A quality inspection system and method for cigarette products or filter tips, the inspection system comprising a mobile platform (1) having an automatic directional drive device, a control system, a wireless data communication device (2), a comprehensive test device (3) and a sampling manipulator (4). A single inspection system can inspect and control the quality of a plurality of product manufacturing machines by automatically navigating a sampling system and an inspection system. The inspection system eliminates system errors caused by concurrent use of a plurality of inspection systems and realizes one-time sampling and measurement, while reducing measurement errors caused by temperature changes, solving the problem of long-distance transport between sampling and measurement, avoiding sample damage during sample transport, effectively reducing the calibration workload of the inspection system, improving working efficiency, and lowering production costs.
Drawings

FIG 1

Control system

Communication control subsystem

Lifting drive device

Sampling control subsystem

Sampling manipulator

Navigation control subsystem

Measurement control subsystem

Comprehensive test device

Electric drive device

Directional drive device

Drive wheel

Drive wheel rotary encoder

Bogie

Bogie rotary encoder
System initialization

Establishment of motion trajectory of sampling position

Mobile positioning

Sampling

Sample inspection

Data processing

Acquire the set quantity of samples?

Y

The next manufacturing machine?

Y

N

Return to charging station and stand by

FIG2
Sample inlet unit

Weight measurement unit

Circumference/length/roundness test unit

Draw resistance and ventilation degree test unit

Moisture and density test unit

Sample collecting device

FIG 3
Motion trajectory

Sampling position 1#

Manufacturing machine 1#

Sampling position 2#

Manufacturing machine 2#

Sampling position 3#

Manufacturing machine 3#

FIG 4
Description

Quality Inspection System and Method for Cigarette Products or Filter Tips

Technical Field

The present invention relates to an inspection system and method, and in particular to a quality inspection system and method for cigarette products or filter tips.

Background

Today, modern cigarette manufacturing machines can yield filter-tipped cigarettes at a high rate of over 20,000 cigarettes per minute, and filter tip forming machines are capable of producing filter tip at a rate of 1,000 meters per minute. In an effort to realize massive production, multiple product manufacturing machines are typically used for concurrent production in cigarette workshops. To achieve the purpose that manufacturing machines can produce, under high-speed production conditions, products meeting quality standards such as cigarettes or filter tips, and to gain the capability of inspecting whether their draw resistance, ventilation degree, weight and external physical characteristics (e.g. length, circumference, roundness, etc.) are consistent with technical indices, the common practice is to take a sample out of the manufacturing machine using a manual or automatic sampling system and then transport the sample to measurement systems for measurement to determine whether the quality indices of the sample conform to technological requirements.

To date, inspection methods featured by manual sampling have yet to be thoroughly improved or replaced on account of the presence of technical defects in automatic measurement systems. The conventional automatic sampling technologies that are being studied generally can be divided into two categories: one is one-to-one system configuration in which the technical quality of products is inspected and controlled on the premise that one sampling and measurement system corresponds to one of the manufacturing machines; and the other appears in the form of one-to-many system configuration, which is to say, one measurement system corresponds to a plurality of remote samplers, and samples are transported through pipelines to measurement systems for purposes of inspection and technical control. Yet, there are still shortcomings in these two approaches:

1. As for the one-to-one system structure, it is imperative that one manufacturing machine is equipped with a set of independent measurement and sampling systems, and therefore there are high system costs for those workshops where as many as several tens of manufacturing machines are applied, and multiple measurement systems also lead to large workloads in system calibration,
management and maintenance. More importantly, multiple sets of measurement systems will bring influence factors such as indefinite measurement results. As a consequence, to form an ultimate inspection basis for the quality of products, manual random inspection is still required.

2. In case of the one-to-many system structure, one measurement system corresponds to multiple remote samplers, and samples are transported to shared measurement systems through pneumatic pipelines to finish measurement. Its drawback lies in the fact that there are complex system structures and high operating, maintenance and construction costs since stationary samplers and transportation pipelines need to be mounted inside production workshops. What’s more, the current pneumatic pipelines transportation technologies are only applicable for transportation of filter tips. Damages to the sample or changes in technical indices occur when cigarette products are subjected to pneumatic transportation. Furthermore, different environmental temperatures at which the existing one-to-many measurement systems and manufacturing machines are kept will result in measurement errors of parameters affected by changes in environmental temperature, such as draw resistance and ventilation degree of the sample, as a result of which a true reflection of the inspection results cannot be offered.

In view of the above-mentioned problems existing in the prior art, the present invention provides an innovative quality inspection system for cigarette products or filter tips and a realization method thereof.

**Summary of the Invention**

Provided in the present invention is a quality inspection system for cigarette products or filter tips, which comprises a mobile platform having an automatic directional drive device, a control system, a wireless data communication device, a comprehensive test device and a sampling manipulator.

The control system comprises a communication control subsystem, a navigation control subsystem, a measurement control subsystem and a sampling control subsystem.

The comprehensive test device, the sampling manipulator and the control system are mounted on the mobile platform having the automatic directional drive device, an output end of the navigation control subsystem is connected to an input end of the automatic directional drive device, an output end of the sampling control subsystem is connected to an input end of the sampling manipulator, an output end of the measurement control subsystem is connected to an input end of the comprehensive test device, and the communication control subsystem and the wireless data communication device are connected with each other.

The sampling manipulator is provided with a lifting drive device that is capable of adjusting and controlling the sampling manipulator to rise or drop by driving the sampling manipulator to move up and down.
The mobile platform having the automatic directional drive device is driven to travel by a drive wheel connected with a servo motor. The drive wheel is connected with a rotary encoder to transmit a rotation angle vector signal to the navigation control subsystem for calculating traveling speed and distance. The traveling direction of the mobile platform is controlled by a servo electric bogie, a direction wheel is mounted on the bogie, an output end of the rotary encoder of the servo electric bogie is connected to an input end of the navigation control subsystem. When the bogie is rotated, a direction rotary encoder inspects an output direction angle vector signal and the navigation control subsystem controls the traveling direction of the mobile platform according to the direction angle vector signal.

The mobile platform is provided with a front-end laser safety inspection sensor and a rear-end ultrasonic radar, to inspect and dodge obstacles and people during traveling. A quick-replaceable battery pack and a miniature air compressor are mounted on the rear end of the mobile platform to supply power required for system operation. A charging contact is disposed at the bottom of the mobile platform. The mobile platform is automatically moved to a charging station and charged while the system is idle. An air pressure and signal hybrid quick connection plug is disposed at the front end of the mobile platform for switching on rotation speed pulse signals for belts of the air compressor and the product manufacturing machines.

The comprehensive test device comprises a sample inlet unit, technical index test units and a sample collecting device, and the technical index test units include a weight measurement unit, a circumference/length/roundness test unit, a draw resistance and ventilation degree test unit, and a moisture and density test unit. The comprehensive test device is structured in such a manner that the sample inlet unit is connected with an inlet of one technical index test unit, an outlet of the technical index test unit is connected with an inlet of the next technical index test unit, an outlet of the last technical index test unit is connected with the sample collecting device, so as to create a sample measurement path. A sample to be inspected enters from the sample inlet unit, then is tested for every technical index by the technical index test units one by one, and finally is collected by the sample collecting device.

Also provided in the present invention is a quality inspection method for cigarette products or filter tips, which comprises the following steps:

1. system initialization;
2. establishment of a motion trajectory of sampling position;
3. mobile positioning: the navigation control subsystem controls the automatic directional drive device which is connected to it, to cause the mobile platform to travel to designated sampling position of a cigarette or filter tip manufacturing machine in accordance with a preset motion trajectory;
4. sampling: the sampling control subsystem controls the sampling manipulator which is connected to it, to acquire a sample from a product manufacturing machine and then transport the sample to the sample inlet unit of the comprehensive test device;
5. sample inspection: the measurement control subsystem controls the comprehensive test device which is connected to it, to test technical indices of the sample and thus obtain test results;
6. data processing: the communication control subsystem controls the wireless data communication device which is connected to it, to transfer the test result data to a database for processing;
7. judging, by the inspection system, whether sampling meets the requirement for set quantity; if not, returning to S4 to resume sampling, and if so, proceeding with the next step; and
8. judging, by the inspection system, whether inspection for the next product manufacturing machine is performed; if so, returning to S2 to repeat these steps, and if not, the inspection system returning to a charging station and standing by.

The comprehensive test device is provided therein with four technical index test units, including a weight measurement unit, a circumference/length/roundness test unit, a draw resistance and ventilation degree test unit, and a moisture and density test unit, all of which forming a sample measurement path. A sample to be inspected enters from the sample inlet unit, then is tested for each technical index by the technical index test units one by one, and finally is collected by the sample collecting device. When the inspected product is a filter tip product, the moisture and density test unit and the ventilation degree test unit are set to an off state in the process of sampling and measurement, so that inspection for ventilation degree as well as moisture and density is not needed during the transmission of the sample.

The technical solution provided in the present invention enables innovative designs and improvements over the fixedly-disposed measurement systems and the fixedly-mounted sampling systems in the prior art. A single inspection system can inspect and control the quality of a plurality of product manufacturing machines by engineering the sampling and inspection systems into automatically navigated systems. The inspection system eliminates system errors caused by concurrent use of a plurality of inspection systems and realizes one-time sampling and measurement. And also, the inspection system and method reduce measurement errors caused by temperature changes, solve the problem of long-distance transportation between sampling and measurement, avoid sample damage during sample transportation, enhance system maintainability while achieving great management convenience, effectively reduce the calibration workload of the inspection system, improve working efficiency, and lower production costs.

**Brief Description of the Drawings**
FIG. 1 is a structure block diagram of a quality inspection system for cigarette products or filter tips;
FIG. 2 is a flowchart of a quality inspection method for cigarette products or filter tips;
FIG. 3 is a schematic diagram illustrating the structure of a comprehensive test device of a cigarette sample inspection system;
FIG. 4 is a schematic diagram illustrating a motion trajectory of sampling position in the inspection method; and
FIG. 5 is a schematic diagram illustrating the state of the inspection system.

**Detailed Description of the Invention**

The content given in the present invention will be detailed below with reference to the drawings. As shown in FIG. 1 and FIG. 5, the inspection system is composed of integrated central control systems, and employs a motion control system to control a mobile platform (1), a wireless data communication device (2), a comprehensive test device (3) and a sampling manipulator (4); the sampling manipulator (4) and the mobile platform (1) are driven to travel by a drive wheel (6) connected with a servo motor, the drive wheel (6) is connected with a rotary encoder to transmit a rotation angle vector signal to the navigation control subsystem for calculating traveling speed and distance. The traveling direction of the mobile platform (1) is controlled by a servo electric bogie, and a direction wheel (7) is mounted on the bogie. An output end of a rotary encoder of the servo electric bogie is connected to an input end of the navigation control subsystem. When the bogie rotates, a direction rotary encoder inspects an output direction angle vector signal and the navigation control subsystem controls the traveling direction of the mobile platform (1) according to the direction angle vector signal. The mobile platform (1) is provided, at the front part thereof, with a laser safety inspection sensor (10) and, at the rear part thereof, with an ultrasonic radar (11) to inspect and dodge obstacles and people during traveling. A quick-replaceable battery pack and a miniature air compressor are mounted at the rear part of the mobile platform to supply power required for system operation. A charging contact is disposed at the bottom of the mobile platform. The mobile platform is automatically moved to a charging station and charged while the system is idle. An air pressure and signal hybrid quick connection plug is disposed at the front end of the mobile platform for switching on rotation speed pulse signals for belts of the air compressor and the manufacturing machines.

The sampling manipulator (4) is provided with a lifting drive device (5) that is capable of adjusting and controlling the sampling manipulator to rise or drop by driving the sampling manipulator to move up and down. A negative pressure suction disk (8) is disposed at the front end of the sampling manipulator (4), and a sample (9) to be acquired, such as a cigarette sample or
filter tip sample, is gripped by the negative pressure suction disk (8). The description that follows is exemplified by a cigarette sample. As shown in FIG 2, first the system is initialized. A motion trajectory of sampling position is established as required by the inspection for the cigarette sample. When sampling begins, the navigation control subsystem controls the automatic directional drive device connected therewith to cause the mobile platform (1) to travel to the designated sampling position of a cigarette or filter tip manufacturing machine in accordance with the preset motion trajectory. The sampling control subsystem controls the sampling manipulator (4) connected therewith to acquire the sample (9) from a product manufacturing machine and then transport the sample to the sample inlet unit (12) of the comprehensive test device. The measurement control subsystem controls the comprehensive test device (3) connected therewith to, as shown in FIG 3, test the technical indices of the sample. The sample is tested for every technical index by the technical index test units one by one, so as to obtain test results. The communication control subsystem controls the wireless data communication device (2) connected therewith to transfer the test result data to a database for processing, and in this way one sampling test for the cigarette sample is completed. The motion trajectory of sampling position for the sample is shown in FIG. 4. On the basis of needs of users, the inspection system and method enable inspection for cigarette products produced by a plurality of product manufacturing machines.
Claims

1. A quality inspection system for cigarette products or filter tips, comprising a mobile platform having an automatic directional drive device, a control system, a wireless data communication device, a comprehensive test device and a sampling manipulator, the comprehensive test device, the sampling manipulator and the control system being mounted on the mobile platform having the automatic directional drive device, characterized in that the control system comprises a communication control subsystem, a navigation control subsystem, a measurement control subsystem and a sampling control subsystem, an output end of the navigation control subsystem is connected to an input end of the automatic directional drive device, an output end of the sampling control subsystem is connected to an input end of the sampling manipulator, an output end of the measurement control subsystem is connected to an input end of the comprehensive test device, and the communication control subsystem and the wireless data communication device are connected with each other.

2. The quality inspection system for cigarette products or filter tips according to claim 1, characterized in that the sampling manipulator is provided with a lifting drive device to adjust and control the sampling manipulator to rise or drop.

3. The quality inspection system for cigarette products or filter tips according to claim 1, characterized in that the mobile platform having the automatic directional drive device is driven by a drive wheel connected with a servo motor, the traveling direction of the mobile platform is controlled by a servo electric bogie, and a direction wheel is mounted on the bogie.

4. The quality inspection system for cigarette products or filter tips according to claim 1 or 3, characterized in that the mobile platform having the automatic directional drive device is provided with a front-end laser safety inspection sensor and a rear-end ultrasonic radar, a quick-replaceable battery pack and a miniature air compressor are mounted on a rear end of the mobile platform, and a charging contact is disposed at the bottom of the mobile platform.

5. The quality inspection system for cigarette products or filter tips according to claim 1, characterized in that the comprehensive test device comprises a sample inlet unit, technical index test units and a sample collecting device, and the technical index test units include a weight measurement unit, a circumference/length/roundness test unit, a draw resistance and ventilation degree test unit, and a moisture and density test unit.

6. A quality inspection method for cigarette products or filter tips, comprising the following steps:
   (1) system initialization;
   (2) establishment of a motion trajectory of sampling position;
(3) mobile positioning: the navigation control subsystem controls the automatic directional drive device which is connected to it, to cause the mobile platform to travel according to a preset motion trajectory to the designated sampling position of a cigarette or filter tip manufacturing machine;

(4) sampling: the sampling control subsystem controls the sampling manipulator which is connected to it, to acquire a sample from a product manufacturing machine and then transport the sample to the sample inlet unit of the comprehensive test device;

(5) sample inspection: the measurement control subsystem controls the comprehensive test device which is connected to it, to test technical indices of the sample and thus obtain test results;

(6) data processing: the communication control subsystem controls the wireless data communication device which is connected to it, to transfer the test result data to a database for processing;

(7) judging, by the inspection system, whether sampling meets the requirement for set quantity; if not, returning to S4 to resume sampling, and if so, proceeding with the next step; and

(8) judging, by the inspection system, whether inspection for the next product manufacturing machine is performed; if so, returning to S2 to repeat these steps, and if not, the inspection system returning to a charging station and standing by.

7. The quality inspection method for cigarette products or filter tips according to claim 6, characterized in that the comprehensive test device is provided therein with four technical index test units, including a weight measurement unit, a circumference/length/roundness test unit, a draw resistance and ventilation degree test unit, and a moisture and density test unit.

8. The quality inspection method for cigarette products or filter tips according to claim 6, characterized in that the sample enters from the sample inlet unit, then is tested for each technical index by the technical index test units one by one, and finally is collected by the sample collecting device.

9. The quality inspection method for cigarette products or filter tips according to claim 6, characterized in that when the sample is a filter tip product, the moisture and density test unit and the draw resistance and ventilation degree test unit are set to an off state in a process of sampling and measurement, so that inspection for ventilation degree as well as moisture and density is not needed during the transmission of the sample.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

A24C 5/34 (2006.01) i; G01N 33/00 (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)

A24C 5; G01N 33

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)

CNKI & CNAIS & CNTEXT: cigarette, filter tip, filter rod, cigarette holder, navigation, automatic orientation, communication

EPODOC & WPI & ETXT: cigar+, tobacco, mouthpiece, navigation, auto+, position, direct, communication

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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** See patent family annex.

Special categories of cited documents:

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Authorized officer: SHI, Jianping
Telephone No.: (86-10) 62085675

Form PCT/ISA/210 (second sheet) (July 2009)
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