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Applied Technology in Control System Design of Asphalt Concrete Mixer's Based on PLC

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Abstract. In view of current production technology of asphalt concrete mixing plant and technology, a distributed computer control system based on PLC and field bus is developed. The compensation iteration self-learning algorithm is adopted, the compensation amount of learning algorithm of the system is designed and the course program control algorithm is presented. Therefore the precision of the system's measurement and control is improved and the transmission error is reduced.

Introduction

The control system design of asphalt concrete mixing plant is directly related to its production quality, production efficiency and the level of automation control and management. During the process of mixing station's mixing control, due to the head loss and material flow instability, greater difficulty is brought to actual control batching accuracy. During the process of dynamic weighing, factors such as "flying" and "blanking" material's impact effect to the scale is obvious. In this paper the system of compensation amount learning algorithm method based on iteration self-learning control is designed. According to the algorithm, process control is realized, and the precision of production ingredients is improved, the scrap rate is reduced.

Overall control system of mixing plant

The mixing plant's control system adopts the control scheme of "computing unit state control technology + PLC control technology + optimization control algorithm+ field bus technology", through profibus-DP field bus and Ethernet communication of distributed computer control system, it's consisted of by upper computer, PLC, distributed I/O units, touch screen, frequency converter, intelligent instrument, etc. The overall structure is shown in Figure1.

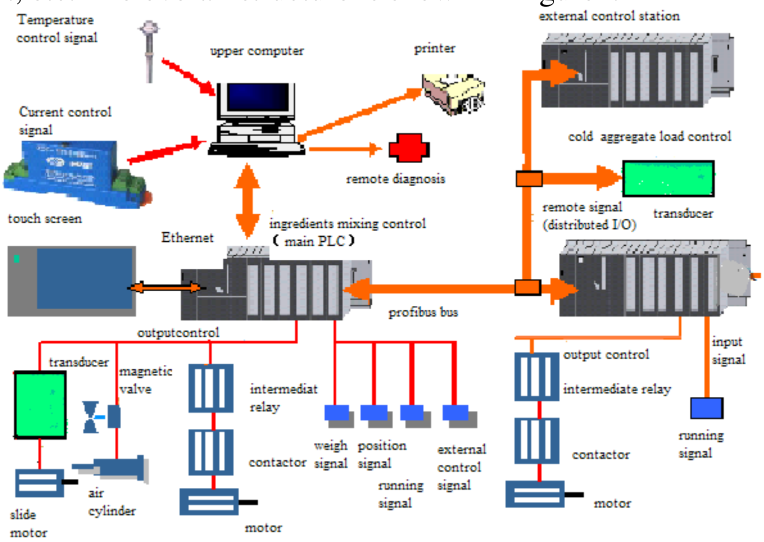

Figure.1 Neural network structure

It’s PLC control system’s module configuration is shown in Table 1.

Table1 PLC module configuration

Number	Name	Model	Quantity
1	Power module	PS307 5A	1
2	CPU unit	CPU315-2DP	1
3	DI unit	SM321(32 channels)	2
4	DO unit：	SM322(32 channels)	2
5	AI unit：	SM331(8 channels)	1
6	Ethernet communication module	CP343-1	1
7	Distributed IO unit	ET200M	1
8	DI unit	SM321(16 channels)	1
9	DO unit	SM322(8 channels)	1

Dosing control program

Dosing control is the core of whole control system, including formula input, weighing, mixing and feeding process control. The accuracy of the ingredients directly affects the product quality. Dosing control is achieved by PLC master station’s control action to the weighing device. The system is equipped with stone weighing device, hot aggregate weighing apparatus and asphalt weighing device, stones of various sizes are weighed in a certain order and share one weighing device, powder is weighed with one weighing device, the pitch is weighed with one weighing device as well.

Dosing process is divided into four sub modules area: aggregate’s weighing sub-module, material’s weighing sub-module, asphalts weighing sub-module, ingredients’ compensation sub-module. Through the program block, the user program is distributed to different blocks and layered structure is built to organize the program.

Dosing control compensation quantity analysis

In the process of dosing control, material drops from storage bin and whereabouts to weighing hopper, its actual weight is obtained by the sensor signal after they arrived at weighing hopper. Because there is excess material in the air, so the weight signal of sensor can’t timely reflect actual material’s weight falling from the hopper. Moreover, when the door is closed, the last actual material weight in the weighing hopper should include the portion of amount gap (also known as "flying"). The gap caused by material’s “flying” and flow’s instability changes random and brings greater difficulties to the improvement of dosing accuracy.

The only way to overcome the weighing error caused by gap is to shut the feeding door earlier in the dosing process, namely to close the feeding door before the set value formula is reached and stop the material flow. As amount of gap all drops into the weighing hopper, finally the weight of actual ingredients is the sum of two values: one is the weight value just as the door is closed and the other one is the amount gap. As long as the actual ingredient weight is in the range of the allowable deviation of set value, the dosing accuracy control is completed. Due to the effect of various factors, the gap value is a random variable. How to determine the initial lead (compensation dosage) to make the gap equals to the right value is the problem to solve.

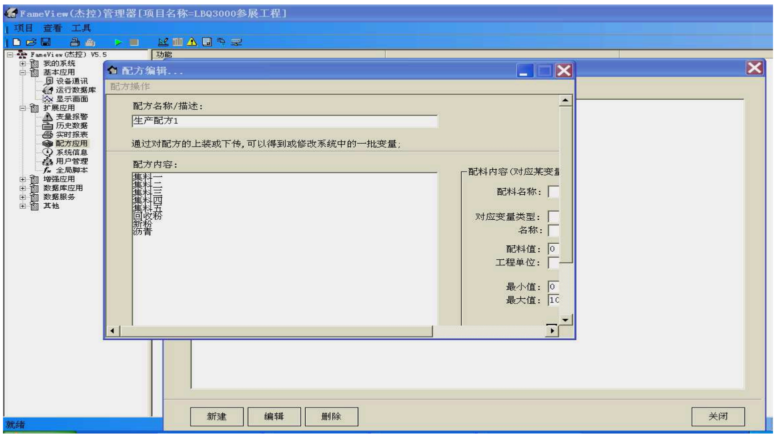

Figure.2 Recipe management interface

Self-learning iteration algorithm design

As the material is fallen into the scale from upper place, the material's particle size, the material's height position, its requisite amount, even the weighing order all directly affect the ingredients' precision. Generally empirical data is adjusted combined with self-learning to solve the influence of gap quantity to ingredients accuracy. Using the empirical formula, the iteration self-learning control method is used to forecast and calculation of gap to realize automatic fall correction and improve the accuracy of measurement based on pure lag mathematical model.

In iteration self-learning control system, the learning of control function is realized via the memory of past experience (the weighted sum of control unction and error), the convergence of algorithm depends on the determination of weighting factor. The core of this learning system is the assumptions of the system's invariance as well as the continuous repetitive training process based on memory unit. The learning rule is easy to follow, and can implement off-line calculation in training intervals, thus it not only has good real-time performance, but also has certain robustness for interference and the change of system model.

First before the weighing for the first time, set an initial value of compensation amount (W_{f1}) according to the experience artificially,

$$W_{f1} = u \tag{1}$$

u is generally valued as 5% of the formula Wt, in the first weighing time, make the difference between it and the formula value as the control value, when it is equal to Wt - W_{f1}, closed signal is sent and end weighing ends in advance. At this point, there is error $\triangle W_1$ between the formula value and actual value,

$$\varDelta W1 = W1 - Wt \tag{2}$$

A new switch coefficient is produced:

$$W_{f2} = W_{f1} + q\,\varDelta W_1 = W_{f1} + q(W_1 - Wt) \tag{3}$$

q is weighted factor.

The weighing error for the first time is calculated, then the weighted value sum of the initial value and actual error is set as the next compensation amount to determine a new divide value as the basis of control the next weighing, after the second weighing, calculate a new compensation amount, which is in fact calculated considering the last two times' errors. And so on, such correction is carried on every time after weighing, the more weighing, the less error.

According to the learning algorithm of compensation amount, ingredients compensation sub-module is compiled and called every weighing.

Conclusion

Compensation amount learning algorithm design based on iteration self-learning control method adopts compensation program control to the dosing control process, increases system ingredients and control precision, in the process of dynamic weighing, factors such as "flying" and "blanking" material's impact effect to the scale are reduced obviously.From actual use's test, dosing control measuring accuracy can reach 0.5% or less of the aggregate, 0.35% or less of powder, 0.3% or less bitumen, 0.3% or less oil stone mixing ratio of mixture after 4 to 5 batch parameters' automatically adjustion, to meet the classy quality standards and achieved satisfactory effect. Now the design has been applied to many domestic large and medium-sized asphalt concrete mixing equipments, it's proved to be of great significance to the intelligent control system development of road construction machinery.

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