Design and Application of Cigarette Maker’s Online Inspection System for Cigarette Appearance

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Abstract. In order to solve the problem that the continuous appearance inspection of the online product of the single-piece cannot be carried out during the process, the online appearance inspection system of the cigarette-making unit was designed according to the running characteristics of the machine. The device is mainly composed of a camera control unit, a light source control unit, a signal processing unit and a data communication unit. The system first obtains the cigarette machine production status and single cigarette segmentation signals of continuous cigarettes through an axis encoder. The light source control unit and camera control unit work together to obtain images of a single cigarette at different stations, and perform real-time calculation and integration through the signal processing unit. After the shaft encoder, the processed signal is aligned with the cigarette, and finally the rejection is performed through the rejection valve. The ZJ17 rolling unit and cigarette products with a diameter of 5.4mm, a total length of 84mm, a cigarette length of 54mm, and a filter length of 30mm were tested. The results showed that the online appearance inspection system of the cigarette unit of the rolling unit had a detection accuracy rate of ≥ 98%, missed rejection rate ≤ 2%, false rejection rate ≤ 2%. The device realizes the continuous detection of the appearance of the single product of the spliced product online, and opens up new ideas for the quality assurance of the appearance of the spliced product.

1. Introduction
Product quality is an important part of the core competitiveness of tobacco companies. At present, in the tobacco industry, there are mainly three types of splicing units, namely the PROTOS series, the GD 121 series and the domestic ZJ series. The above three types of splicing equipment are equipped with many detectors, such as leak detectors and missing mouth Detectors, OTIS detectors, have played a better role in ensuring the quality of cigarettes. However, its appearance defects such as puncture of cigarettes, entrapment, yellow spots, various stains, corrugations of cork paper, skew, overlap, length of cigarettes, etc. cannot be detected online. Generally, manual inspection is used. In this way, the guarantee of the appearance quality of the cigarette is lack of the full sample nature. For this reason, it is necessary to design an online single-piece continuous detection system for the appearance of cigarettes in a cigarette splicing unit to realize the online detection of appearance defects of cigarettes.[1-8]

2. System Structure
2.1. Technical principle
The core of the online single continuous detection system for the appearance of cigarettes is based on computational vision. Computer vision inspection is to use machines instead of human eyes to make measurements and judgments. Vision inspection refers to the conversion of the captured object into an image signal by machine vision products (that is, image pickup devices, divided into two types: CMOS and CCD), which is transmitted to a dedicated image processing system. Digitized signals; the image system performs various operations on these signals to extract the features of the target, and then controls the field equipment operations based on the results of the discrimination. It is a valuable mechanism for production, assembly or packaging. It has immeasurable value in the function of detecting defects and preventing defective products from being delivered to consumers. \[9-11\]

2.2. Technical solution

When the cigarette is running on the drum, the entire surface of the cigarette will be transformed by 180° from the detection wheel to the rejection wheel. Therefore, by capturing the image of the cigarette on the detection wheel and the rejection wheel, the entire cigarette can be obtained. The outer surface of the sensor is used to detect defective cigarettes through image processing. After the system judges and processes, the waste cigarettes are removed through the removal valve.

The system includes two sets of image capture components, which are respectively located in the FLO (removal wheel part) and the air leakage voltage stabilization module (detection wheel part); each set of image capture components includes prism (light path processing), lens camera (captured image), Lighting (providing light source) and other components.

The system includes a set of image processing components, including an industrial computer and an IO board. The images are processed by synchronously capturing images, and the processing results are eliminated through the board output.

The system contains two sets of light source control components, which are mainly used to provide power and trigger pulses for camera components;

For ZJ17 machine, the synchronization pulse adopts MCP and DCP, and the waste rejection signal is output to waste rejection valve Y31 to reject the waste cigarettes. For ZJ17E and other models, the shaft encoder pulse is used for synchronization;

The appearance detection control and detection functions are implemented by windows software. The parameter settings and adjustments are implemented on the HJY-2 / MLP, including but not limited to image processing settings, function activation or non-existence, detection parameter settings, auxiliary learning functions, and Expansion functions may be added in the future, while a separate touch display operation mode is reserved. The system architecture is shown in the following figure:
3. Methods and steps

3.1. Hardware design and transformation

A. Mechanical content:
   Reconstruction of the test wheel assembly of the rolling unit:

The detection wheel assembly is installed behind the leak detection, and the cigarette branch tube is transferred out of the cap, and mainly detects point defects (like puncture) and area defects (like folding).

Reconstruction of waste rejection wheel assembly of the splicing unit:

Figure 2. Rolling unit modification
The detection wheel assembly is integrated with the FLO and installed at the location where the FLO detects. It mainly detects point defects (pricks, etc.) and area defects (folds, etc.). At the same time, it includes the integration of traditional mouth detection, loose head detection, and OTIS. The mouth detection uses a photoelectric switch, and the signal is directly connected to the converter. The loose head detection uses an infrared sensor, which is connected to the adapter through the detection scanning circuit. The connector is connected to the reject wheel assembly.

3.2. Software design
The system software is compiled with Windows-based VC ++ program. The block diagram is as follows:

![Figure 4. 3-parts relationship](image)

- CVIS: Human-computer interaction system program, used for parameter setting, data statistics, calibration setting and other operations
- CIPS: Image processing algorithm program, used to process the image of the surface of cigarettes, to achieve the system detection function;
- CSYN: Synchronous timing, used for synchronous triggering of camera shooting and defect removal.

The software structure diagram is shown below:

![Figure 5. Software Deployment](image)

- The software of the cigarette stick appearance inspection system of the rolling unit is divided into six modules, which are permission settings, calibration settings, defect sampling, various parameter settings, quality reports, and information reading.

4. Application effect
Test model: CDTM cigarette machine ZJ17D fine support model is used as test model to carry out online application effect test.
Test specifications: 97mm fine cigarette, filter length 30mm, diameter 5.4mm.
Test process and method:
1) Man-made appearance defects, check whether the removed cigarettes contain defects, the index requirements: $\geq 98\%$
2) Manually check the cigarettes flowing into the next process to see if there are missing cigarettes. The index requirement is $\leq 2\%$.
3) Test results: SE Part, accuracy rate: 100%, missed rejection rate 0.2%; MAX part: 100%, missed rejection rate 1.8%.

5. Conclusion
A visual sensor is used as the core to design an online cigarette detection system for the cigarette splicing unit. This device can continuously detect the appearance of cigarette products at the full speed of the cigarette splicer. Among them, the rejection accuracy is 100% The missed rejection rate is 1.8%.

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