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(54) GRAYSCALE STATE SEQUENCE BASED FEED SORTING DEVICE

(57) A grayscale state sequence based feed sorting device, comprising a grayscale sensor (3), a main controller (4), a rejection mechanism (5), a tray (1), and a guide chute (2). The grayscale sensor acquires a grayscale state sequence of a material and sends same to the main controller, and the main controller matches the acquired grayscale state sequence of the material with preconfigured standard discharge attitude data; if the grayscale state sequence of the material matches the preconfigured standard discharge attitude data, the material is in a target discharge attitude (7) and the material is allowed to pass through the rejection mechanism; otherwise, the material is in a non-discharge attitude (8), and the main controller controls the rejection mechanism to return the material to an initial position of the tray; through vibration of the tray, the discharge attitude of the returned material is changed; and along with the operation of the feed sorting device, all materials finally reach a discharge station (6) in the target discharge attitude through the guide chute. By detecting the grayscale state sequence of materials, the device realizes high-speed material sorting with a low error rate.

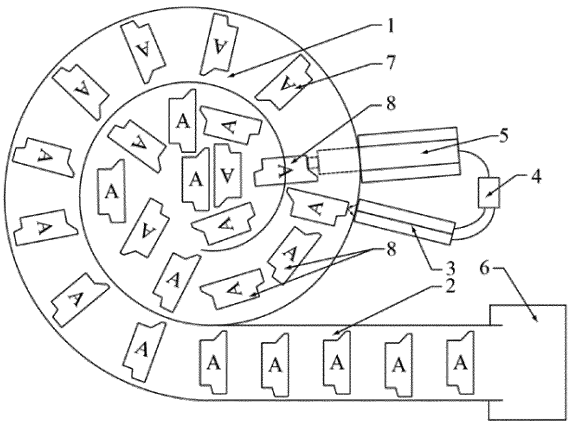

FIG. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of automatic production technologies, and in particular, to a grayscale state sequence based feed sorting device.

DESCRIPTION OF RELATED ART

[0002] Automatic feeding is the first section for implementing production automation, and efficient and reliable operation of a feed device is a necessary condition for successfully completing automatic production. An automatic production line requires that the feed device feeds materials to a loading station with a constant speed and a uniquely determined attitude. However, raw materials are usually unordered materials that may be mixed with defects or materials of another type. On one hand, the feed device needs to screen raw material states to meet a requirement of the loading station; on the other hand, the feed device further needs to remove the defects or foreign materials in the raw materials. The core for achieving the objective of automatic feeding is a material sorting technology.

[0003] The material sorting technology is a technology of sorting different products or products of different grades according to a certain standard or requirement to meet different needs. Material sorting can not only improve quality and utility of products, but also adapt to different needs of different users, thereby achieving rational, economic and effective use of resources, and reducing environmental pollution and ecological damage. In this era with rapid economic development and diversified subdivided needs, resources are gradually consumed and the environmental problem is becoming severer. Material sorting, as a main section during material circulation processing, is of great significance economically and ecologically.

[0004] With the emergence of concepts such as Industry 4.0 and Made in China 2025, industrial automation has prospered, and the material sorting technology has also been gradually developed from inefficient manual sorting to automatic sorting. Compared with the conventional manual sorting, the automatic sorting technology has incomparable advantages in aspects such as efficiency and accuracy, and therefore is developing rapidly. Various physicochemical properties, such as classes and shapes, of materials to be sorted differ greatly. As a result, mechanisms of sorting processes vary enormously. Therefore, a specialized subject, namely, material sorting, has been developed.

[0005] Based on the sorting mechanisms, sorting methods are mainly classified into screening, magnetic separation, optical separation, electric separation, flotation separation and other sorting methods. The optical separation is a sorting method related to optical attributes of sorting objects, and materials to be sorted are identified according to optical attributes of the sorting objects, for example, light absorption, reflection, and scattering. The core of an optical sorting device is a photoelectric detection device and a corresponding data processing system. The photoelectric detection device in the optical sorting method is generally provided with an optical transmitting unit and an optical receiving unit. Main forms of the optical transmitting unit include a point light source, a line light source, or an area light source formed by a laser, an infrared ray, an ultraviolet ray, and other visible light of various wavelengths. The optical receiving unit mainly includes a point grayscale sensor, a linear array charge-coupled device, a grayscale or color image sensor, and the like.

[0006] A Chinese patent application (publication number: CN102989693B) discloses a laser-transmission-based material sorting method and device. Materials to be sorted are irradiated by using a laser line source, the transmission light forms different intensity distribution at the back of the materials according to different transparent attributes and volume scattering of different materials, and a control system performs processing on the intensity distribution signal and compares the signal with reserved corresponding parameters of a material to be retained in the system, to determine whether the materials are foreign materials. The method is applicable to sorting of materials with very good transmission properties, such as raisins, vegetables, fruits, and marine products, but for non-transparent substances, it is relatively difficult to implement sorting. A Chinese patent application (publication number: CN106269570A) discloses a material sorting device and sorting method, and features of materials to be sorted are extracted by using dual infrared images of different wavelengths. In the method, different materials are distinguished according to infrared absorption differences between substances. Compared with an infrared image with a single wave band, more information is obtained from the dual infrared image in the method, thereby helping improve accuracy of material sorting. Although the method is applicable to most materials having infrared absorption differences, there are disadvantages of a low sorting speed and high system costs. A Chinese patent application (publication number: CN104390987A) discloses a new optical fiber sensor and detection method for detecting a surface defect of a steel ball. In the optical fiber sensor, a sensor probe is formed by using 19 fibers, and the surface defect of the steel ball is calculated by using photoelectric conversion signals from 6 channels. In the method, roughness and a displacement change defect on the surface of the steel ball may be accurately measured. However, because a relatively large quantity of fibers are used, and operations of conversion and acquisition processing on signals from 6 channels need to be performed, it is difficult to apply the method to a material sorting system.

[0007] A time sequence is a number sequence arranged in a time order. Time sequence analysis is a statistical method for dynamic data. The method is based

on a random process theory and a mathematical statistical method, and resolve actual problems by studying statistical regularity of random data sequences. The time sequence analysis is a theory and method for establishing a mathematical model through curve fitting and parameter estimation according to time sequence data obtained through systematic observation. The time sequence analysis is usually applied to fields such as macro-control on the national economy, regional comprehensive development planning, enterprise operation and management, forecasting of market potentials, meteorological and hydrological forecasting, earthquake forecasting, forecasting of crop pest disasters, environmental pollution control, ecological balance, astronomy, and oceanography.

[0008] By summarizing the current sorting methods, it can be found that an image-based method is usually used to achieve relatively high sorting accuracy, but high-speed sorting cannot be implemented due to a limited image processing speed; and to implement high-speed sorting, a point photoelectric sensor is usually used to improve a sorting speed, but a sorting error rate is relatively high. Therefore, a material sorting method that can implement high-speed sorting and has a low error rate is required. Material grayscale state sequence analysis is a technical approach to achieve the objective.

SUMMARY OF THE INVENTION

Technical Problem

[0009] To resolve the technical problem put forward in the background technology above, the present invention provides a grayscale state sequence based feed sorting device, thereby overcoming defects in the prior art, and implementing material sorting with a high speed and a low error rate by detecting a grayscale state sequence of a material.

Technical Solution

[0010] In order to achieve the technical objective described above, a technical solution of the present invention is as follows:

A grayscale state sequence based feed sorting device, including a grayscale sensor, a main controller, a rejection mechanism, a tray, and a guide chute, where all materials are placed on the tray and move forward along with the tray, the grayscale sensor acquires a grayscale state sequence of a material and sends the grayscale state sequence to the main controller, and the main controller performs identifies the grayscale state sequence;

the main controller matches the grayscale state sequence of the material with preconfigured standard discharge-allowed attitude data and preconfigured standard discharge-prohibited attitude data; if the grayscale state sequence matches any one piece of the preconfigured standard discharge-allowed attitude data, it indicates that the material is in a target discharge attitude and the material is allowed to pass through the rejection mechanism; and if the grayscale state sequence matches the preconfigured standard discharge-prohibited attitude data, it indicates that the material is in a non-discharge attitude, and the main controller controls the rejection mechanism to return the material to an initial position of the tray; through a falling process in the rejection mechanism and vibration of the tray, the attitude of the returned material is changed and a system performs identification again when the material reaches the rejection mechanism again;

if the grayscale state sequence does not match any piece of the standard discharge-allowed attitude data and the standard discharge-prohibited attitude data, the main controller performs a corresponding operation on the material in this condition according to a preconfigured treatment solution, where the treatment solution includes allowing passing through the rejection mechanism, prohibiting passing through the rejection mechanism, and shutdown warning; and

along with operation of the feed sorting device, the material finally reaches a discharge station in the target discharge attitude through the guide chute, or an operation is completed according to a treatment solution preconfigured by a user.

[0011] Further, each piece of the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data includes a plurality of grayscale states and a state transition sequence between grayscale states; and in a case that the grayscale state sequence of the material acquired by the grayscale sensor meets the state transition sequence in the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data, it is determined that the grayscale state sequence of the material matches the standard discharge-allowed attitude data or the standard discharge-prohibited attitude data.

[0012] Further, each grayscale state in the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data includes a value range of a grayscale value and an occurrence frequency or duration of the grayscale value.

[0013] Further, the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data is obtained through learning by using the feed sorting device in advance, a material is enabled to move forward on the tray in a determined attitude, the grayscale sensor acquires a grayscale state sequence of the material within an entire detection area and sends

the grayscale state sequence to the main controller, the main controller analyzes features of the grayscale state sequence to obtain grayscale states included in the material and a state transition sequence, that is, preconfigured standard attitude data, the preconfigured standard attitude data is stored in the main controller, and the standard attitude data is preconfigured as the standard discharge-allowed attitude data or the standard discharge-prohibited attitude data by the user.

[0014] Further, the grayscale sensor is a photoelectric sensor and includes an optical transmitting unit and an optical receiving unit, where the optical transmitting unit transmits a modulated optical signal, and the optical receiving unit outputs a grayscale value of a material at a light spot detection position.

[0015] Further, if the material is transparent or semitransparent, a thru-beam-type photoelectric sensor is used as the photoelectric sensor; and if the material is non-transparent, a reflective photoelectric sensor is used as the photoelectric sensor.

[0016] Further, in a case that a reflective photoelectric sensor is used as the photoelectric sensor, an emission light wavelength of the optical transmitting unit is adjusted according to a reflective attribute of the material.

[0017] Further, a plurality of pieces of standard discharge-allowed attitude data, a plurality of pieces of standard discharge-prohibited attitude data, and a plurality of treatment solutions for unmatched materials are preconfigured in the main controller, and a discharge attitude or a combination of discharge attitudes of a material is flexibly changed according to different requirements of the discharge station.

[0018] Further, grayscale state sequences of materials that are important or easy to be confused are pre-selected as feature templates, and operations of the rejection mechanism that respectively correspond to the feature templates are set, to help distinguish states with high resemblance; and for other grayscale state sequences that do not belong to the feature templates, treatment solutions are preconfigured, and corresponding operations of the rejection mechanism or a warning operation is performed according to the treatment solutions, thereby reducing a setting quantity and difficulty of the feature templates of materials whose states are easy to be distinguished.

Advantageous Effect

[0019] Beneficial effects achieved by using the technical solution described above:

(1) In the present invention, a time sequence analysis method is applied to a material sorting system. When a material passes through a photoelectric detection area, a calculation unit performs discrete time sampling on a grayscale sensor to obtain a grayscale state sequence, and type information is obtained by analyzing and calculating a variation feature of the state sequence. Compared with a classification method based on a single grayscale value, the method can greatly improve the accuracy of material feature identification.

(2) In the present invention, there is no need to stop in the photoelectric detection area during a feeding process, and compared with an image processing method, the grayscale state sequence feature identification method has a higher speed, thereby helping improve operation efficiency of a feed device.

(3) The present invention is compatible to a thru-beam-type grayscale sensor and a reflective grayscale sensor, thereby meeting feed sorting requirements of transparent, semitransparent, and non-transparent materials.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a schematic structural diagram of the present invention;

FIG. 2 is a diagram of grayscale state transition of material discharge according to an embodiment; and

FIG. 3 is a schematic diagram of a grayscale sequence of different attitudes of a material A according to an embodiment.

[0021] Descriptions of reference numerals: 1. Tray; 2. Guide chute; 3. Grayscale sensor; 4. Main controller; 5. Rejection mechanism; 6. Discharge station; 7. Target discharge attitude; 8. Non-discharge attitude.

DETAILED DESCRIPTION OF THE INVENTION

[0022] Technical solutions of the present invention are described below in detail with reference to the accompanying drawings.

[0023] In the present invention, a grayscale state sequence based feed sorting device is designed. As shown in FIG. 1, the device includes three parts: a grayscale sensor 3, a main controller 4, and a rejection mechanism 5, and in combination with a tray 1, a guide chute 2, and a discharge station 6, a programmable universal feed sorting devices is formed.

[0024] A working process of the device is as follows: all materials are placed on the tray 1 and move forward along with the tray 1, the grayscale sensor 3 acquires a grayscale state sequence of a material and sends the grayscale state sequence to the main controller 4, and the main controller 4 determines whether the acquired grayscale state sequence is already identified. If the grayscale state sequence is already identified, the main controller 4 matches the acquired grayscale state sequence

of the material with preconfigured standard discharge attitude data; if the grayscale state sequence of the material matches the preconfigured standard discharge attitude data, it indicates that the material is in a target discharge attitude 7 and the material is allowed to pass through the rejection mechanism 5; and if the grayscale state sequence of the material does not match the preconfigured standard discharge attitude data, it indicates that the material is in a non-discharge attitude 8, and the main controller 4 controls the rejection mechanism 5 to return the material to an initial position of the tray 1; through falling of the material in the rejection mechanism 5 and vibration of the tray 1, the discharge attitude of the returned material is changed; and if the grayscale state sequence is not identified, the main controller 4 controls the tray 1 to stop operation, and simultaneously sends abnormal alarm information to a staff member. Along with operation of the feed sorting device, all materials finally reach the discharge station 6 in the target discharge attitude through the guide chute 2.

[0025] In this embodiment, the grayscale sensor 3 is a photoelectric sensor and includes an optical transmitting unit and an optical receiving unit, where the optical transmitting unit transmits a modulated optical signal, and the optical receiving unit outputs a grayscale value of a material at a light spot detection position. If the material is transparent or semitransparent, a thru-beam-type photoelectric sensor is used as the photoelectric sensor; and if the material is non-transparent, a reflective photoelectric sensor is used as the photoelectric sensor. In a case that a reflective photoelectric sensor is used as the photoelectric sensor, an emission light wavelength of the optical transmitting unit is adjusted according to a reflective attribute of the material, so that a reflective signal has better quality and a higher signal-to-noise ratio.

[0026] To perform the grayscale state matching operation, standard discharge attitude data needs to be predefined. The standard discharge attitude data is a state sequence including grayscale states corresponding to discharge attitudes of a material and a transition relationship between states. The state sequence is predesigned in the main controller, and transition conditions between all state transition sequences and states constitute a standard for determining a material type. The state sequence may be constituted by manually controlling the material to move with a suitable and constant speed in the target attitude in front of the grayscale sensor, and simultaneously controlling the main controller to perform sampling and learning. Therefore, the main controller needs to be provided with a learning control interface, for example, a learning key. After the learning key is pressed, the main controller enters into a learning state, the material in a correct attitude is enabled to pass through in front of the grayscale sensor with a constant speed, and after detecting that the material completely passes through the detection area, the main controller performs state transition on the acquired grayscale sequence. It is determined that data points of proximate grayscale values are a same grayscale state, thereby obtaining a state space including all grayscale states of attitudes of a target material. A target feature may be defined as a state sequence including a set of specified state transition sequences in the state space. S is used for representing a grayscale state, G is used for representing a grayscale value, and F is used for representing an occurrence frequency of a grayscale or duration of the grayscale. Specific implementations are described by using a single piece of preconfigured target attitude data as an example herein. Extension to a plurality of pieces of preconfigured target attitude data may be implemented according to this example. Such extension without creative efforts still falls within the patent protection scope of the present invention.

[0027] FIG. 2 is a diagram of transition of discharge attitude states of a single target material. A condition of entering an S 1 state is that: a grayscale value is between 0.7 and 0.9, and a continuous occurrence frequency of the grayscale value is equal to 4. A condition of entering an S2 state is that: a grayscale sequence in which the grayscale is in a range of 0.3 to 0.5 continuously occurs for three times before timeout. A condition of entering an S4 state is that the grayscale value is decreased to be less than 0.1 before timeout. An unconditional output result of S4 is true, and an unconditional output result of S3 is false. From the figure, it can be seen that a grayscale state sequence of attitudes of the target material is M={S1->S2->S4}, and the result is true only for a material grayscale state sequence the same as this state sequence, and then it is determined that the attitude of the material is a discharge attitude; otherwise, the rejection mechanism performs an operation of returning the material to the tray.

[0028] A derivation process of a grayscale state sequence is described below by using four surfaces of a material A as an example. FIG. 3 shows four possible feed attitudes a, b, c, and d of the material A in FIG. 1. From FIG. 1, it can be seen that the discharge station requires a discharge attitude to be the attitude a in FIG. 3. The main controller needs to calculate four grayscale sequences in FIG. 3, separate the attitude a, and return materials of the attitudes b, c, and d to the tray through the rejection mechanism. Symbol G[x] is used for representing a grayscale sequence x. Through measurement, it is obtained that:

G[a]={0.05, 0.88, 0.87, 0.85, 0.86, 0.66, 0.41, 0.42, 0.39, 0.04}

G[b]={0.03, 0.38, 0.41, 0.43, 0.40, 0.39, 0.61, 0.78, 0.86, 0.01}

G[c]={0.02, 0.81, 0.83, 0.79, 0.85, 0.79, 0.81, 0.78, 0.77, 0.78, 0.87, 0.79, 0.81, 0.83, 0.82, 0.84, 0.81, 0.83, 0.78, 0.75, 0.81, 0.01}

G[d]={0.04, 0.15, 0.43, 0.51, 0.81, 0.82, 0.79, 0.81,

0.81, 0.78, 0.79, 0.84, 0.79, 0.85, 0.81, 0.79, 0.83, 0.81, 0.35, 0.15, 0.01}

[0029] State transition judgment is performed on the four grayscale sequences according to the transition conditions of various states in FIG. 2, and results are as follows:

$$S[a]=\{Sl->S2->S4\}$$

$$S[b]=\{\}$$

$$S[c]=\{Sl->S3\}$$

$$S[d]=\{Sl->S3\}$$

[0030] A result obtained from state transition judgment performed on G[a] is S[a], and an output result is true. A grayscale sequence represented by G[b] does not meet the condition of entering S1, and the grayscale sequence thereof is empty, and therefore a result is empty. A grayscale sequence represented by G[c] may successfully enter the S1 state, but wait overtime in the S1 state, thereby entering S3, and a result is false. A judgment result of G[d] is the same as that of G[c].

[0031] By means of judgment on the output results in the diagram of sequence state result transition, "true" represents being the same as the target discharge attitude, and "false" represents being different from the target discharge attitude. Therefore, it can be concluded that the state a belongs to the target discharge attitude, and the states b, c, and d do not belong to the target discharge attitude.

[0032] From the foregoing judgment results, it can be seen that a material with an abnormal discharge attitude may be strictly screened out by using a state sequence and transition conditions between states. The main controller may process, in real time, grayscale data received by the grayscale sensor, without waiting until the entire material grayscale state sequence is acquired. Grayscale state sequence analysis is an almost real-time online data processing method. The entire process of grayscale sampling, feature identification, calculation and judgment, and responding has a small calculation burden, and may be completed before the material moves to the rejection device. Such a design has almost no impact on a discharge speed. When material type changes, learning may be performed again, to create a transition diagram of discharge attitude grayscale states of a new target material. This conversion operation can be completed by guiding a computing unit with a small amount of manual intervention.

[0033] A grayscale state sequence based feed sorting device provided in the present invention provides a new idea for automatic feeding. Automatic feeding is a section of great significance during automatic production. It is difficult to universalize a conventional feed device because material objects are of various types and have greatly different features. As a result, it is expensive to customize a feed device. Therefore, it is of great economic value and practical significance to implement a programmable universal feed device with high efficiency and high reliability.

[0034] The embodiment described above is merely for describing the technical concept of the present invention, but is not intended to limit the protection scope of the present invention. All technical concepts put forward according to the present invention and any modifications made based on the technical solution fall within the protection scope of the present invention.

Claims

1. A grayscale state sequence based feed sorting device, comprising a grayscale sensor, a main controller, a rejection mechanism, a tray, and a guide chute, wherein all materials are placed on the tray and move forward along with the tray, the grayscale sensor acquires a grayscale state sequence of a material and sends the grayscale state sequence to the main controller, and the main controller identifies the grayscale state sequence;
the main controller matches the grayscale state sequence with preconfigured standard discharge-allowed attitude data and preconfigured standard discharge-prohibited attitude data; if the grayscale state sequence matches any one piece of the preconfigured standard discharge-allowed attitude data, it indicates that the material is in a target discharge attitude and the material is allowed to pass through the rejection mechanism; and if the grayscale state sequence matches the preconfigured standard discharge-prohibited attitude data, it indicates that the material is in a non-discharge attitude, and the main controller controls the rejection mechanism to return the material to an initial position of the tray; through a falling process in the rejection mechanism and vibration of the tray, the attitude of the returned material is changed and a system performs identification again when the material reaches the rejection mechanism again;
if the grayscale state sequence does not match any piece of the standard discharge-allowed attitude data and the standard discharge-prohibited attitude data, the main controller performs a corresponding operation on the material in this condition according to a preconfigured treatment solution, wherein the treatment solution comprises allowing passing through the rejection mechanism, prohibiting passing through the rejection mechanism, and shutdown

warning; and
along with operation of the feed sorting device, the material finally reaches a discharge station in the target discharge attitude through the guide chute, or an operation is completed according to a treatment solution preconfigured by a user.

2. The grayscale state sequence based feed sorting device according to claim 1, wherein each piece of the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data comprises a plurality of grayscale states and a state transition sequence between grayscale states; and in a case that the grayscale state sequence of the material acquired by the grayscale sensor meets the state transition sequence in the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data, it is determined that the grayscale state sequence of the material matches the standard discharge-allowed attitude data or the standard discharge-prohibited attitude data.

3. The grayscale state sequence based feed sorting device according to claim 2, wherein each grayscale state in the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data comprises a value range of a grayscale value and an occurrence frequency or duration of the grayscale value.

4. The grayscale state sequence based feed sorting device according to claim 2, wherein the preconfigured standard discharge-allowed attitude data or standard discharge-prohibited attitude data is obtained through learning by using the feed sorting device in advance, a material is enabled to move forward on the tray in a determined attitude, the grayscale sensor acquires a grayscale state sequence of the material within an entire detection area and sends the grayscale state sequence to the main controller, the main controller analyzes features of the grayscale state sequence to obtain grayscale states comprised in the material and a state transition sequence, that is, preconfigured standard attitude data, the preconfigured standard attitude data is stored in the main controller, and the standard attitude data is preconfigured as the standard discharge-allowed attitude data or the standard discharge-prohibited attitude data by the user.

5. The grayscale state sequence based feed sorting device according to claim 1, wherein the grayscale sensor is a photoelectric sensor and comprises an optical transmitting unit and an optical receiving unit, the optical transmitting unit transmits a modulated optical signal, and the optical receiving unit outputs a grayscale value of the material at a light spot detection position.

6. The grayscale state sequence based feed sorting device according to claim 5, wherein if the material is transparent or semitransparent, a thru-beam-type photoelectric sensor is used as the photoelectric sensor; and if the material is non-transparent, a reflective photoelectric sensor is used as the photoelectric sensor.

7. The grayscale state sequence based feed sorting device according to claim 6, wherein in a case that a reflective photoelectric sensor is used as the photoelectric sensor, an emission light wavelength of the optical transmitting unit is adjusted according to a reflective attribute of the material.

8. The grayscale state sequence based feed sorting device according to claim 1, wherein a plurality of pieces of standard discharge-allowed attitude data, a plurality of pieces of standard discharge-prohibited attitude data, and a plurality of treatment solutions for unmatched materials are preconfigured in the main controller, and a discharge attitude or a combination of discharge attitudes of a material is flexibly changed according to different requirements of the discharge station.

9. The grayscale state sequence based feed sorting device according to claim 1, wherein grayscale state sequences of materials that are important or easy to be confused are pre-selected as feature templates, and operations of the rejection mechanism that respectively correspond to the feature templates are set; for other grayscale state sequences that do not belong to the feature templates, treatment solutions are preconfigured, and corresponding operations of the rejection mechanism or a warning operation is performed according to the treatment solutions.

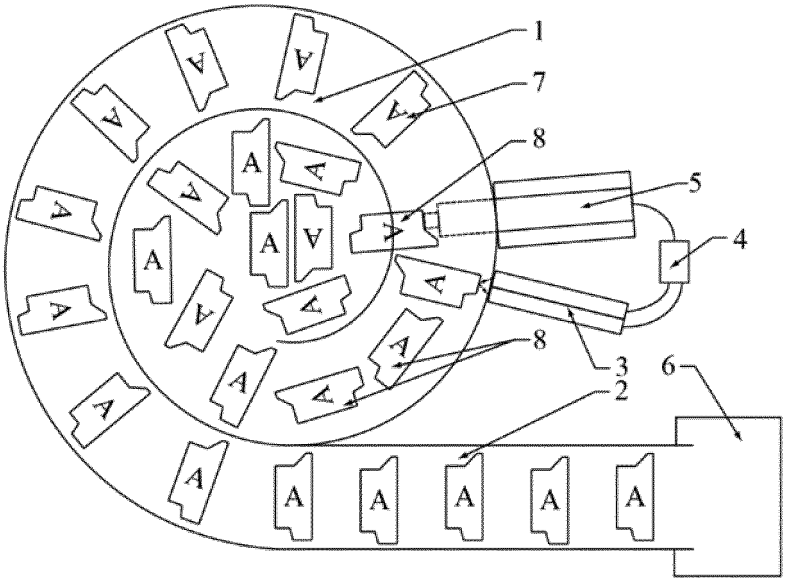
1
7
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FIG. 1

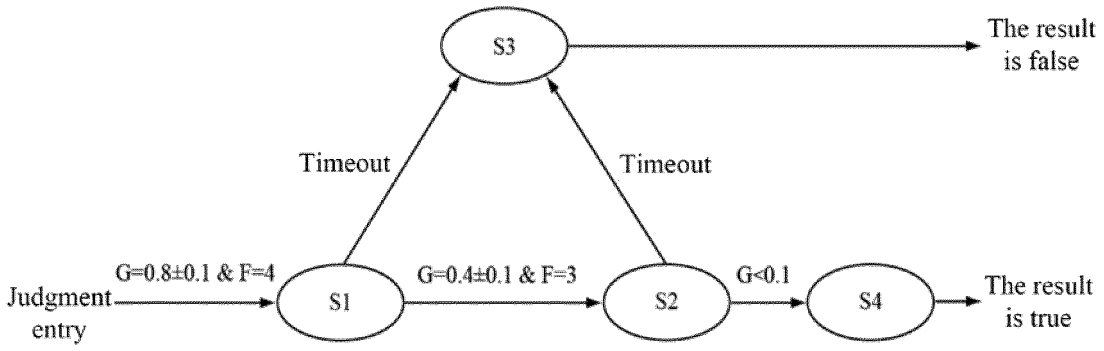
S3
The result is false
Timeout
Timeout
G=0.8±0.1 & F=4
G=0.4±0.1 & F=3
G<0.1
Judgment entry
S1
S2
S4
The result is true

FIG. 2

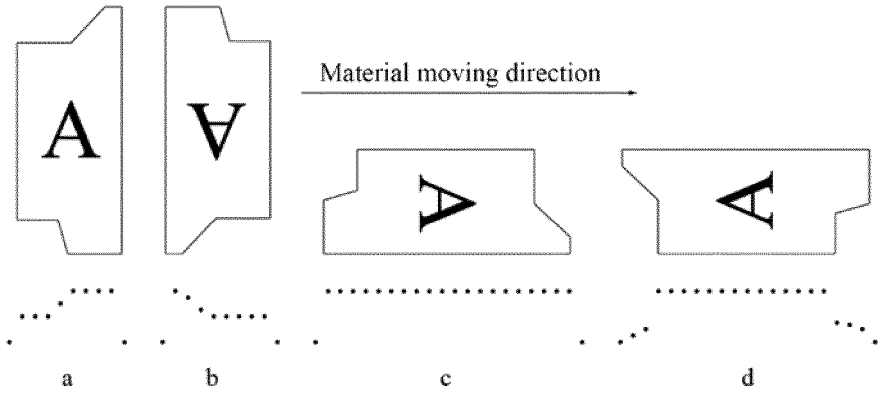

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/103845

A. CLASSIFICATION OF SUBJECT MATTER

B07C 5/342(2006.01)i; B07C 5/36(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, WPI, EPODOC, CNKI: 送料, 分选, 灰度, 值, 状态, 姿态, 序列, 变化, 离散, 采样, 剔除, 光电传感器, 控制, 数据, 收集, 比较, 匹配, 出料, feed+, sort+, gray, grayscale, scale, level, state, sequence, discrete, sensor, control+, data, collect+, compare+, discharge

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 103008259 A (HEFEI MEYER OPTOELECTRONIC TECHNOLOGY INC.) 03 April 2013 (2013-04-03) description, particular embodiments, and figures 1-13	1-9
A	CN 203484357 U (HEFEI MEYER OPTOELECTRONIC TECHNOLOGY INC.) 19 March 2014 (2014-03-19) entire document	1-9
A	CN 205165215 U (HENAN POLYTECHNIC UNIVERSITY) 20 April 2016 (2016-04-20) entire document	1-9
A	CN 104390987 A (UNIVERSITY OF JINAN) 04 March 2015 (2015-03-04) entire document	1-9
A	CN 102989693 A (HEFEI MEYER OPTOELECTRONIC TECHNOLOGY INC.) 27 March 2013 (2013-03-27) entire document	1-9
A	CN 105251707 A (CHANGSHA UNIVERSITY OF SCIENCE & TECHNOLOGY) 20 January 2016 (2016-01-20) entire document	1-9

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 May 2018	**14 June 2018**
Name and mailing address of the ISA/CN **State Intellectual Property Office of the P. R. China** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/103845

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 101111502 B1 (COMAS CO., LTD.) 22 February 2012 (2012-02-22) entire document	1-9

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/103845

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 103008259 A	03 April 2013	CN 103008259 B	20 August 2014
CN 203484357 U	19 March 2014	None	
CN 205165215 U	20 April 2016	None	
CN 104390987 A	04 March 2015	CN 104390987 B	04 January 2017
CN 102989693 A	27 March 2013	CN 102989693 B	12 November 2014
CN 105251707 A	20 January 2016	CN 105251707 B	28 July 2017
KR 101111502 B1	22 February 2012	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 102989693 B **[0006]**
- CN 106269570 A **[0006]**
- CN 104390987 A **[0006]**