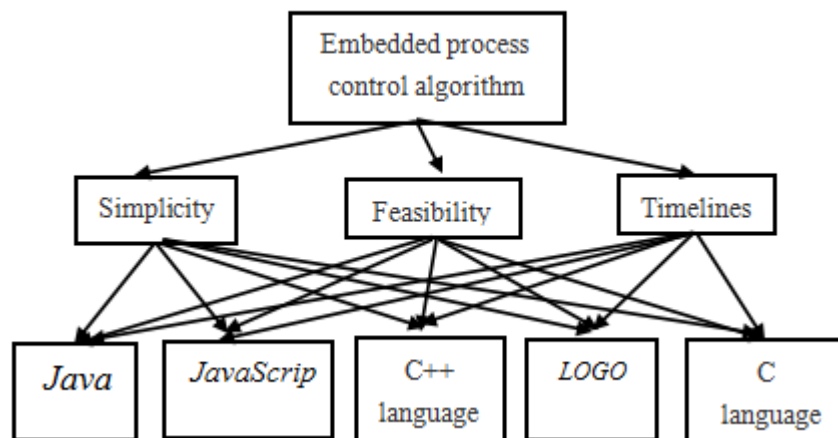


Figure 10 : Fuzzy algorithm evaluation

The concept is based on the evaluation index set fuzzy algorithm:

$$U = \{u_1, u_2, \dots, u_m\}, m = 1, 2, \dots, 5$$

Determine the evaluation index set = {Java, Java Scrip, C++language, LOGO, language}.  
Based on the concept of collection evaluation grades:

$$V = \{v_1, v_2, \dots, v_n\}, n = 1, 2, 3, 4$$

Determine the evaluation index set = {Very good, good, general, poor}.

By the definition of the weights, that :  $w = \{\mu_1, \mu_2, \dots, \mu_m\}, m = 1, 2, \dots, 5$

Among them : 
$$\sum_{m=1}^6 \mu_m = 1$$

and normalization formula, finally evaluation weights:

$$w = \{0.2 \quad 0.18 \quad 0.22 \quad 0.15 \quad 0.25\}$$

Reuse membership degree principle :

$$\mu_{in}(u_i) = \begin{cases} 0 & u_i \leq v_{in-1} \\ \frac{u_i - v_{in-1}}{v_{in} - v_{in-1}} & v_{in-1} < u_i < v_{in} \\ 1 & u_i \geq v_{in} \end{cases}$$

To calculate the fuzzy evaluation matrix  $R$ , Ultimately through fuzzy operator  $M(\cdot, \oplus)$ , and fuzzy judgment set  $S$ , by the relationship between them:

$$S = w \circ R = (\mu_1, \mu_2, \dots, \mu_m) \circ \begin{pmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{pmatrix} = (s_1, s_2, \dots, s_n)$$

obtain the result :  $S = \{0.22 \quad 0.12 \quad 0.23 \quad 0.17 \quad 0.26\}$

Thus it can be concluded:

C language is the basic algorithm in many algorithms of embedded process control system, and it's score is the highest trough the fuzzy algorithm.

Followed by C language, Java, LOGO, javas script, This shows that the budget law requirements for embedded process control systems are very strict

Different embedded process control system require different procedures to achieve its language and different programming.

### CONCLUSION

The embedded process control system is a new type of control system which based on embedded system and process control system. This paper studied it's structure and algorithm, then get the conclusion below:

(1) The formation principle of embedded process control system was elaborated in the introduction. The embedded process control system was put forward in the end by respectively introduces relevant theory and combining the advantages of the embedded system and process control system.



(2) Open-loop embedded process control systems and closed-loop embedded process control systems were elaborated in the part of embedded process control system structure. By analyzing their structure and application. Thus states: the difference between the two embedded process control systems is in the part of the operating system. The open-loop embedded process control system is simple process operation, while the closed-loop embedded process control system is single cycle operation system. The embedded application process control system) is widely used in necessities of life, such as in transportation, medical, industrial production, household equipment, etc.

(3) C language, C ++ language, Java, Java Scrip, LOGO several programming languages were introduced in the algorithm of embedded process control system. Algorithm embedded process control system was studied and evaluated on the basis of fuzzy algorithm. Thus indicating: different embedded process control system require different procedures to achieve its language and different programming algorithm. In many algorithm of the process control system, C language and C ++language is the basic algorithm.

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