

New Intelligent Unmanned Retail Shopping Container Design

Peng Lu*, Yiting Gao

Tianjin University of Science and Technology, China

E-mail: * lupeng970504@163.com

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Abstract

During the COVID-19 epidemic, unmanned retail has seen new opportunities for growth. The common unmanned retail methods are vending machines and unmanned supermarkets, which have the disadvantages of low product variety and high store costs, respectively. In this paper, a new intelligent unmanned retail shopping container is designed, integrating unattended technology with the container. Through the two-dimensional code, electronic anti-theft, RFID and other technologies, designed to achieve the shopping process of the goods that are taken away, the whole data. At the same time, the designed shopping containers can be deployed closer to consumers, providing a safer and more convenient shopping experience for people.

Keywords: intelligent, unmanned retail, unattended, shopping container

1. Introduction

Since the beginning of 2020, the COVID-19 virus has been wreaking havoc around the world and countries around the world have taken a variety of measures to promote social distancing to slow the spread of the virus. Against this backdrop, traditional forms of retailing have been severely impacted, while the unmanned retail sector has been presented with new opportunities for growth.

The overall unmanned retail industry is growing rapidly, with the unmanned retail market in China alone set to exceed US\$10 billion by 2020. In the unmanned retail sector, unmanned kiosks are still the dominant format. In addition, unmanned stores have gradually emerged in recent years, with companies such as Amazon, Jingdong and Alibaba launching their own brands of unmanned stores^{1,2}.

The aim of unmanned stores is to combine the benefits of physical and online retail using IoT and AI technologies³. However, each of these two forms of unmanned retail has its own distinct disadvantages. Unmanned kiosks are limited by their own capacity and

can offer customers a very limited variety and number of items. And because of the small size of the vending machine, the amount of goods stored is not much, requiring staff to frequently replenish the goods, which invariably increases the cost of labor.

Most of the unmanned convenience stores operated by e-commerce companies are laid out in stores along the streets around large communities and office buildings. Unmanned convenience stores require a large operating area and cannot really reach consumers. At the same time, the high rents of street-level stores around large communities and office buildings also bring significant operating costs for businesses.

Based on the above discussion, a new unmanned retail model is designed in this paper, which is the new intelligent unmanned retail shopping container. The new intelligent unmanned retail shopping container area and ordinary small convenience store the same but does not require a fixed storefront, companies can change the shopping container operation location at any time, in the convenience of a greater increase⁴.

The types and quantities of goods in the shopping containers are also the same as in a normal convenience store, and can achieve a high degree of matching between the container arrangement and the location of the consumer's shopping needs. At the same time, unattended technology is used in the new intelligent unmanned retail shopping containers to truly realize the full self-service and digitalization of the shopping process.

2. Overall Design

The new intelligent unmanned retail shopping container is a 6 meters long, 3 meters wide, 2.9 meters high, weighing within 4 tons of a shopping container, which covers an area of about 18 square meters. The new intelligent unmanned retail shopping container mainly adopts four key technologies: access control system, RFID IOT, automatic settlement and intelligent monitoring. In terms of structure, the shopping container adopts a design that separates the entrance from the exit and the shopping area from the settlement area. The overall design effect of the new intelligent unmanned retail shopping container is shown in Fig.1.

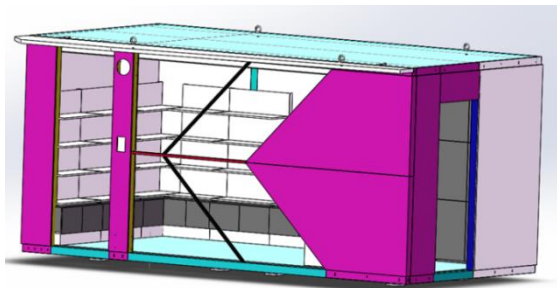


Fig.1 Shopping container modeling drawing

3. Hardware Design

3.1. Industrial control computer

Industrial control computer, is a general term for a tool that uses a bus structure to detect and control production processes and electromechanical equipment and process equipment. It has important computer attributes and features, such as having a CPU, hard disk, memory, peripherals, interfaces and touch screen with operating system, control network and protocols, computing power, and friendly human-machine interface.

The model number QY-P070-HM industrial control computer is used in this design. It has a highly scalable multi-core series application processor, 2GB DDRIII high-speed memory on board, and 8GB FLASH storage. The industrial control computer also provides on-board WiFi, 100 Gigabit Ethernet, and 3G/4G network connectivity, allowing for a flexible network application environment.

3.2. Access control

The access controller used in this design is a four-door unidirectional network controller, the model selected WG2054. WG2054 has a series of functions such as real-time monitoring, illegal sweeping alarm, number of people in the door inquiry and limited number of people. WG2054 adopts high-speed operation circuit, fast computing speed, even after full storage swipe card can open the door instantly, without any delay. At the same time, the access control system uses TCP/IP communication protocol, which effectively optimizes the communication quality, communication speed and real-time communication of the system and can provide faster services to consumers.

3.3. Alarm host

The alarm host of the new intelligent unmanned retail shopping container adopts the model 968C-NET anti-theft alarm. When the front-end detector is triggered, the detector will send a signal to the alarm host, and the alarm host will immediately drive the tweeter to sound the alarm on site after receiving the signal, and at the same time call the administrator's cell phone alarm. The alarm host can not only link wireless cameras for regular deployment, but also remote monitoring, remote listening and fire alarm through cell phone APP. It can effectively face the sudden fire and power failure of the shopping container and deter customers from stealing in the shopping container.

4. Software Design

4.1. General system control

The overall control of the system is the fundamental guarantee that the new intelligent unmanned retail shopping containers can operate properly. The core of the shopping container control system design is to use the

embedded system to complete the control of the whole program by adding several task blocks to achieve the required functions.

Through the powerful multi-process and multi-task real-time management function of the embedded system, thus greatly simplifying the control of the whole system. The most important task modules in the whole shopping container control system are: intelligent access control, RFID IOT, automatic settlement and intelligent anti-theft.

The control system is run by first testing the network connection part to test whether the Wi-Fi communication is smooth and whether the console is properly connected to the cloud server. After ensuring the network communication is smooth, enter the access control task, when the customer is ready to enter the cashier room with goods, close the exit door of the cashier area at this time and wait for the code sweeping module to complete the task of code sweeping and upload to the cloud server side.

After the data comparison on the server side completes the calculation of the total amount of goods, the payment QR code is generated to the customer. After the customer finishes the payment on the cell phone, the server side will transmit the information to the main control system, and the controller will open the exit door to let the customer leave and then open the entrance door to welcome the next customer again. Throughout the operation process, there are voice prompts to ensure that customers are familiar with the operation process.

4.2. Intelligent access control

As the new intelligent unmanned retail shopping container is unattended during daily operation, an intelligent access control system is designed at the entrance of the shopping container to ensure customers' shopping safety and reduce the rate of commodity theft and loss. The smart access control system uses attribute-based access control.

The smart access control system uses the Attribute-Based Access Control (ABAC). ABAC implements an attribute-based access policy that provides greater security and flexibility while accomplishing fine-grained access control ⁵, with the following four main types of attributes.

(1) Subject attributes: Each attribute that can determine the identity of the accessing user.

(2) Object properties: the door lock itself has the properties.

(3) Environmental attributes: time, network rate, etc. are environmental attributes.

(4) permission attributes: different access rights attributes of intelligent access control.

The ABAC model submits unlocking requests based on the user's attributes and needs. The request is uploaded to the Policy Enforcement Point (PEP), which sends the door lock request to the Policy Decision Point (PDP). The PDP is authorized by application and sent down to the PEP. PEP returns the authorization to the user who applied for it, and the user gets the authorization to open the door. The implementation flow of ABAC is shown in Fig.2.

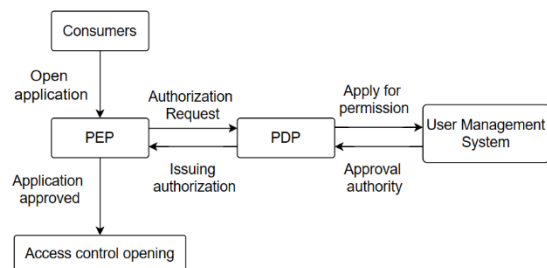


Fig.2 ABAC Process

4.3. RFID identification system

In the design of new intelligent unmanned retail shopping containers, RFID technology is one of the most central technologies. RFID recognition system mainly includes reader, wireless radio frequency electronic label and network information data exchange equipment, etc. The composition of RFID identification system is shown in Fig.3.

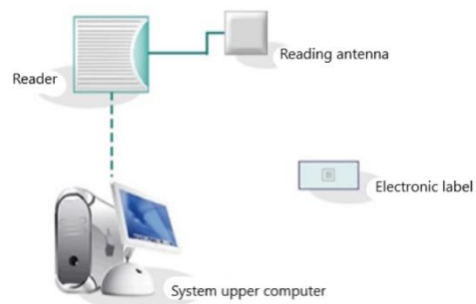


Fig.3 RFID identification system

The new intelligent unmanned retail shopping containers use passive RFID technology, and its basic working principle is not complicated. Passive RFID in

RFID tags without built-in power, when the electronic tag into the reader magnetic field range, through the electromagnetic induction coil induction RFID reader issued by the microwave signal, the chip to achieve a short supply of energy and complete data transmission ⁶. The reader reads the information and decodes it, and then sends it to the upper computer system for relevant data processing. Passive RFID is characterized by battery-free, no contact, no card swipe so not afraid of dirt, and the chip code for the world's only can't be copied, high security, long life.

4.4. Automatic settlement

The automatic settlement system of the new intelligent unmanned retail shopping container is a settlement system based on the above RFID tags, and the two are closely related and inseparable. The settlement process is shown in Fig.4.

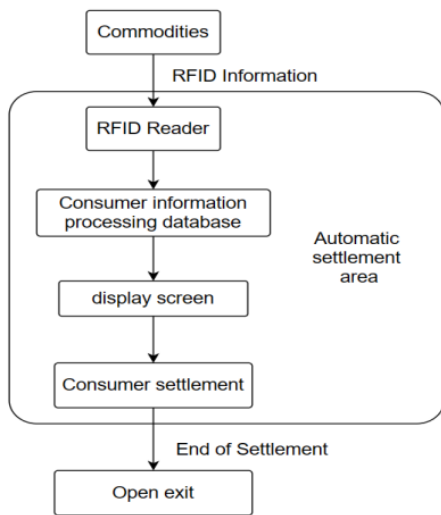


Fig.4 Settlement process

The automatic settlement system consists of three parts: commodities, automatic settlement desk and upper computer. When the customer selects the product and enters the automatic checkout area, the RFID reader will automatically identify the RFID electronic tag attached to the outer package of the product. After receiving the commodity information, the consumer information processing upper system settles the commodity and transmits the corresponding consumption information to the display through the serial port. The consumer's purchase information and payment QR code are

eventually fed back on the display, and the customer checks out by paying online.

At the same time, this design links the automatic billing system to the access control system for linkage control. When the customer enters the settlement area for payment, the entrance and exit of the settlement area will be in the closed state, at this time the system will send instructions through the serial interrupt to open the RFID reader for tag reading. Wait for the customer to finish paying before the exit door of the checkout area opens and allows the customer to leave. When the infrared radar in the checkout area does not detect a customer, it opens the entrance door to receive the next customer who is ready to check out from the shopping area.

4.5. Intelligent anti-theft

In order to effectively reduce the theft rate of the unmanned retail shopping containers, this design uses the " Electronic Article Surveillance System " (EAS). The EAS system consists of transmitters, transmitting antennas, receivers and receiving antennas installed at the entrances and exits of shopping containers. RFID tags on goods with special printed circuitry inside, when the customer normally sweeps the code to settle the bill, and then carries the goods through the detection door equipped with detectors will not send an alarm, while the consumer will trigger an alarm if he carries unpaid goods through the detection door.

5. Conclusion

The new intelligent unmanned retail shopping container designed in this paper provides consumers with a variety of services such as identity verification, automatic settlement, and self-service payment by using unattended technology, allowing consumers to enjoy a high-quality and fast consumption experience without going through the merchant's manual service.

At the same time the new intelligent unmanned retail shopping containers can be deployed closer to consumers, which can greatly improve the current status of community shopping, significantly improve the business efficiency of unmanned retail and effectively increase the repurchase rate of goods.

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Authors Introduction

Mr. Peng Lu



He is a second year master student at Tianjin University of Science and Technology. His research is about multi-sensor fusion, artificial intelligence, and robotics.

Ms. Yiting Gao



She is a first year master student in Tianjin University of Science and Technology. Her research is about deep learning, neural networks.