

Description

Method and Device for Determining Operating Trajectory Curve, and Electronic Device

Cross-Reference to Related Application

The present application claims priority to Chinese Patent Application No. 202211137659.2, filed with China National Intellectual Property Administration on September 19, 2022, and entitled "METHOD AND DEVICE FOR DETERMINING OPERATING TRAJECTORY CURVE, AND ELECTRONIC DEVICE", which is incorporated herein by reference in its entirety.

Technical Field

The present application relates to the field of production design in the process industry, and in particular to a method and device for determining an operating trajectory curve, and an electronic device.

Background

During intermittent production in the process industry, it is common to establish a standard operating trajectory curve before each batch production, and an underlying control system operates according to the standard operating trajectory curve. However, in practice, the initial state of a production device may vary in different batches. In this case, an operator adjusts, based on experience, the operating trajectory in the production process, which leads to variations in the yield and quality of final products in each batch. These adjustments are subjective in nature, and have defects such as being mainly qualitative rather than quantitative and lacking precise adjustments. Therefore, it is necessary to perform data analysis on production results and operating trajectories in multiple batches to obtain the optimal standard operating trajectory curve.

In the related technologies, the generation of the standard operating trajectory curve is typically manually specified, which cannot adapt to gradual changes of the production device and changing production demands. As for the above-mentioned problems, effective solutions have not yet been proposed.

Summary

Embodiments of the present application provide a method and device for determining an operating trajectory curve, and an electronic device, so as to at least solve the technical problems

that the existing generation of a standard operating trajectory curve is typically manually specified, which cannot adapt to gradual changes of a production device and changing production demands.

According to one aspect of an embodiment of the present application, a method for determining an operating trajectory curve is provided. The method includes: operating data and output data of a production device in multiple batches are obtained, where the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date; splicing operation is performed on operating data and output data corresponding to the same collection date in the multiple batches to obtain a splicing data set; similarity between splicing data in the splicing data set is determined, and the splicing data in the splicing data set is classified according to the similarity to obtain multiple categories of data, where the data with the similarity greater than a preset threshold is classified into the same category; a target category of data is selected from the multiple categories of data, and weight values corresponding to operating parameters in different batches are determined from the target category of data, where the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and an operating trajectory curve corresponding to the target category of data is determined at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

In some embodiments of the present application, the splicing operation on operating data and output data corresponding to the same collection date in the multiple batches includes: operating time corresponding to the operating data is acquired; the operating data with the same operating time is aligned and sorted according to the operating time to obtain first data; the first data and output data corresponding to the same collection date are spliced to obtain splicing data; and splicing data corresponding to different collection dates is determined to obtain a splicing data set.

In some embodiments of the present application, the step of determining weight values corresponding to operating parameters in different batches from the target category of data includes: collection dates corresponding to operating parameters in different batches in the target category of data are acquired to obtain a plurality of collection dates; the plurality of collection dates are sorted in order of proximity to the current date to obtain a target collection date set; and weight values of batches corresponding to the plurality of collection dates in the target collection date set are determined.

In some embodiments of the present application, the step of determining weight values of batches corresponding to the plurality of collection dates in the target collection date set includes:

weight values of batches corresponding to two adjacent dates in the target collection date set are determined, where the weight of the batch corresponding to the first date in the two adjacent dates is a preset multiple of the weight of the batch corresponding to the second date, the first date is the closer of the two adjacent dates to the current date, the second date is the farther of the two adjacent dates to the current date, and the preset multiple is an arbitrary value greater than 1.

In some embodiments of the present application, after the weight values of the batches corresponding to the two adjacent dates in the target collection date set are determined, the method further includes: a weight set of batches corresponding to all dates in the target collection date set is obtained; an equation is formulated according to a quantitative relationship between all the weight values in the weight set; and the equation is solved, and a first weight value between the batches corresponding to the two adjacent dates in the target collection date set is obtained.

In some embodiments of the present application, the step of determining an operating trajectory curve corresponding to the target category of data includes: a target weight value of a batch corresponding to each date in the target collection date set is determined based on the first weight value; and target operating parameters are determined according to the target weight value and values of operating parameters of the batch corresponding to the target weight value at different operating times, where the target operating parameters are values of operating parameters of the operating trajectory curve corresponding to the target category of data at different operating times.

In some embodiments of the present application, the operating trajectory curve is a curve plotted in a coordinate system where the horizontal axis represents the operating time and the vertical axis represents the values of the operating parameters at the operating time.

According to another aspect of this embodiment of the present application, a device for determining an operating trajectory curve is further provided, and includes: an acquiring component, configured to acquire operating data and output data of a production device in multiple batches, where the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date; a splicing component, configured to perform splicing operation on operating data and output data corresponding to the same collection date in the multiple batches to obtain a splicing data set; a classification component, configured to determine similarity between splicing data in the splicing data set, and classify the splicing data in the splicing data set according to the similarity to obtain multiple categories of data, where the data with the similarity greater than a preset threshold is classified into the same category; a first determining component, configured to select a target category of data from the multiple categories of data, and determine

weight values corresponding to operating parameters in different batches from the target category of data, where the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and a second determining component, configured to determine an operating trajectory curve corresponding to the target category of data at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

According to another aspect of this embodiment of the present application, an electronic device is further provided, and includes: a memory, configured to store program instructions, and a processor. The processor is connected with the memory and configured to implement the program instructions for achieving the following functions: operating data and output data of a production device in multiple batches are obtained, where the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date; splicing operation is performed on operating data and output data corresponding to the same collection date in the multiple batches to obtain a splicing data set; similarity between splicing data in the splicing data set is determined, and the splicing data in the splicing data set is classified according to the similarity to obtain multiple categories of data, where the data with the similarity greater than a preset threshold is classified into the same category; a target category of data is selected from the multiple categories of data, and weight values corresponding to operating parameters in different batches are determined from the target category of data, where the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and an operating trajectory curve corresponding to the target category of data is determined at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

According to another aspect of this embodiment of the present application, a non-volatile storage medium is further provided. The non-volatile storage medium includes a stored computer program. A device where the non-volatile storage medium is located performs, by running the computer program, the method for determining an operating trajectory curve.

In the embodiments of the present application, the operating data and the output data of the production device in the multiple batches are obtained; the splicing operation is performed on the operating data and the output data corresponding to the same collection date in the multiple batches to obtain the splicing data set; similarity between the splicing data in the splicing data set is determined, and the splicing data in the splicing data set is classified according to the similarity to obtain the multiple categories of data; the target category of data is selected from the multiple

categories of data, and the weight values corresponding to the operating parameters in different batches are determined from the target category of data; and the operating trajectory curve corresponding to the target category of data is determined at least based on the weight values and the values of the operating parameters in batches corresponding to the weight values. Therefore, the purpose of automatically generating the operating trajectory in the production process is achieved, thereby achieving the technical effect of improving the operating trajectory generation efficiency, and solving the technical problems that the existing generation of the standard operating trajectory curve is typically manually specified, which cannot adapt to gradual changes of the production device and changing production demands.

Brief Description of the Drawings

The accompanying drawings described herein are used to provide a further understanding of the present application, and form a part of the present application. Exemplary embodiments of the present application and descriptions thereof are used to explain the present application, but do not constitute any inappropriate limitation to the present application. In the accompanying drawings:

Fig. 1 is a block diagram of a hardware structure of a computer terminal (or electronic device) for implementing a method for determining an operating trajectory curve according to an embodiment of the present application;

Fig. 2 is a flowchart of a method for determining an operating trajectory curve according to an embodiment of the present application; and

Fig. 3 is a structural diagram of a device for determining an operating trajectory curve according to an embodiment of the present application.

Detailed Description of the Embodiments

In order to make those skilled in the art better understand solutions of the present application, the technical solutions in the embodiments of the present application are clearly and completely described in conjunction with the accompanying drawings in the embodiments of the present application as below, and it is apparent that the described embodiments are merely a part rather all embodiments of the present application. Based on the embodiments of the present application, all other embodiments obtained by those of ordinary skill in the art without creative labor shall fall within the scope of protection of the present application.

It should be noted that the terms such as "first" and "second" of the specification and claims of the present application and the foregoing accompanying drawings are used to distinguish similar

objects but are not necessarily intended to describe specific sequences or precedence orders. It should be understood that such used data is interchangeable where appropriate so that the embodiments of the present application described here can be implemented in an order besides those illustrated or described here. Moreover, the terms "include", "contain" and any other variants thereof mean to cover the non-exclusive inclusion. For example, a process, method, system, product, or device that includes a list of steps or units is not necessarily limited to those expressly listed steps or units, but may include other steps or units not expressly listed or inherent to such a process, method, system, product, or device.

First, some nouns or terms used in the description of the embodiments of the present application are explained below:

Intermittent production process: also known as a batch production process, refers to all work steps being performed at the same location but at different times, with unstable operating states and parameters changing over time. For example, a batch of raw materials are added to a device, operations are performed, products are discharged, then, the device is cleaned, new materials are added again, and the cycle is repeated.

An operating trajectory refers to a trajectory generated by the variation of operating parameters over time.

In the related technologies, the standard operating trajectory curve is of great importance. It is meaningful to make adjustments only on a good standard operating trajectory curve. However, the existing generation of the standard operating trajectory curve is generally manually specified, which introduces a certain degree of subjectivity. Moreover, with the gradual changes of the production device and changing production demands, the approach of using the single fixed standard operating trajectory curve cannot well adapt to these changes.

In order to solve the above problems, the embodiments of the present application provide corresponding solutions, which are described in detail as below.

A method for determining an operating trajectory curve provided in an embodiment of the present application may be implemented in a mobile terminal, a computer terminal, or similar computing devices. Fig. 1 illustrates a block diagram of a hardware structure of a computer terminal (or electronic device) for implementing a method for determining an operating trajectory curve. As shown in Fig. 1, the computer terminal 10 (or electronic device) may include one or more processors (which are illustrated as 102a, 102b, ..., and 102n in the figure, and may include but not limited to a microcontroller unit (MCU) or a field programmable gate array (FPGA) or other

processing units), a memory 104 configured to store data, and a transmission component 106 set for a communication function. In addition, a display, an input/output interface (I/O interface), a universal serial bus (USB) port (included as one of ports of the I/O interface), a network interface, a power supply, and/or a camera may also be included. Those of ordinary skill in the art can understand that a structure shown in Fig. 1 is merely illustrative, and does not limit the structure of the above electronic device. For example, the computer terminal 10 may further include more or fewer components than those shown in Fig. 1, or have configurations different from those shown in Fig. 1.

It should be noted that the one or more processors and/or other data processing circuits may be generally referred to as "data processing circuits" in this specification. The data processing circuit may be embodied fully or partially as software, hardware, firmware, or any other combination. In addition, the data processing circuit may be a single stand-alone processing component or integrated fully or partially into any one of other components in the computer terminal 10 (or electronic device). As described in this embodiment of the present application, the data processing circuit acts as a processor control (e.g., in selecting a path of a variable resistor terminal connected to the interface).

The memory 104 may be configured to store software programs and components of application software, such as program instructions/a data storage apparatus corresponding to the method for determining an operating trajectory curve in this embodiment of the present application. The processor performs, by running the software programs and the components stored in the memory 104, various functional applications and data processing, thereby implementing the above method for determining an operating trajectory curve. The memory 104 may include a high-speed random access memory, and may also include a non-volatile memory, such as one or more magnetic storage apparatuses, a flash memory, or another nonvolatile solid-state memory. In some examples, the memory 104 may further include memories remotely disposed relative to the processor, and these remote memories may be connected to the computer terminal 10 through networks. The examples of the above networks include but not limited to an Internet, an intranet, a local area network, a mobile communication network, and a combination thereof.

The transmission component 106 is configured to receive or send data through one network. A specific example of the above networks may include a wireless network provided by a communication supplier of the computer terminal 10. In an example, the transmission component 106 includes a network interface controller (NIC), which may be connected with another network device by using a base station, so as to communicate with the Internet. In an example, the transmission component 106 may be a radio frequency (RF) component, which is configured to communicate with the Internet in a wireless manner.

The display may be, for example, a touchscreen liquid crystal display (LCD), which allows a user to interact with a user interface of the computer terminal 10 (or electronic device).

It should be noted that in some optional embodiments, the computer device (or electronic device) shown in Fig. 1 may include a hardware component (including a circuit), a software component (including computer code stored on a computer-readable medium), or a combination of the hardware component and the software component. It should be noted that Fig.1 is merely an example of a specific example, and is intended to illustrate the types of components that can exist in the computer device (or electronic device).

In the above operating environment, this embodiment of the present application provides a method embodiment for determining an operating trajectory curve. It should be noted that steps shown in a flowchart of the accompanying drawings may be performed in a computer system, such as a set of computer executable instructions. In addition, although a logical sequence is shown in the flowchart, the illustrated or described steps may be performed in a different sequence than presented here in some cases.

Fig. 2 is a flowchart of a method for determining an operating trajectory curve according to an embodiment of the present application. As shown in Fig. 2, the method includes the following steps:

Step S202: operating data and output data of a production device in multiple batches are obtained, where the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date.

In some embodiments of the present application, the operating data may include process data such as pressure, temperature, and flow. The operating data is continuously changing at different times. For example, the operating data can be collected every 1s. The output data, for example, may include yield, energy consumption per unit, a product top-grade rate, etc. The output data within the same batch is the same. It should be noted that the data included in the operating data and the output data are only used as examples for illustrations, and in practical production, other data may also be included, which is not elaborated here.

Step S204: splicing operation is performed on operating data and output data corresponding to the same collection date in the multiple batches to obtain a splicing data set.

Before performing splicing on the data in step S204, data preprocessing is performed on the acquired operating data and output data, an outlier, a missing value, etc. within the data are processed, and after the data preprocessing, the operating data and the output data corresponding

to the same collection date in the multiple batches are collected, that is, the operating data at the same time is aligned according to the operating time to be spliced with the output data at the same collection date (i.e., the same batch) to obtain an operating-output data set, namely, the above splicing data set.

Step S206: similarity between splicing data in the splicing data set is determined, and the splicing data in the splicing data set is classified according to the similarity to obtain multiple categories of data, where the data with the similarity greater than a preset threshold is classified into the same category.

In step S206, in the splicing data set, the data with the similarity greater than the preset threshold is classified into the same category through a clustering algorithm, the clustering algorithm, for example, may be a K-means algorithm, etc., and the multiple categories of data are obtained after clustering.

Step S208: a target category of data is selected from the multiple categories of data, weight values corresponding to operating parameters in different batches are determined from the target category of data, where the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data.

In step S208, for the multiple categories of data, category center data of each category is selected as representative data of the category, namely, a case. The case is labeled, such as a low-energy-consumption case, a high-yield case, and a high-quality case, and the collection of the plurality of cases forms a case library. One case is selected from the case library, that is, the target category of data is selected from the multiple categories of data, the selected case includes data of n batches, and the weight values corresponding to the operating parameters in different batches are determined from the target category of data.

In step S208, the operating parameters are at least one controllable data in the operating data. For example, when the operating data includes pressure, temperature, and flow, if the flow can be adjusted through a valve, the flow can be considered as an operating parameter. If the pressure and the temperature are not adjustable, the pressure and the temperature cannot be considered as operating parameters.

Step S210: an operating trajectory curve corresponding to the target category of data is determined at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

In this embodiment of the present application, the operating data and the output data in the different batches are collected; the outlier, the missing value, etc. in the data is processed through data preprocessing so as to improve the accuracy of drawing the operating trajectory curve by the system; through data integration, the operating data and the output data in the different batches are collected to obtain the operating-output data set; the similar operating-output data in the operating-output data set forms the cases through the clustering algorithm; the cases are labeled to form the case library; and the weight of the selected case in each batch is calculated so as to calculate the standard operating trajectory curve, thereby automatically generating the standard operating trajectory curve according to a production demand goal without manual formulating.

In step S204 of the method for determining an operating trajectory curve, the splicing operation on operating data and output data corresponding to the same collection date in the multiple batches specifically includes the following steps: operating time corresponding to the operating data is acquired; the operating data with the same operating time is aligned and sorted according to the operating time to obtain first data; and the first data and output data corresponding to the same collection date are spliced to obtain splicing data; and splicing data corresponding to different collection dates is determined to obtain a splicing data set.

In this embodiment of the present application, because the intermittent production process belongs to batched production, the operating data in each batch has two dimensions: the variable and time, namely, the value and operating time of the operating data, and the output data only has one dimension, when the operating-output data set is established, it is necessary to splice the operating data and the output data in one batch to form a set of operating-output data. The following examples are adopted for illustrations:

Operating-output data in a certain batch is shown in Table 1 below:

Table 1 Operating-output data in a batch

Operating data					
Operating time	Operating parameter 1	Operating parameter 2	Operating parameter 3	.. .	Operating parameter n
1 h	25	2250	60	.. .	...
2 h	27	2700	65	.. .	...
3 h	30	3100	70	.. .	...
...	...	...	...	.. .	...
Output data					

Yield	11251
Energy consumption per unit	45.34
Product top-grade rate	10.01

In the splicing data set, the operating-output data with the similarity greater than the preset threshold is clustered into the same category through the clustering algorithm, thereby obtaining the multiple categories, namely, the multiple categories of data. The category center data of each category is selected as the representative data of the category, namely, the case. Table 2 illustrates cases obtained after clustering in the splicing data set.

Table 2 Cases obtained after clustering in the splicing data set

Operating data									
Case	Case 1				Case 2				...
Cluster center					Cluster center				
Operating time (h)	Operating parameter 1	Operating parameter 2	...	Operating parameter n	Operating parameter 1	Operating parameter 2	...	Operating parameter n	...
1	25	2250	...	2950	24	2230	...	2813	...
2	27	2700	...	3045	26	2800	...	2988	...
3	30	3100	...	3159	31	3150	...	3063	...
...	...	...	...	...	...	...	...	...	...
Output data									
Yield		11120			13058				...
Energy consumption per unit		45.23			42.17				...
Product top-grade rate		10.97			11.51				...

After the generated cases are labeled, the contents shown in Table 3 are obtained.

Table 3 Labeled cases

Operating data									
Case	Common case				Low-energy-consumption case				...
Cluster center					Cluster center				
Operating time (h)	Operating parameter 1	Operating parameter 2	...	Operating parameter n	Operating parameter 1	Operating parameter 2	...	Operating parameter n	...
1	25	2250	...	2950	24	2230	...	2813	...
2	27	2700	...	3045	26	2800	...	2988	...
3	30	3100	...	3159	31	3150	...	3063	...
...	...	...	...	...	...	...	...	...	...
Output data									

Yield	11120	13058	...
Energy consumption per unit	45.23	42.17	...
Product top-grade rate	10.97	11.51	...

In step S208 in the method for determining an operating trajectory curve, the step of determining weight values corresponding to operating parameters in different batches from the target category of data specifically includes the following steps: collection dates corresponding to operating parameters in different batches in the target category of data are acquired to obtain a plurality of collection dates; the plurality of collection dates are sorted in order of proximity to the current date to obtain a target collection date set; and weight values of batches corresponding to the plurality of collection dates in the target collection date set are determined.

In the above step, the step of determining weight values of batches corresponding to the plurality of collection dates in the target collection date set specifically includes the following steps: weight values of batches corresponding to two adjacent dates in the target collection date set are determined, where the weight of the batch corresponding to the first date in the two adjacent dates is a preset multiple of the weight of the batch corresponding to the second date, the first date is the closer of the two adjacent dates to the current date, the second date is the farther of the two adjacent dates to the current date, and the preset multiple is an arbitrary value greater than 1.

In this embodiment of the present application, the batches are sorted based on the proximity to the current time. Assuming that the weight of the batch closer to the time is 1.5 times greater than the weight of the batch farther from the time, the value of 1.5 corresponds to the above preset multiple. It should be noted that the preset multiple is an arbitrary value greater than 1. Moreover, the preset multiple selected in the different batches may be the same or different, and the specifically selected value may be properly set according to practical situations. Set k_1 as the weight of the batch farthest from the time, $k_2=1.5k_1$, $k_3=1.5k_2=1.5^2k_1, \dots$, and $k_n=1.5^{n-1}k_1$, and the sum of all the weights is 1, that is,

$$k_1+1.5k_1+1.5^2k_1+ \dots +1.5^{n-1}k_1=1.$$

By solving k_1 , k_2 , k_3 , ..., and k_n are obtained.

In the above step, after the weight values of the batches corresponding to the two adjacent dates in the target collection date set are determined, the method further includes the following steps: a weight set of batches corresponding to all dates in the target collection date set is obtained; an equation is formulated according to a quantitative relationship between all the weight values in the weight set; and the equation is solved, and a first weight value between the batches corresponding to the two adjacent dates in the target collection date set is obtained.

In this embodiment of the present application, the target category of data is selected from the multiple categories of data. For example, data in the low-energy-consumption case in Table 3 is selected. Assuming that the low-energy-consumption case includes operating-output data in four batches, see Table 4 and Table 5.

Table 4 Batch data in the low-energy-consumption case

Operating data									
Batch	Batch 1				Batch 2				...
Operating time (h)	Operating parameter 1	Operating parameter 2	...	Operating parameter n	Operating parameter 1	Operating parameter 2	...	Operating parameter n	...
1	25	2250	...	2950	24	2230	...	2813	...
2	27	2700	...	3045	26	2800	...	2988	...
3	30	3100	...	3159	31	3150	...	3063	...
...	...	...	...	...	...	...	...	...	...
Batch information									
Batch end time		January 5, 2022			February 14, 2022			...	

Table 5 Batch data in the low-energy-consumption case (continuation)

Operating data									
Batch	Batch 3				Batch 4				...
Operating time (h)	Operating parameter 1	Operating parameter 2	...	Operating parameter n	Operating parameter 1	Operating parameter 2	...	Operating parameter n	...
1	22.5	2025	...	2655	28.8	2676	...	3375.6	...
2	24.3	2430	...	2740.5	31.2	3360	...	3585.6	...
3	27	2790	...	2843.1	37.2	3780	...	3675.6	...
...	...	...	...	...	...	...	...	...	...
Batch information									
Batch end time		March 27, 2022			April 30, 2022			...	

Set k_1 as the weight of the batch farthest from the time, in the case that "the weight of the batch closer to the time is 1.5 times greater than the weight of the batch farther from the time", $k_2=1.5k_1$, $k_3=1.5k_2=1.5^2k_1$, and $k_4=1.5k_3=1.5^3k_1$. The sum of all the weights is 1, shown in the following equation:

$$k_1+1.5k_1+1.5^2k_1+1.5^3k_1=1$$

By solving $k_1=0.123$, $k_2=0.185$, $k_3=0.277$, and $k_4=0.415$. The solved value corresponds to the first weight value.

In step S210 in the method for determining an operating trajectory curve, the step of determining an operating trajectory curve corresponding to the target category of data specifically includes the following steps: a target weight value of a batch corresponding to each date in the target collection

date set is determined based on the first weight value; and target operating parameters are determined according to the target weight value and values of operating parameters of the batch corresponding to the target weight value at different operating times, where the target operating parameters are values of operating parameters of the operating trajectory curve corresponding to the target category of data at different operating times.

In this embodiment of the present application, values of the operating parameters of the standard operating trajectory curve at each time are calculated according to the following formulas:

$$\begin{cases} s_{p,t} = \sum_{i=1}^n k_i * x_{p,i,t} \\ k_1 + k_2 + \dots + k_n = 1 \end{cases}$$

$s_{p,t}$ denotes the value of the operating parameter p in the operating trajectory curve at the time t , $x_{p,i,t}$ denotes the value of the operating parameter p in the i^{th} batch at the time t , and k_i denotes the weight in the i^{th} batch.

In an optional embodiment, taking the low-energy-consumption case including operating-output data of four batches as an example, suppose that the current date is May 1, 2022, and the batch 1 is the farthest from the current date, and correspondingly, has the minimum weight. Following this pattern, the value of the operating parameter 1 of the operating trajectory at the first hour is shown as:

$$k_4 * 28.8 + k_3 * 22.5 + k_2 * 24 + k_1 * 25 = 0.415 * 28.8 + 0.277 * 22.5 + 0.185 * 24 + 0.123 * 25 = 25.7.$$

The operating parameter 2 to the operating parameter n is calculated according to the above method. Similarly, the operating parameter 1 to the operating parameter n at the second hour to the m^{th} hour is calculated according to the above method.

In the method for determining an operating trajectory curve, the operating trajectory curve is a curve plotted in a coordinate system where the horizontal axis represents the operating time and the vertical axis represents the values of the operating parameters at the operating time.

In this embodiment of the present application, the weighted average of each operating parameter at each time is calculated based on the batch weight, and these weighted averages are connected to obtain the standard operating trajectory curve.

The present application focuses on intermittent production scenarios in the process industry. By performing data analysis on the operating data of historical batches and output data of final products, the standard operating trajectory curve is generated from multiple optimal batches according to the production targets. The method for determining an operating trajectory curve in this embodiment of the present application has the following advantages: firstly, it is unnecessary to require manual pre-formulation of the standard operating trajectory curve; secondly, the cases are obtained according

to real historical data and serve as the basis for formulating the standard operating trajectory curve; thirdly, taking into account the increasing significance of batches closer to the current time, a method for weight calculation in different batches is designed for similar cases; and fourthly, the standard operating trajectory curve is obtained based on the weighted averages of different batches for the similar cases.

Fig. 3 is a structural diagram of a device for determining an operating trajectory curve according to an embodiment of the present application. As shown in Fig. 3, the device includes:

an acquiring component 302, configured to acquire operating data and output data of a production device in multiple batches, where the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date;

a splicing component 304, configured to perform splicing operation on operating data and output data corresponding to the same collection date in the multiple batches to obtain a splicing data set;

a classification component 306, configured to determine similarity between splicing data in the splicing data set, and classify the splicing data in the splicing data set according to the similarity to obtain multiple categories of data, where the data with the similarity greater than a preset threshold is classified into the same category;

a first determining component 308, configured to select a target category of data from the multiple categories of data, and determine weight values corresponding to operating parameters in different batches from the target category of data, where the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and

a second determining component 310, configured to determine an operating trajectory curve corresponding to the target category of data at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

It should be noted that the device for determining an operating trajectory curve shown in Fig. 3 is set to perform the method for determining an operating trajectory curve shown in Fig. 2, and therefore, the relevant explanations and descriptions in the method for determining an operating trajectory curve are also applicable to the device for determining an operating trajectory curve, which are not repeated herein.

This embodiment of the present application further provides a non-volatile storage medium. The non-volatile storage medium includes a stored computer program. A device where the non-volatile storage medium is located performs, by running the computer program, the following method for determining an operating trajectory curve: operating data and output data of a production device in

multiple batches are obtained, where the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date; splicing operation is performed on operating data and output data corresponding to the same collection date in the multiple batches to obtain a splicing data set; similarity between splicing data in the splicing data set is determined, and the splicing data in the splicing data set is classified according to the similarity to obtain multiple categories of data, where the data with the similarity greater than a preset threshold is classified into the same category; a target category of data is selected from the multiple categories of data, and weight values corresponding to operating parameters in different batches are determined from the target category of data, where the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and an operating trajectory curve corresponding to the target category of data is determined at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

The sequence numbers of the foregoing embodiments of the present application are merely for the description purpose but do not imply the preference among the embodiments.

In the foregoing embodiments of the present application, the embodiments are described with respective focuses. For a part that is not described in detail in an embodiment, refer to related descriptions in other embodiments.

In the several embodiments provided in the present application, it should be understood that the disclosed technical content may be implemented in other manners. The above described apparatus embodiments are merely illustrative, such as unit division which is merely logical function division, and during practical implementation, there may be additional division manners. For example, a plurality of units or assemblies may be combined or integrated into another system, or some features may be ignored or not executed. In addition, shown or discussed mutual coupling or direct coupling or communication connection may be realized through some interfaces, and unit or component indirect coupling or communication connection may be in an electrical form or other forms.

The units described as separate components may or may not be physically separated, and components displayed as units may or may not be physical units, that is, may be located in one position, or may be distributed on a plurality of network units. Some or all of the units may be selected according to actual needs to achieve the objective of the solution of this embodiment.

In addition, functional units in the embodiments of the present application may be integrated into a processing unit, or the units may be physically separated, or two or more units may be integrated into a unit. The integrated unit may be implemented in the form of hardware or a software functional unit.

If the integrated unit is implemented in the form of the software functional unit and sold or used as an independent product, the integrated unit may be stored in a computer-readable storage medium. Based on the understanding, the technical solutions of the present application essentially or parts making contribution to the prior art or all or part of the technical solutions may be embodied in a software product form. A computer software product is stored in a storage medium and includes a plurality of instructions for making a computer device (e.g., a personal computer, a server, or a network device) perform all or part of the steps of the methods in the embodiments of the present application. The storage medium includes a U disk, a read-only memory (ROM), a random access memory (RAM), a portable hard drive, a magnetic disk, or an optical disk, or other media capable of storing program code.

The above contents are merely preferred implementations of the present application. It should be noted that a plurality of improvements and modifications may also be made by those of ordinary skill in the technical field without departing from the principle of the present application, and shall fall within the scope of protection of the present application.

Industrial applicability

The technical solutions provided by the embodiments of the present application are applicable to the field of production design in the process industry. In the embodiments of the present application, the operating data and the output data of the production device in the multiple batches are obtained; the splicing operation is performed on the operating data and the output data corresponding to the same collection date in the multiple batches to obtain the splicing data set; similarity between the splicing data in the splicing data set is determined, and the splicing data in the splicing data set is classified according to the similarity to obtain the multiple categories of data; the target category of data is selected from the multiple categories of data, and the weight values corresponding to the operating parameters in different batches are determined from the target category of data; and the operating trajectory curve corresponding to the target category of data is determined at least based on the weight values and the values of the operating parameters in batches corresponding to the weight values. Therefore, the purpose of automatically generating the operating trajectory in the production process is achieved, thereby achieving the technical effect of improving the operating trajectory generation efficiency, and solving the technical problems that the existing generation of the standard operating trajectory curve is typically manually specified, which cannot adapt to gradual changes of the production device and changing production demands.

Claims

1. A method for determining an operating trajectory curve, comprising:

acquiring operating data of a production device in multiple batches and output data of the production device in the multiple batches, wherein the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date;

performing splicing operation on operating data and output data corresponding to a same collection date in the multiple batches to obtain a splicing data set;

determining similarity between splicing data in the splicing data set, and classifying the splicing data in the splicing data set according to the similarity to obtain multiple categories of data, wherein data with the similarity greater than a preset threshold is classified into a same category;

selecting a target category of data from the multiple categories of data, and determining weight values corresponding to operating parameters in different batches from the target category of data, wherein the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and

determining an operating trajectory curve corresponding to the target category of data at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

2. The method as claimed in claim 1, wherein performing splicing operation on operating data and output data corresponding to the same collection date in the multiple batches comprises:

acquiring operating time corresponding to the operating data;

aligning operating data with same operating time and sorting the operating data according to the operating time to obtain first data; and

splicing the first data and output data corresponding to the same collection date to obtain the splicing data; and

determining splicing data corresponding to different collection dates to obtain the splicing data set.

3. The method as claimed in claim 1, wherein determining weight values corresponding to operating parameters in different batches from the target category of data comprises:

acquiring collection dates corresponding to operating parameters in different batches in the target category of data to obtain a plurality of collection dates;

sorting the plurality of collection dates in order of proximity to a current date to obtain a target collection date set; and

determining weight values of batches corresponding to the plurality of collection dates in the target collection date set.

4. The method as claimed in claim 3, wherein determining weight values of batches corresponding to the plurality of collection dates in the target collection date set comprises:

determining weight values of batches corresponding to two adjacent dates in the target collection date set, wherein a weight of a batch corresponding to a first date in the two adjacent dates is a preset multiple of a weight of a batch corresponding to a second date, the first date is a closer of the two adjacent dates to the current date, the second date is a farther of the two adjacent dates to the current date, and the preset multiple is an arbitrary value greater than 1.

5. The method as claimed in claim 4, wherein after determining weight values of batches corresponding to two adjacent dates in the target collection date set, the method comprises:

obtaining a weight set of batches corresponding to all dates in the target collection date set;

formulating an equation according to a quantitative relationship between all the weight values in the weight set; and

solving the equation to obtain a first weight value between the batches corresponding to the two adjacent dates in the target collection date set.

6. The method as claimed in claim 5, wherein determining the operating trajectory curve corresponding to the target category of data comprises:

determining a target weight value of a batch corresponding to each date in the target collection date set based on the first weight value; and

determining target operating parameters according to the target weight value and values of operating parameters of a batch corresponding to the target weight value at different operating times, wherein the target operating parameters are values of operating parameters of an operating trajectory curve corresponding to the target category of data at different operating times.

7. The method as claimed in claim 6, wherein the operating trajectory curve is a curve plotted in a coordinate system where a horizontal axis represents the operating time and a vertical axis

represents values of operating parameters at the operating time.

8. A device for determining an operating trajectory curve, comprising:

an acquiring component, configured to acquire operating data of a production device in multiple batches and output data of the production device in the multiple batches, wherein the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date;

a splicing component, configured to perform splicing operation on operating data and output data corresponding to a same collection date in the multiple batches to obtain a splicing data set;

a classification component, configured to determine similarity between splicing data in the splicing data set, and classify the splicing data in the splicing data set according to the similarity to obtain multiple categories of data, wherein data with the similarity greater than a preset threshold is classified into a same category;

a first determining component, configured to select a target category of data from the multiple categories of data, and determine weight values corresponding to operating parameters in different batches from the target category of data, wherein the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and

a second determining component, configured to determine an operating trajectory curve corresponding to the target category of data at least based on the weight values and values of operating parameters in batches corresponding to the weight values.

9. The device as claimed in claim 8, wherein the splicing component is configured to acquire operating time corresponding to the operating data; align operating data with same operating time and sort the operating data according to the operating time to obtain first data; and splice the first data and output data corresponding to the same collection date to obtain the splicing data; and determine splicing data corresponding to different collection dates to obtain the splicing data set.

10. An electronic device, comprising:

a memory, configured to store program instructions; and

a processor, connected with the memory and configured to implement the program instructions for achieving the following functions: acquiring operating data of a production device in multiple

batches and output data of the production device in the multiple batches, wherein the operating data is data collected by different instruments, the output data is product data related to products produced by the production device, and each batch of the multiple batches corresponds to a different collection date; performing splicing operation on operating data and output data corresponding to the a collection date in the multiple batches to obtain a splicing data set; determining similarity between splicing data in the splicing data set, and classifying the splicing data in the splicing data set according to the similarity to obtain multiple categories of data, wherein data with the similarity greater than a preset threshold is classified into a same category; selecting a target category of data from the multiple categories of data, and determining weight values corresponding to operating parameters in different batches from the target category of data, wherein the target category of data is any category of data from the multiple categories of data, and the operating parameters are at least one piece of controllable data in the operating data; and determining an operating trajectory curve corresponding to the target category of data at least based on the weight values and values of operating parameters in batches corresponding to the weight values.