Design of Intelligent Control System for Cigarettes

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Abstract. In order to solve a series of cigarette quality problems, such as removing not completely of cigarette machine defected, wrong brand of temporarily storing cigarette, quality tracking of problem cigarettes. Based on internet of things and data acquisition, an intelligent cigarette control system is designed. Based on the technology of RFID and communication with the data acquisition control system, the target of a comprehension cigarette quality control has come true. And has the function of brand comparison, the unqualified cigarette marked, the condition monitoring and so on. The machine of PROTUS 70 was used for testing, the results show that: The system can realize a series of functions, such as the marking of unqualified cigarettes, comparison of cigarette brands, comprehension status monitoring of temporary cigarette and quality tracing.

1. Introduction
With the continuous advancement of “Industry 4.0” and “Smart Factory”, intelligent quality control of cigarette quality is particularly important for cigarette factories. Mengjin Gao [1] proposed a method for the damage region capture technology of an automatic cigarette sorting machine. Linjie Zheng [2] proposed a method for online inspection of tax paste quality based on CNN technology. Yu liang Li [3] proposed the design of the filter rod error prevention monitoring system. Changyong Yang [4] proposed the development and application of the whole process information management system of cigarette accessories based on the concept of error prevention. Miaozhen Guo [5] designed the Logistics elevated library system in Hangzhou Cigarette Factory. The above methods intelligently control the quality of cigarette in the fields of cigarette packaging, raw and auxiliary materials supply, and filter rod error prevention. However, there is still little research on the intelligent control of cigarettes. Study a set of intelligent control system for cigarettes, realize the mark of unqualified cigarettes, monitor the whole process of temporary storage of cigarettes, and prevent brand errors, which will help improve the quality of our products and promote the "high quality development" of enterprises. In response to such problems, RFID-based Internet of Things technology [6] has been widely used.

When the cigarette machine and the packaging machine are in normal operation, since their speed is matched, the cigarette can be directly packed into the packaging machine for packaging. However, under special circumstances, the quality of cigarettes is abnormal. At this time, the cigarettes must be placed on the pallet and then wait for inspection and quality confirmation. When the packaging machine is shut down, in order to improve the efficiency, the cigarettes are also stored in the pallet, and then unloaded into the packaging channel through the unloading machine when needed. In this process, there are many possibilities for human intervention, hidden dangers of quality, and hidden dangers of wrong brands. Therefore, it is necessary to design a set of intelligent control system for cigarettes.
2. Problem Analysis

In normal production, the cigarettes produced by the cigarette machine are delivered directly to the packaging machine through the conveying channel. However, when the packaging machine is stopped or decelerated, the cigarettes produced by the cigarette machine will be temporarily loaded by the loading machine. When the packaging machine speeds up or the cigarette machine is stopped, and the cigarette is in short supply, the cigarette is sent to the conveying channel through the unloader. The purpose of the loading machine and the unloading machine is to balance the production pace, prevent the waste of cigarettes caused by too much upstream production, and avoid the production downtime caused by downstream shutdown. However, in actual production, the control of temporary storage of cigarettes is more complicated, mainly reflected in the following aspects: (1) When one of the different units has less cigarette production and a large demand, and another cigarette machine produces more cigarettes and less demand, in order to ensure smooth and uninterrupted production, the machine staff will borrow cigarettes from each other, if the operator is not operating properly, it is easy to cause wrong brands; (2) There is a risk in the use of cigarette empty pallets. If pallets are borrowed between different machines, it is easy to cause Cigarette flavor mixed; (3) when the cigarette machine is in production, if the worker finds that the cigarette may have quality problems, he will first unload the cigarettes through the loading machine, and then let the cigarettes passed after the inspection is correct. These cigarettes are placed on the ground. If it is mistakenly put on the unloading machine, there will be a quality accident; (4) The cigarettes temporarily stored when the output of the cigarette machine is relatively high may cause water loss after storage for a period of time, thus affecting the quality level of the cigarettes, If it continues to be reused, there will be a large risk of quality accident.

3. Design of Intelligent Control System for Cigarettes Based on Internet of Things

According to the above analysis results, a design concept of “temporary cigarette library” was proposed, and the intelligent control system was designed to control the “inbound” and “outbound” of all temporary cigarettes.

3.1. System Overall Architecture Design

Figure 1 shows that the architecture design of the whole system consists of two parts: the upper management system and the bottom electronic control execution system. Literature [7] discusses the application of big data technology in condition monitoring, Literature [8] discusses the application of RFID-based logistics management system, Literature [9] discusses the research of big data analysis in condition monitoring and fault handling of smart distribution networks, Applying big data analysis and internet of things technology to industrial production, it has been widely used in other industries. In this regard, the upper management system is divided into three parts: quality early warning subsystem, digital mining control system and database system. The bottom electronic control system is composed of RFID control subsystem, workshop PLC control system and loading and unloading machine subsystem. The RFID control subsystem is mainly responsible for writing the cigarette brand, production time, machine number and other information into the electronic label when the cigarette is "loaded into the warehouse". When the cigarette is “unloaded out of the warehouse”, the RFID electronic label is read, The cigarette brand information inside is compared with the current machine brand information collected by the digital collection; The workshop PLC control system mainly interacts with the RFID subsystem, releases the cigarettes that have passed the brand verification, and locks the cigarettes that failed the verification, and prompts the alarm. On the one hand, the digital acquisition control subsystem is mainly responsible for taking away the electronic tag information collected by the RFID control subsystem and storing it in the database, and all the loaded cigarettes will enter a virtual “temporary cigarette library”. On the other hand, the production status of the cigarette machine is comprehensively collected (including brand, work order, suction resistance, circumference, etc.). When the quality index of the cigarette continues to be abnormal, the loading signal is automatically sent to the loading machine. The quality early warning subsystem mainly monitors the status of the cigarettes in the “temporary cigarette library” in real time, Record when the cigarettes are in stock and when they are out of the library, and warns the cigarettes that have
not been out of the warehouse for a long time; The database system stores and records the cigarette information in the “temporary cigarette library” in real time; the loading and unloading machine subsystem is mainly responsible for the “input-loading and output-unloading” of cigarettes.

3.2. Subsystem Function Block Design

The upper management system is composed of the database main service and the data acquisition and control main service on the hardware architecture, Figure 2 show that Upper management system and MES exchange information, In terms of software architecture, three major functional blocks are designed and implemented: 1. Realize information interaction with MES and RFID subsystems; 2. Established a virtual “temporary cigarette library” to replace the management of the “stereo library”. 3. Send the interlock signal to the workshop PLC controller to realize the control function of the loading machine and the unloading machine.

Figure 1. Schematic Diagram of the Intelligent Control System for Cigarettes

Figure 2. Interaction between Upper Management System and MES
The bottom electronic control execution system consists of an RFID control subsystem, a workshop PLC system, and a loading and unloading machine system. In the hardware selection as shown in Figure 3 below, the RFID control subsystem uses the Turck model TI-BL20-E-EN-2, industrial Ethernet connection, response time is less than 0.1s, the entire read and write process can be in 2s. Completed inside, With the current highest speed cigarette machine 20,000 per minute and 4000 pallets of cigarettes, 5 pallets per minute, Turck's RFID electronic tag reader fully meets the production requirements; The PLC controller of the workshop adopts Siemens 400PLC 6ES7416-3ES06-0AB0, which supports PROFINET connection, which can expand the space and facilitate the later upgrade; In the software function, after testing, the following three functions are realized: 1. Receiving the interlock signal sent by the control system and controlling the loading and unloading machine. 2. When the cigarette is “loaded into the warehouse”, the digital mining control system sends the status information of the current cigarette to the RFID control system. The information is written by the RFID control software into the cigarette RFID chip. 3. All RFID read/write records, loading information, and unloading information are sent by the RFID subsystem to the digital acquisition control system, which is stored in the database system for easy to traceability and query.

![Figure 3. Bottom Control Execution System](image)

**4. Application Effects**

4.1. Test Design

Test materials, instruments and equipment: The equipment selected is the G line PROTOS 70 cigarette machine, the complexity loader and unloader, the workshop PLC (Siemens 400); the material is the long mouth cigarette (length 120mm), long mouth Cigarette pallet (rated 4000 / grid), Turck electronic label (TW-R20-B128/128Byte); the instrument is a handheld wireless electronic tag reader (Symbol).

Testing method: 1. the cigarette machine operates normally at a speed of 7000 sticks per minute, simulating the continuous abnormality of the short index of cigarettes. According to the design function, whether the logarithmic data has been collected, whether the panel loading signal is given to the workshop PLC, and whether the pallet loading machine is triggered to trigger the cigarette Tests based on indicators such as “loading and storage”; 2. Simulate the shutdown of the packaging machine under normal production conditions and test whether the loading machine will "load pallets into the warehouse" of cigarettes; 3. Use a wireless handheld electronic tag reader to read data on cigarettes that are normally loaded and cigarettes that are abnormally loaded. Check whether the cigarette brand, production time, and production machine are successfully written in the electronic tag Platform,
quality status, etc. (Before the electronic label experiment, make sure there is no information in it); 4. Put the cigarettes that are "loaded into warehouse" with abnormal quality and other machine of cigarettes of different brands (the brand is new version) on the composite unloader and test whether they have a series of functions such as locking the cigarette pallet and flashing the alarm; 5. After the test of the electronic control system is completed, verify that the "warning subsystem" in the upper management system has real-time query of RFID information, traceability, inbound and outbound record query, unqualified cigarette lock library record query, and unqualified cigarette unlock record query. Manually unlock unqualified cigarettes and other functions.

4.2. Result Analysis
The test was performed in accordance with the test methods and steps. The device was abnormal during the test. The test results showed that: 1. Table 1 showed that the RFID subsystem can write and read information about the cigarette brand, production time, machine, and quality status on the electronic tag. The quality status written by the RFID with abnormal quality cigarettes is "waiting for inspection". Under normal circumstances, the quality status of the "loaded into warehouse" cigarettes is "qualified".

| Pallet number | Pallet number | Item number | Rfid data | Label ID | Quality mark |
|---------------|---------------|-------------|-----------|----------|--------------|
| 1             | 17315         | LYB10       | LYB10F032019083093001 | 780374195 | qualified    |
| 2             | 17316         | LYA10       | LYA10G062019083092914 | 780435821 | qualified    |
| 3             | 17340         | LRB20       | LRB20E022019083093139 | 122891704 | qualified    |
| 4             | 17359         | LRB10       | LBB10E032019083091525 | 780573231 | qualified    |

2. When a new version of the cigarette is put into the test cigarette machine unit (The brand tested is long-mouth). The unloader locks the pallet and flashes the alarm. At the same time, the Interactive interface displays "Brand verification failed"; and puts the quality status as "to be inspected" into the unloader. The unloader locks the pallet and flashes the alarm at the same time. The Interactive interface displays "Quality status is abnormal". Four accuracy tests performed the test results are shown in Table 2 below.

| Number of experiments | Wrong number of pallets | Number of pallets to be inspected | Number of alarms | Rejection rate |
|-----------------------|--------------------------|-----------------------------------|------------------|---------------|
| 1                     | 100                      | 100                               | 200              | 100%          |
| 2                     | 100                      | 100                               | 200              | 100%          |
| 3                     | 100                      | 100                               | 200              | 100%          |
| 4                     | 100                      | 100                               | 200              | 100%          |

3. The upper-level "warning subsystem" can achieve real-time query, traceability, and a series of query functions such as inbound and outbound record query, manual unqualified cigarette unlocking, manual unlocking record query.

After testing the entire cigarette intelligent management and control system, through the construction of a virtual "Temporary cigarette library", the "inbound" and "outbound" management of temporarily stored cigarettes was achieved, and quality control, error prevention management were achieved.
5. Conclusion
The intelligent management and control system mentioned in this article integrates the Internet of Things technology, condition monitoring, and big data technology into the management process of temporarily stored cigarettes. By constructing an "intelligent management system for cigarettes", Creatively proposed the concepts of virtual " temporary cigarette library " and " product quality mark ", Realized intelligent " in-warehouse " and " out-warehouse " management of temporarily stored cigarettes, Realized brand error prevention management, product defect rate management, and quality traceability management of temporarily stored cigarettes, effectively improving product quality. Laid the research foundation for the company to build a "smart factory". The next step will be to use big data technology and condition monitoring to analyze and analyze the temporarily stored cigarette data and analyze the reasons for elimination. Construct a mathematical model to guide the cigarette machine to optimize production, reduce the false rejection rate, and improve the effective operation rate of the equipment.

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