Research on a New Automated Cash Register System

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Abstract. In order to comply with the requirements of modern society well, we develop an automated supermarket cash register system using modern computer information processing technology and machinery automation technology. The system consists of five sub-parts, including transmission subsystem, scanning subsystem, payment subsystem, packaging subsystem and security subsystem specifically. The hardware configuration and software of the system are not independent. There is an organic integration. The information is shared and the structure is connected between different modules. The automated cash register system enables a full and comprehensive scanning to merchandises, which means that no matter in what direction the bar code of the goods is, the system can complete the scanning accurately without repeating or missing. Besides, the system supports a variety of payment methods. What's more, it can pack goods automatically. With the advantages of celerity, accuracy, convenience and efficiency, it solves the problems of low efficiency and high rate of error of the manual cash register mode. It may even enable unattended supermarkets in the future. It meets the requirements of both businesses and consumers, improving the competitiveness of the mall to increase profits and creating an easy and convenient shopping environment for customers at the same time. All in all, the application of cash register automation system is an inevitable trend with social development.

Introduction

With the social development and economic prosperity, people's consumption activities is growing and their requirements are also becoming high. Good quality of goods is no longer the only factor to attract consumers, they are more concerned about whether they can receive fine and efficient service. At the same time, the major drawbacks of manual cash register which is now widely used in most shopping malls and supermarkets are becoming increasingly apparent. There are more and more shopping rush hours when consumers have to wait in line for checkout due to complexity and low efficiency of the traditional cash register and coupled with growing consumer population density. And as a result of it, we may sometimes encounter a mishandling checkout. The traditional way to the cash register has been difficult to adapt to the growing consumer groups and the increasingly fast pace of life. In order to ensure profits, improve competitiveness of malls and meet customers' needs, there is urgent need to introduce new ideas and technology as well as management techniques into supermarkets. [1][2]

Computer science is becoming more and more mature with the continuous improvement of science and technology, playing an increasingly important role. People has deeply realized its powerful functions and applied it to many areas in human activities. At the same time, at the guidelines of "Twelfth Five Year Plan", automation technology has also been recognized by more and more industries. [3]

This paper proposes an automated cash register system for shopping malls and supermarkets. The system relies on modern computer information processing technology and automation technology. It can complete all activities in the cash register, including the transfer of goods, code scanning, payment, and bags. The system is quick, convenient, practical and efficient. It can even achieve unattended supermarkets.

System Overview

As shown in Fig. 1, automated cash register system consists of consumer channel and commercial channel, including transmission subsystem, scanning subsystem, payment subsystem, packaging subsystem and security subsystem five parts. The parts are combined together through the computer system so as to achieve the integration of information structure. The entire device is installed in the outlet of the mall. The consumer channel includes payment subsystem and security subsystem; while the commodity channel consists of the other three subsystems, e.i. transmission subsystem, scanning subsystem and packaging subsystem. With the automated system, supermarkets can realize unmanned management, that is --no shopping guide and no cashier, creating a casual shopping environment for consumers while providing a fast and efficient sales service. The whole shopping process is random and consumers can select merchandises according to their needs and preferences instead of worrying there will be shopping guides at his side.
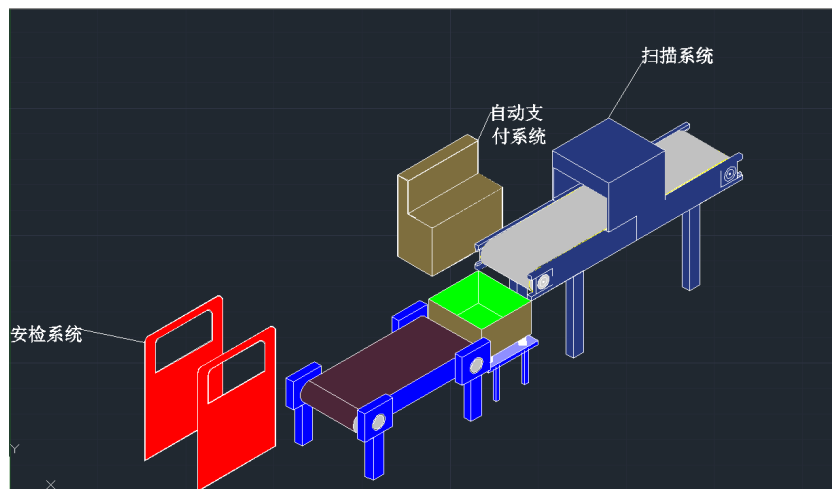

Figure 1.   The structure of the overall automated cash register system

Fig. 2 shows a flow chart of the entire system. Consumers should arrive at the mail exit after they choose what to buy. Then they are supposed to put the goods one by one on the conveyor entry quickly. In this way, the goods will enter the commercial channel through the transmission subsystem, and at the same time, consumers will enter the consumer channel. Goods in transit are sent to scanning subsystem first, where a comprehensive scanning is completed by Infrared ray scanners disposed in a the spherical cavity. When the scanning is done, the information of the commodities weight and volume is sent to the computer in package subsystem while the information of commodity price and amount to the computer connected with payment subsystem. When the information is conveyed to payment subsystem in the custom channel, customers complete payment and print a ticket after they check and confirm it is correct. At the same time, commodity enters into packaging subsystem and the subsystem automatically selects a package bag of an appropriate size according to the data collected. After the package is done, the goods will be conveyed out by the transmission subsystem. Then consumers extract their own goods with the specific bar code on ticket printed when paying. Finally customs need to pass the security subsystem to ensure there are no other goods that are not scanned carried with them. Till now, a transaction is completed.
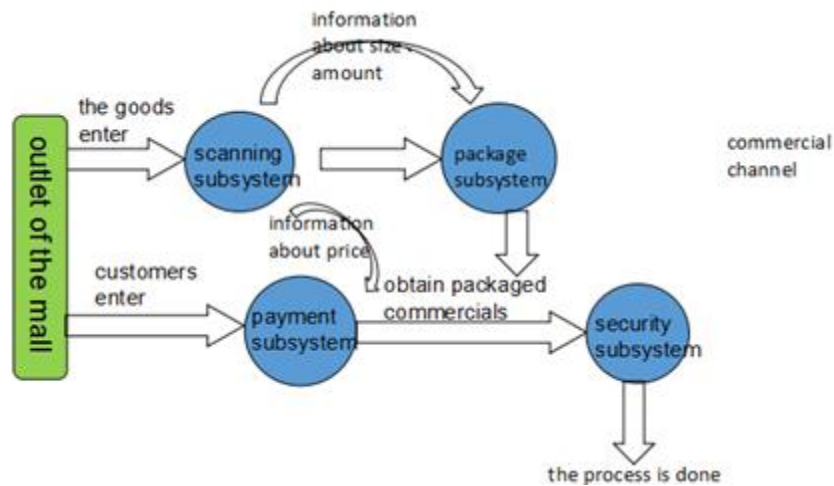
Figure 2.   Automated cash register system flowchart

Subsystem Introduction in Detail

Transmission Subsystem. As you can see in Fig. 3 this subsystem consists of three sections of conveyor belt. The belts are "a" word alignment and the upper surface of each section of conveyor belt maintains at the same level. The first segment is the incoming part. Consumers put goods on it, through which the goods reach the scan code area. The middle part which locates in the spherical scanning cavity is the scan code area whose speed is relatively lower. When the goods pass this segment, a full-automatic and comprehensive scan is completed. The last segment is for outgoing. goods are conveyed to packaging subsystem through this section of conveyor.
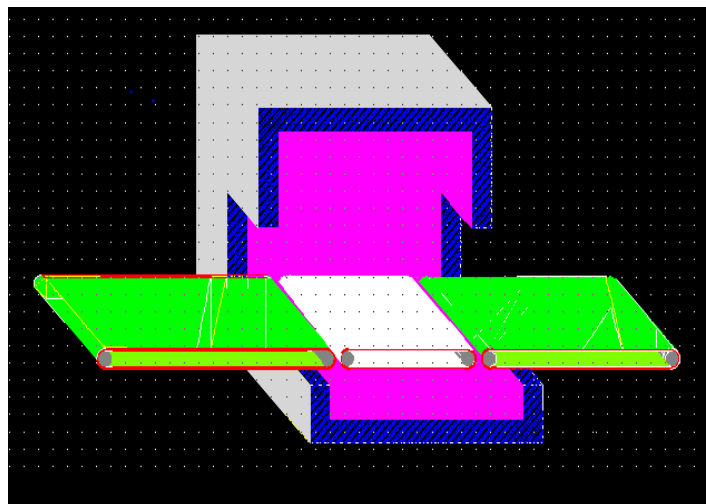

Figure 3.   The structural model of transmission subsystem

Adjustment of the Speed of the Conveyor. The speed of all the three sections of the conveyor belt is controlled by meshing gears (similar to the principle of speed adjustment of mountain bike). Adjust the size of the gear which is directly connected to the motor and get the right speed of each segment of belts. The incoming and outgoing parts of the conveyor require a higher speed to improve efficiency of overall system to reduce customers' waiting time. While in order to ensure scanning effect, it is better to have a lower speed in the middle part.

The belt material. In order to achieve a full range of scanning to merchandises and ensure that when the bar code is downward the goods can still be efficiently scanned, the middle segment of the conveyor is made of a transparent material-- PVC. In this way, the infrared emitted by scanners below the belt can penetrate the transparent material and arrive at the bar code. And the

transparency of PVC material is higher, the effect of scanning is better. As for other parts of the conveyor, we choose general belt to greatly reduce the cost of business. In order to reduce the friction produced by the contact between the PVC material and the speed regulating gear, substitute the belt with general material for the belt ends part of the scan code, the central part still using PVC material. In this way, the PVC belt only contacts with goods, ensuring the transparency of PVC belt and greatly increase of the belt's using life.

Scanning Subsystem. Scan code subsystem consists of three parts, trade entry system, automatic scanning system and commodity memory computing system. Among them, commercial automatic scanning system is the core part of the subsystem.

The main component of scanning subsystem is a spherical scanning chamber with the the middle transparent portion of the belt in transmission subsystem in it. A plurality of infrared scan code devices, each of which is connected to an information input port and PC for transmission of product information are equipped In the scanning chamber. The scan code devices can achieve a full range of scanning and demagnetizing to goods automatically with the help of he transparent belt [4]. For the same item, once one of the scanning devices work with it, completing the scanning and transmitting information successfully, the rest will automatically stop scanning it again. (Note: Input the commodity information into commodity warehouse through the commodity entry system, and then produce a corresponding bar code or two-dimensional code for each product as a sign [5]. According to the product information obtained from the scan code system, Commodity memory computing system find out the memory of goods in commodity warehouse, compute the consuming cost, afferent to payment system and work for customer access.

The Shape of the Cavity. In order to achieve a comprehensive scanning to the commodity and avoid "dead corner" during scanning process, we choose a spherical cavity with smooth and continuous surface (shown in Fig. 4) [6]. Besides, the ball also has a number of other advantages, such as its high degree of symmetry, the geometric property is conducive to a reasonable choice of location for the scanners. Another reason why we choose the shape of sphere is that the surface area and volume of it are relatively small, and as a result of this, we can effectively save space and cut costs by reducing the size of the equipment .
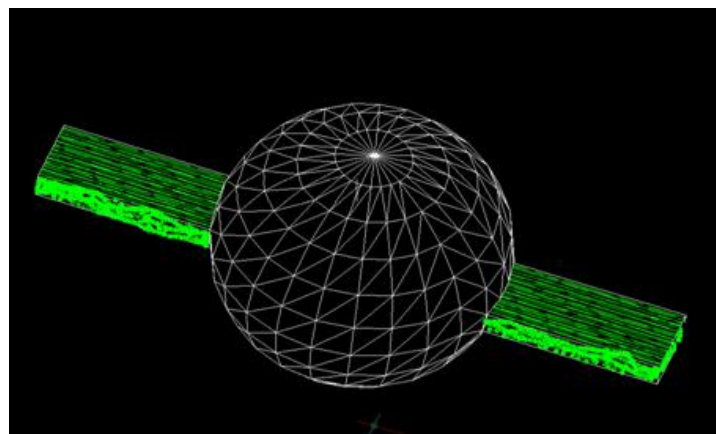

Figure 4.   Spherical scanning cavity

The Installation Location of Infrared Scanners. Our principles when designing the scanning subsystem are as follows: achieving the greatest possible scanning range with as few as possible scanners to ensure the full range of goods scanning. So there is urgent need for a rational arrangement of each scanner to ensure that the infrared emitted by all the scanners can cover the entire chamber [7]. Fig. 5 shows a detailed installation position of each scanner. Above the conveyor 3, the front 12, the rear 4, and both sides, 1 and 5, there are five scanners respectively in the corresponding position of the cavity wall. These scanners complete these few azimuth scan tasks. Besides, we install a plurality of laterally arranged infrared scanners 11 supported by bracket 7 between the upper and lower conveyor belt. These scanners here are near to the goods, which

results in a narrow scanning range. So we increase the number of scanners here to ensure the infrared ray can cover the whole transparent belt. In this way, even the bottom which is the most difficult to scan is exposed in the scanning interval entirely. [8] Regardless of the direction of product bar codes, the scanning subsystem can complete the scanning collect product information accurately.
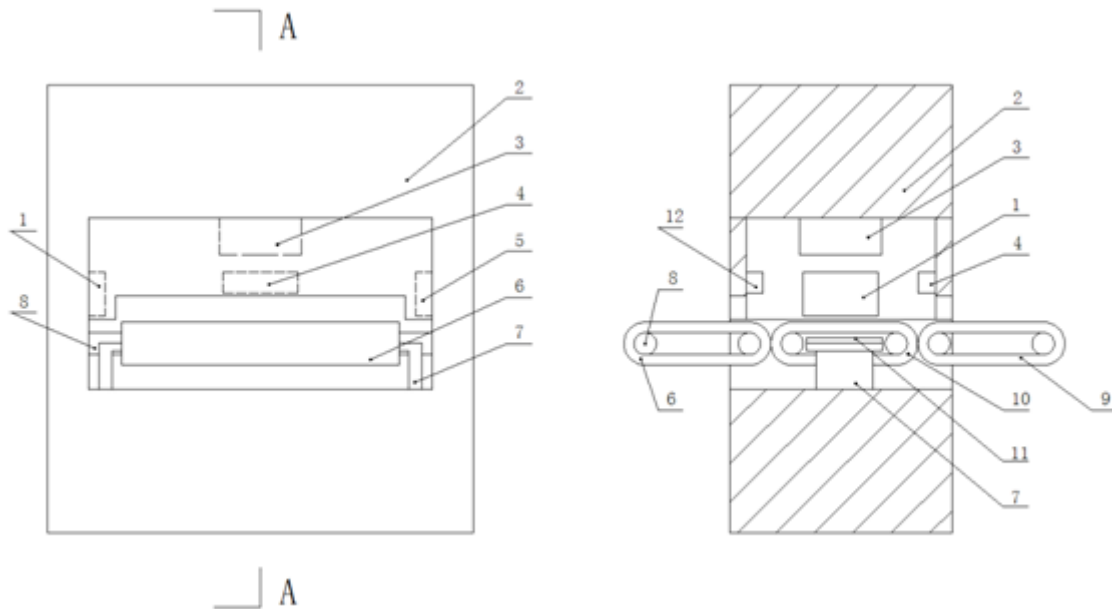

Figure 5.   Diagram of installation of scanners in the spherical cavity

Payment Subsystem. The payment subsystem provides a good interactive environment between customers and computers. Through the operating platform, consumers can view the product information, choose payment methods according to their willing, complete the payment and print a receipt. [9]

The technology in payment systems has been mature at present. It supports a variety of payment methods-- such as alipay, cash, bank cards and so on. [10] Consumers can also apply for consumer banking card for mall. After the scanning subsystem complete work and convey information of goods to the payment subsystem, consumers are supposed to pay for their commodities and print receipt once they confirm the information. The system generates a unique bar code as identification for each purchase of each consumer and it is printed on the receipt. Only with this unique bar code, consumers can obtain their goods in the storage tank. This technology can effectively prevent the chaos to take and avoid taking the wrong thing for customers. It helps maintain order and stability in malls and ensure the interests of both consumers and merchants. [11]

Security Subsystem. After they pay and obtain their goods, Consumers have to accept security checks before departure to ensure that customers can't steal things from the mall. It is done when customers pass through the security gate. If there is no merchandise that is not scanned carried with consumers, they can leave directly. But if unscanned items are checked, the security subsystem will trigger an alarm system and take an appropriate measure to close the security door. The technology in security systems tends to be mature now. And we put it into use directly. This system is put at the outlet of the mall to prevent unscanned items being carried, which ensures the interests of the business greatly.

Packaging Subsystem. We invent a vibrating automatic packaging system. According to information conveyed through scanning subsystem about the number, volume of goods, the package subsystem can choose the right size bag and complete the automatic bagging .

Packaging System Structure and Composition. Packaging system consists of a cargo frame 13, an inclined ramp 14 and the buffer device 18 as shown in Fig. 6. The cargo frame is installed beneath the outgoing part of the conveyor and the bottom of the frame is designed as an inclined ramp.

There is a buffer device whose core component are springs with small elasticity coefficient at the end of the ramp. We can also see from figure 6 that the cargo frame is connected with a vibrating platform which includes the supports 15, the mandrels 16 and the rollers 17. One end of the mandrel is connected with the supports and the other end is linked to the rollers. The two rollers are installed on one axis which is driven by a reciprocating motor. Under the function of the two rotating wheels, the mandrels will drive the supports to move up and down slightly. Then the frame do the same movement as the supports do.

Principle of the Packaging Subsystem. Put a pocket in the framework of goods on the inclined ramp. The goods entries the inclined ramp through the outgoing end of the convey belt, and slips into the bottom of the framework of goods. During the sliding process, the goods stacks neatly under the shake of vibration platform, fully fill the framework of goods and reduce the waste of pocket to achieve the maximum capacity. In addition, there is a box on the vibrating plate, in which there are a lot of disposable plastic bags. When each bag is filled with goods, the consumer takes the bag, and the rest is similarly loaded in the next bag.
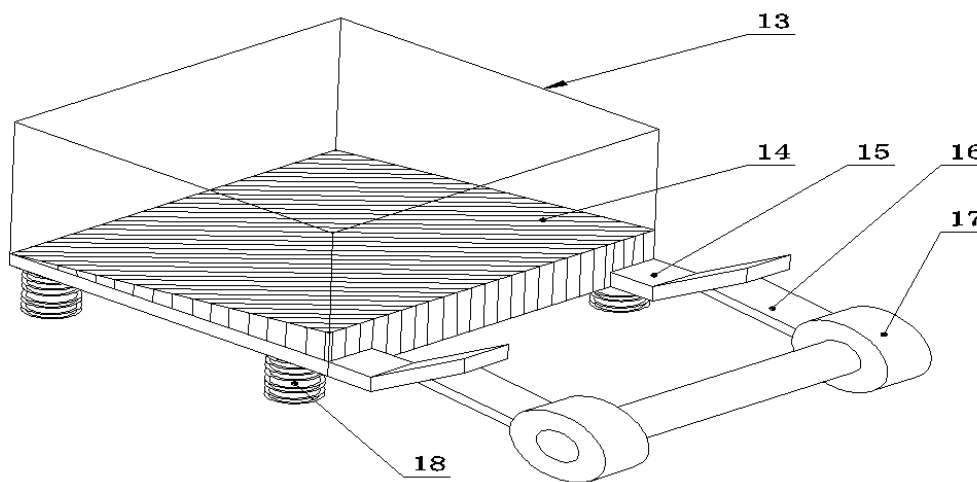

Figure 6.   The structure of the packing subsystem

Prospects

The automated cash register system combines modern computer information processing technology and automation technology together. The transferring, scanning, packaging, payment, security five major subsystems are also connected integrally (information sharing, coupled structure). The application of the automated system can solve artificial cashier drawbacks and meet requirements of both businesses and consumers. It is an inevitable trend that the automated cash register system will take place of the traditional way in the future. It has many advantages. The system is based on existing technology, so it can be purchased at a lower cost. In addition, malls with such an automated system can greatly reduce the hiring of staff, further reducing costs. Automated cash register system is no doubt fast and efficient. And it enables a 24-hour shopping mode. Besides, it not only provides consumers with convenience, but also allows customers to enjoy a satisfactory service.

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