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Research on the Early Warning System of Cold Chain Cargo Based on OCR Technology

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Abstract

This paper designs a set of semi-automatic intelligent cold chain cargo proximity warning system with wireless data transmission, lightweight Optical Character Recognition identification algorithm framework and electronic label automatic warning as the core technology for cold chain dairy Fast Moving Consumer Goods contractors. In terms of hardware, Pulse Frequency Modulation modulation and demodulation are used as the main technology to realize wireless transmission and reception of equipment, and digital electronic tags are added to warn the same batch of upcoming goods. In terms of software, based on Chinese-ocr algorithm, image preprocessing and recognition methods are studied, and an early warning system is designed. So as to realize semi-automatic early warning of cold chain logistics goods.

Keywords

Optical Character Recognition, Wireless Signal Transmission, Image Processing, Cold Chain Logistics Managemen, Automatic Early Warning System

1. Background Introduction

The extraction of cargo information is a crucial part of the logistics supervision procedure. Whether the cargo information can be identified accurately and quickly is the technical key of the entire logistics monitoring system. At present, the technical research on cargo information extraction is divided into the following directions: 1) Using RFID (Radio Frequency Identification) technology, by loading special identification tags, relying on wireless radio frequency technology and using non-contact induction and non-contact dual communication methods, Realize the purpose of automatic identification and data transmission of cargo information; 2) Use the Internet of Things technology to realize the

timely update and tracking of cargo information by building a containerized cargo information intelligent perception system based on the Internet of Things technology; 3) Use OCR (optical Character recognition) technology to realize the collection of information on the surface of the material container; 4) Use machine vision technology to realize the information detection technology of the cargo label.

In industrial applications, most of the current logistics management uses wired data transmission, so that various data control functions can be realized. With the development and collision of different technologies, the use of wired networks such as LAN transmission has indeed provided faster and more convenient hardware support for information transmission in people's daily lives, thus promoting the development of various fields of information technology. However, with the generation and promotion of a new generation of technologies, such as the application of radio frequency, integrated circuit and other technologies in production and life, the manufacturing cost of equipment represented by wireless communication functions is gradually decreasing, and the speed of information transmission of this technology is also gradually increasing. There is a trend of gradually replacing wired transmission equipment. At the same time, the shortcomings of wired equipment, such as: the wiring is cumbersome, the detection of faulty lines is relatively difficult, the update of the equipment requires more capital investment, and cannot be moved at will, and there may be potential safety hazards. Today, when big data technology is becoming more and more mature, people turn their research and development attention to the communication method with wireless as the core technology, especially for equipment demanders with strong mobility requirements, or manufacturers working in dense and dangerous areas. Therefore, a number of typical wireless application design cases have emerged [1], such as: wireless smart home, wireless data acquisition, wireless device management and so on.

In view of the short shelf life of cold chain dairy products, imperfect information supervision standards, large supervision costs and low level of supervision automation in the dealer industry, in order to meet the following needs of municipal dealers:

1) Under limited funds, use existing resources to invest in equipment and reduce the environmental transformation of cold storage.

2) Looking forward to solving intelligent identification and early warning, replacing human identification and early warning

3) Reduce the vulnerabilities of inaccurate technical identification and optimize the identification algorithm.

4) In the special environment of the cold storage, reduce the laying of lines and reduce the possible leakage of electricity, etc.

4) Looking forward to the realization of non-contact management of goods to ensure product hygiene and safety.

Based on the subject knowledge of intelligent manufacturing, this paper pro-

poses a design idea of a semi-automatic intelligent cold chain cargo imminent early warning system with wireless data transmission, lightweight OCR recognition algorithm framework and electronic label automatic early warning as the core technology. Information semi-automatic supervision and early warning are carried out by scanning the digital codes on the outer packaging of the goods. The physical map of the outer packaging of the goods is shown in Figure 1.

The cold chain early warning system equipment mainly includes code entry detector, wireless transmission equipment, information storage server, early warning client and so on. The system is designed to use the existing cargo conveyor belt for the flow of goods, and use the coding and input detection equipment to perform real-time coding and real-time acquisition and input in the delivery of goods. For signal transmission equipment, because the cold storage environment is humid and the temperature is low, there is corrosion and loss of wired transmission materials. In order to reduce the equipment maintenance cost of the enterprise, this system has designed a wireless transmission method for special environments, and intends to use infrared transmission. Load signal for signaling. Display and count all the cold chain cargo code information stored at low temperature on the cargo detection client, and store the batch code in the information storage device, and update the company's internal real-time through the computer LAN, in the company's cargo supervision center Real-time display on the cargo management client through the bluetooth module, and send the reading data to the digital electronic label through the data transmission of the Bluetooth module, and use the electronic label to display the label display and the built-in buzzer for real-time early warning of the cargo. When arranging the goods out of the warehouse, the goods are arranged in batches according to the priority of the temporary time limit, so as to realize the function of positioning the batches of goods. It is planned to design an algorithm that can automatically

Figure 1. Cargo box outer packaging diagram.

detect the code of imminent goods, display the imminent goods on the cargo management client, carry out early warning of the goods by setting the electronic label of the warehouse area, and feed back the corresponding data to each warehouse responsible for Persons, according to the warehouse arrangement grouping for timely processing of goods. The flow chart is shown in Figure 2.

2. Early Warning System Hardware Design

2.1. Hardware Circuit Design

For each cold storage environment of M non-staple food company, there are redundant lines. In view of the high maintenance cost of monitoring equipment every year, the system design intends to use infrared analog data transmission. The composition of the circuit is divided into a transmitting part and a receiving part.

The design part of the transmitting end includes: driving circuit design, signal amplifier design, PFM modulation module design, and light-emitting diode signal transmitting part [2].

The receiving end design part includes: diode receiving part, preamplifier design, PFM demodulation module design and power amplifier design.

The transmitter uses the PFM modulation method to modulate the transmitted information and amplify the signal [3]. After the light source drive processing, the process of changing from an electrical signal to an optical signal is completed. The gallium arsenide infrared light-emitting diode VSLY3943 (wavelength 940 nm, rising edge 5 ns) emits Audio, video, and infrared signals encoded with cargo information. The TEMD1020 infrared receiving head (carrier frequency 20 MHz,

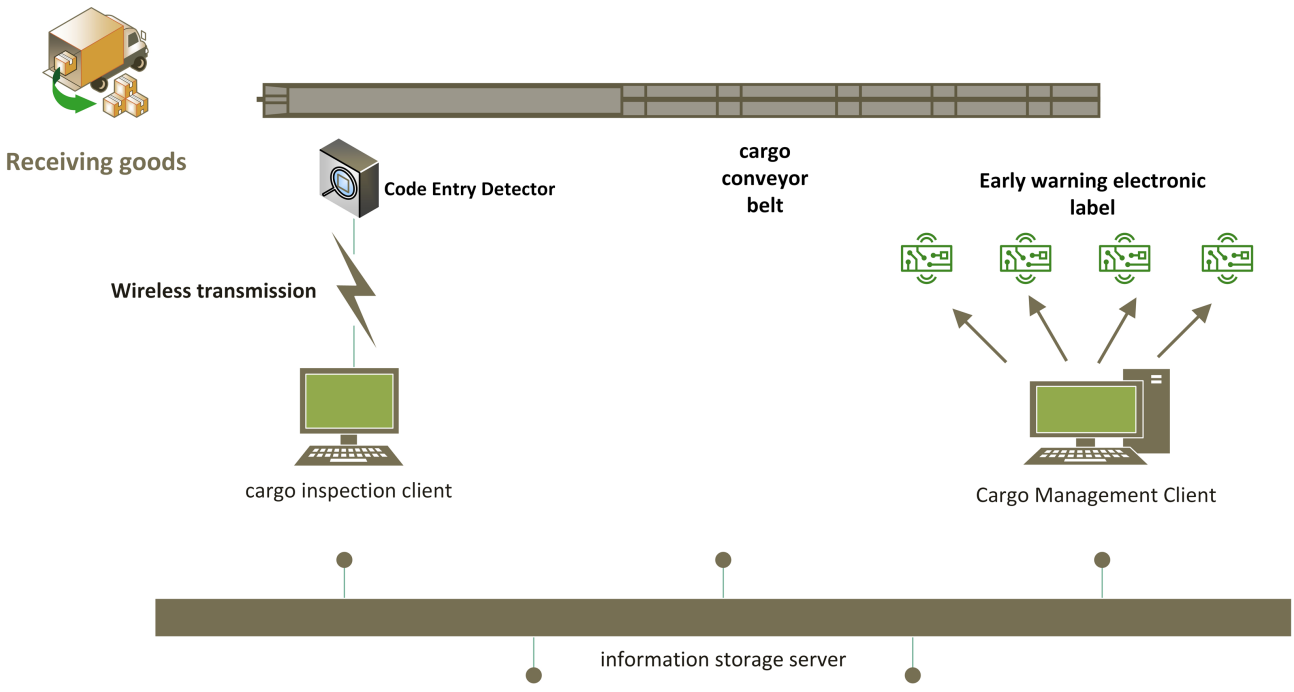

Figure 2. Early warning system topology.

rising edge 4 ns) completes the process of receiving, amplifying, and detecting infrared signals, and finally demodulates the audio and video encoded signals and transmits them to the transmitter. After the circuit decoding process, the demodulated image is executed processing.

Since the modulated carrier has to occupy a certain frequency bandwidth, if the interval between the carrier frequencies is smaller than the bandwidth of the signal, interference will occur between different signals. Since the communication capacity has a positive relationship with the carrier frequency, and the communication capacity has an inverse relationship with the wavelength, using infrared waves as the carrier, its potential communication capacity is in line with the system design requirements [4]. The schematic diagram of infrared image communication is shown in Figure 3.

2.2. Voltage Amplifier Circuit Design

1) Voltage amplifier circuit

The main function of the designed circuit is to enhance the amplitude of the voltage. The circuit has output voltage, power and current on the load at the same time, and is classified in terms of energy control, which is essentially an energy conversion circuit.

2) The main way to improve efficiency

Efficiency η is the ratio of the audio and video signal power (*i.e.* output power P_0 obtained by the load to the encoded audio and video signal of the cargo information and the DC power (P_V) supplied by the power supply.

$$\eta = P_0 / P_V \tag{1}$$

$$P_V = P_0 + P_T \tag{2}$$

It can be seen that if you want to improve the circuit conversion efficiency, you need to optimize the following two aspects:

a) Increase the conversion efficiency of the power supplied by the power supply.

b) Reduce quiescent current to reduce tube consumption.

The quiescent current is the main factor causing energy consumption. Therefore, if the quiescent operating point Q is shifted downward, the power output

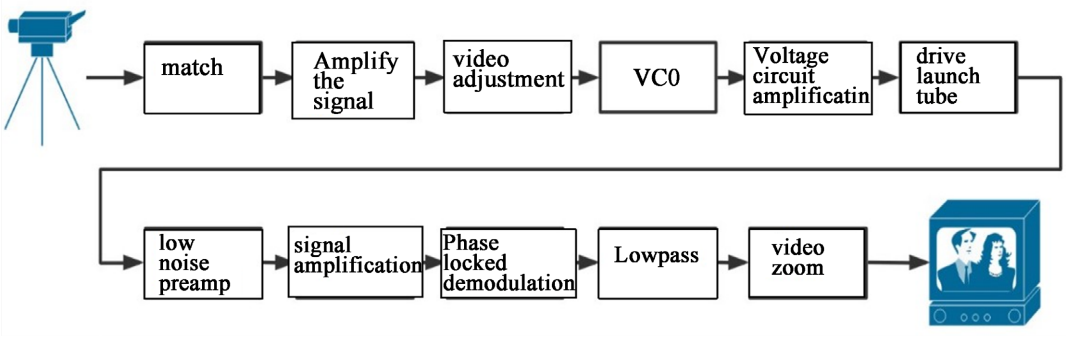

Figure 3. Schematic diagram of infrared image communication.

by the power supply is equal to zero when the signal is 0. When the input signal increases, the power supplied by the power supply also increases. At this time, the power supply power and tube consumption change with the output power, which also changes the low efficiency of Class A amplification [5]. The operational amplifier used in this paper is the voltage amplification method of the analog amplifier, and the front-end signal voltage amplification circuit is designed as shown in Figure 4.

According to the design ideas of the main steps of the system discussed above, the final design of the infrared data wireless transmission circuit board is shown in Figure 5.

2.3. Early Warning Electronic Label Settings

In this design, by adding digital electronic labels, the early warning of the batches of dairy products on the expiry date is carried out. It is necessary to stack the cold chain dairy products in different batches according to the production date, put them on different shelves, and then install electronic labels in front of

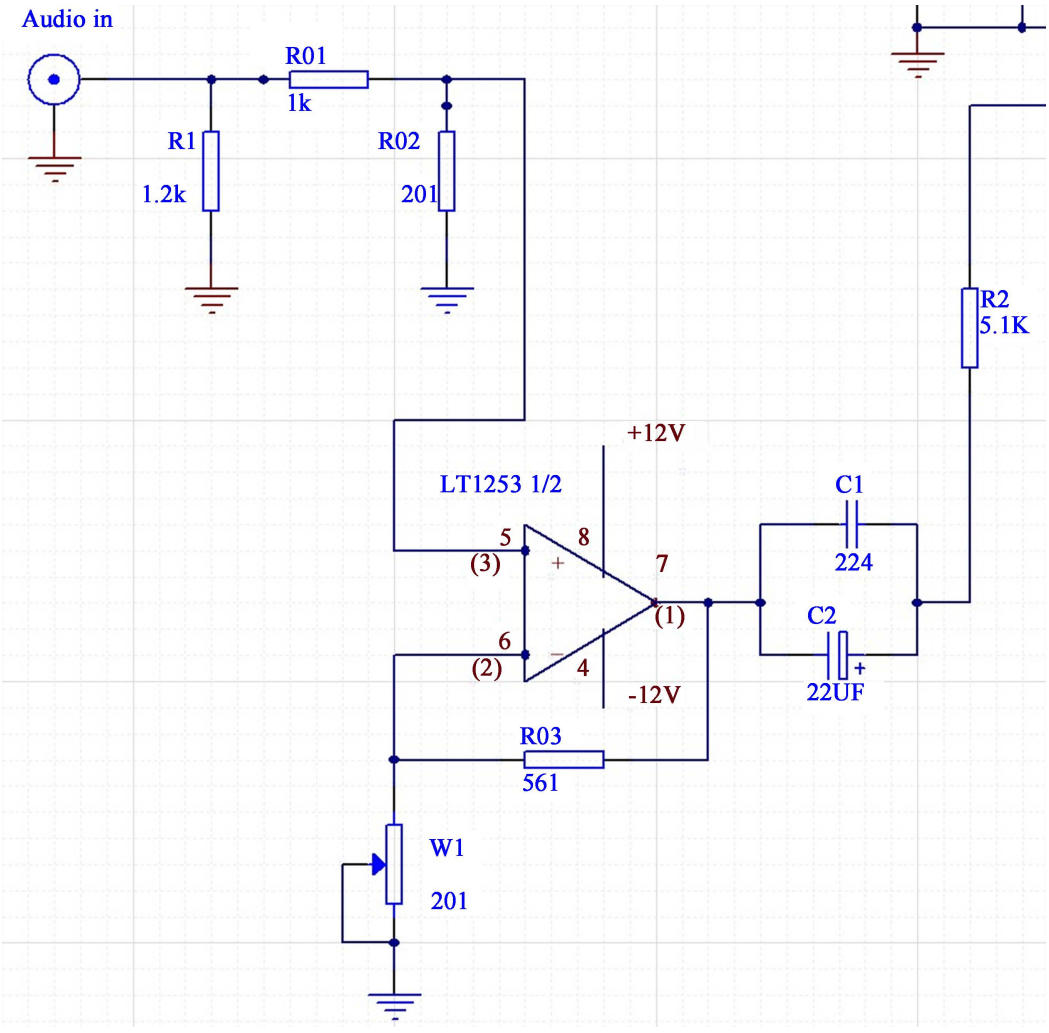

Figure 4. Front-end signal amplifier circuit.

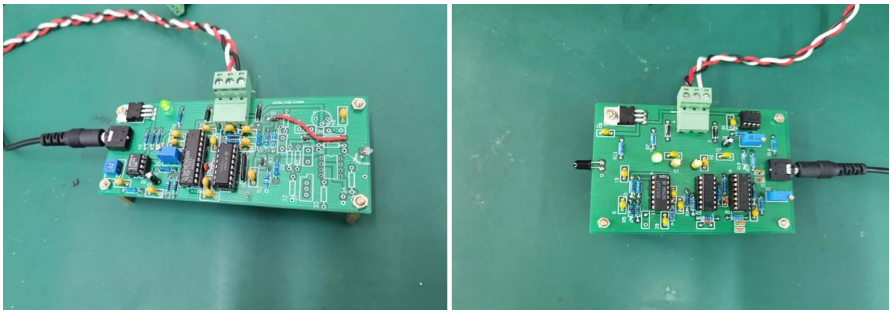

Figure 5. Physical map of transmitter and receiver.

Figure 6. Electronic label physical map.

the shelves. The time limit identification adopts the method of countdown to the temporary period, which is convenient for the cargo management personnel to carry out the inventory of the goods. The physical map of the electronic label is shown in Figure 6.

The electronic label stores the collected information of the goods, transmits the identification information of different batches to the electronic label by using the Bluetooth module data transmission method, and generates a barcode. The dispatcher can scan the barcode to obtain the same batch of goods. The number of goods on the production date can be prioritized by batches according to the temporary time limit when carrying out shipment statistics. When the countdown time limit of the goods is shortened to 7 days, the electronic label will give an alarm and early warning through the built-in buzzer, and then display an early warning mark on the display screen, which is convenient for the positioning of the dispatchers, and completes the cold chain imminent period. The closed-loop design of the cargo early warning system fully excavates and utilizes the collected cargo information, and makes eye-catching reminders on the shelves on schedule. In fact, the early warning effect map is shown in Figure 7.

3. Early Warning System Software Design

Aiming at the demand analysis of the software part of the cold chain early warning system, first of all, based on the current cold chain cargo supervision pain points and the demand for early warning system design, for the design of

Figure 7. Field warning renderings.

the software system of the cold chain detection system, the video materials collected by the hardware are first imported. The system identification module performs video preprocessing, firstly uses the OpenCV software package to obtain video key frames, and performs the next frame preprocessing on the key frames: using binarization processing and binary morphological transformation to process key image information [6], and then using image filtering technology to The target image is subjected to noise filtering [7], and finally the image cutting step is performed to locate and extract key information, so as to transition to image analysis, import the designed chineseocr_lite framework for character recognition, and store the extracted recognition results [8]. Then, the pre-warning module is processed, the result of identification and storage is extracted, and it is judged whether the set pre-warning time has been reached, and finally the code of the imminent goods is displayed on the QT interface, and the system's early-warning is finally completed. The design flow chart of the cold chain early warning system is shown in **Figure 8**.

The chineseocr_lite framework belongs to the new open source OCR framework algorithm. Its main feature is an ultra-lightweight OCR framework, which supports vertical text typesetting recognition and ncnn reasoning. For text detection in any direction, the text direction of the line is automatically determined during recognition. The ultra-lightweight framework has low requirements for enterprise hardware memory, but supports the recognition of vertical text. For the video capture target pictures of industrial pipelines, the picture offset caused by the accidental shipment is more friendly, and it is suitable for irregularities in complex scenes. Target pictures, information collection. Its algorithm frame diagram is shown in **Figure 9**.

3.1. Character Recognition Module Design

The image information is obtained for the video frame obtained by OpenCV [9],

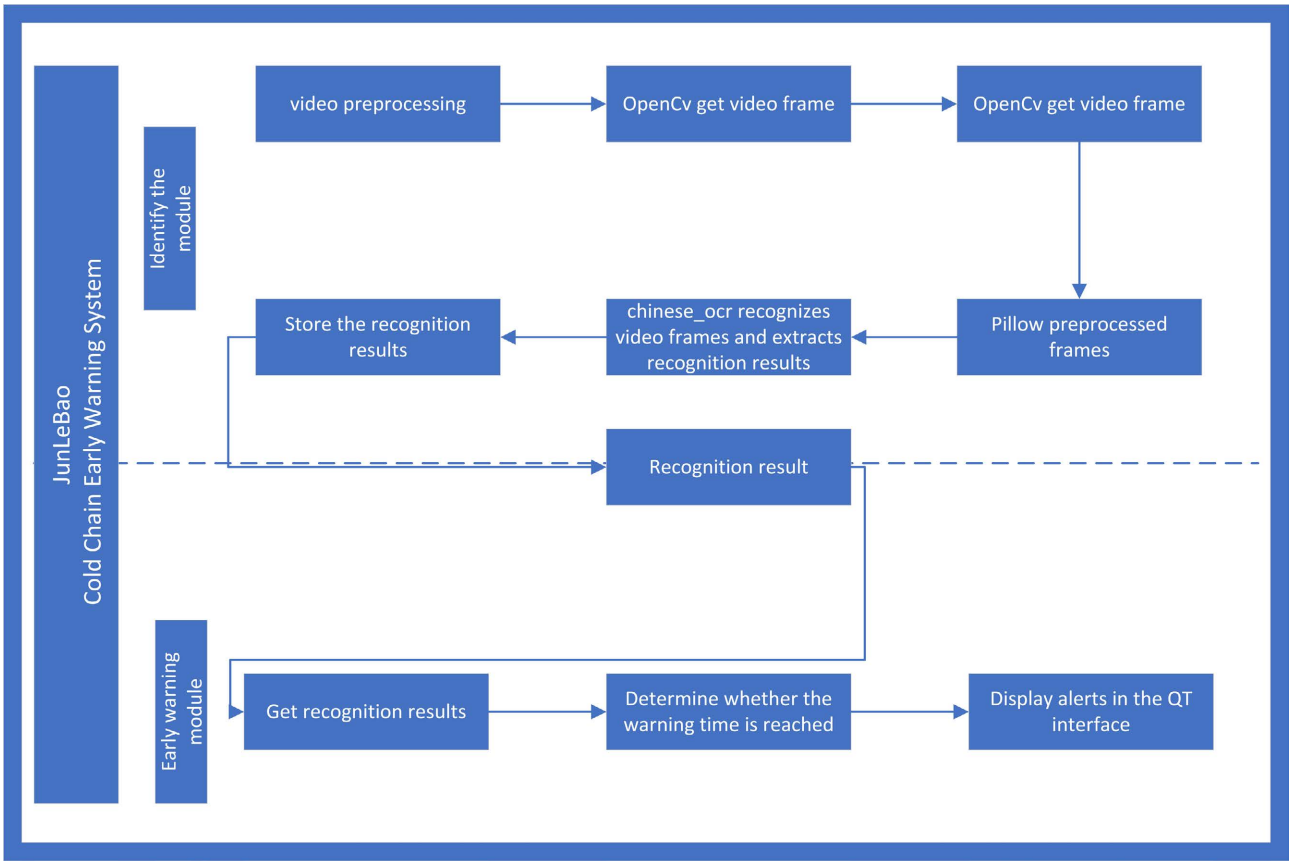

Figure 8. Cold chain early warning system design flow chart.

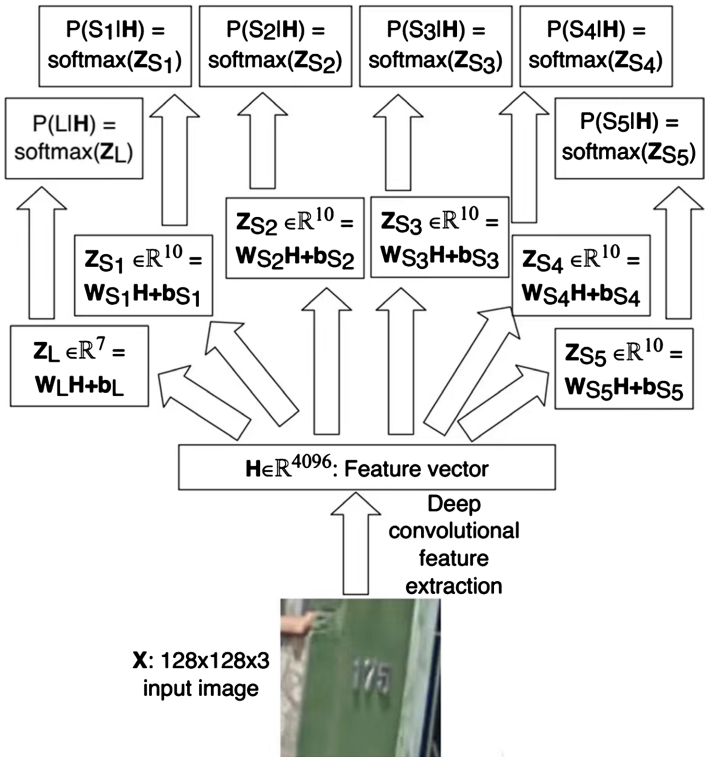

Figure 9. Algorithmic framework.

and the cargo information in the preprocessed target image is cut into blocks and identified. Because each product has a different code, each product has its own "ID", which can distinguish and remark dairy products from different batches, models, and origins. The information contained in the code of each product includes: Origin information, production time, and the exclusive four-digit serial number of each cargo. Such compilation notes also provide convenience for the management of freight storage companies. The information of specific cargoes is divided into pieces, as shown in Figure 10.

Using the OCR algorithm for character recognition not only requires the algorithm to accurately identify each number, but also needs to extract the production time [10], so that the subsequent early warning module can be used for time comparison. The specifications and coding rules of each cargo code are clearly defined by the enterprise, so it is only necessary to extract the characters by digit. For specific key identification algorithms, see Appendix A (Key Code 2). Bring the code into the Python software and run it to identify the test results, as shown in Figure 11. Can accurately identify the cargo code. And extract the time information in the encoding.

3.2. Early Warning Module Design

The designed interface layout is designed to reduce the work intensity of workers and facilitate the training and management of cold chain supervision employees. When the dispatcher clicks the button to start early warning, the real-time identification and early warning can be started, and the identification information of the cargo code on the assembly line is stored in the computer

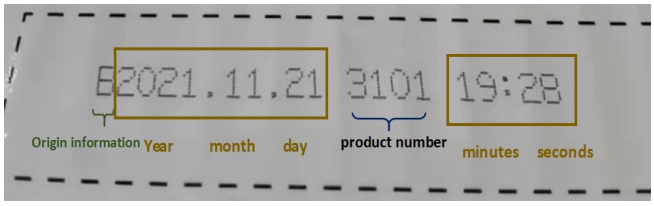

Figure 10. Cargo information segmentation.

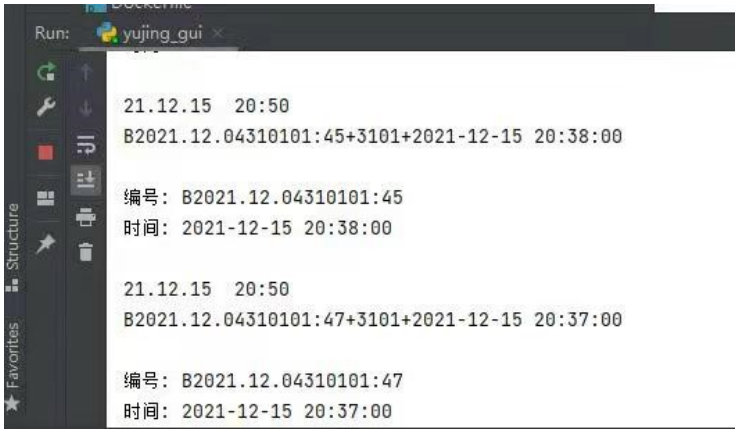

Figure 11. Cargo code identification test results.

Figure 12. Interface layout.

memory, and when the set time is reached, the stored cargo information code is displayed for early warning. Based on the design concept of practicality and simplicity, the designed interface layout is shown in Figure 12.

The code information of a single imminent cargo is preferentially popped up on the cargo management client, and then the same batch of data will be transmitted to the electronic label on the shelf at the back end of the processor via Bluetooth, and the electronic label will locate and alert the cargo personnel, which is convenient for the cargo inspection personnel to prioritize Delivery and rearranging of goods.

4. Summarize

In view of the cold chain dairy management process of the M non-staple food formula, this paper deeply explores the management bottlenecks such as the current regulatory pain points, low intelligence level, and low efficiency of cargo information supervision in the industry, using ECRS four of industrial engineering and management. The principle is to systematically optimize the current supervision process, and design an automatic early warning system for cold chain goods based on OCR technology. The design expectations of the non-staple food company. In the aspect of system supervision process optimization, realize intelligent supervision; In terms of system data transmission optimization, wireless transmission is realized; In the aspect of system information identification and optimization, the operation intelligence is realized.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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