# Research on the design of airport intelligent distribution robot based on Internet of Things technology

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**Keywords:** Internet of things, Smart sharing, Luggage trolley robot, Simulation technology, Application.

**Abstract.** Under the influence of the current intelligent interaction and Internet of Things environment, service quality is becoming more and more important. The airport is a representative occasion under the service design concept and one of the representative demonstrations in service design. This article focuses on the pain points of passengers carrying luggage and walking for a long time, based on the airport business model and service needs, and proposes a practical design method that combines the Internet of Things and sensing technology in the early design and planning stages. The design of the airport's intelligent delivery robot carries many practical functions such as "large storage space, smart screen, transportation, transportation, and navigation" to provide passengers with the best travel experience. Users can scan the QR code on the APP to rent and enjoy the systematic services provided by intelligent robots. Provide temporary services to passengers after airport security check and before boarding, so as to reduce passenger fatigue and improve passengers' first experience before boarding. Strong service can significantly increase passenger flow and reduce the airport's human resource costs, thereby solving the current pain points. , to achieve a win-win situation for the airport and consumers.

## 1 Introduction

As an emerging information technology, Internet of Things technology achieves real-time collection, transmission and analysis of logistics information by combining the physical world with the virtual world. The design and research of airport intelligent distribution robots involves many fields such as Internet of Things technology, robotics, artificial intelligence, and automatic navigation. By introducing Internet of Things technology, airport intelligent distribution robots can realize real-time perception of airport logistics environment information and conduct autonomous navigation and cargo delivery [1]. At the same time, IoT technology can also realize data interaction between robots,

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control centers, and user terminals, and provide a user operation interface to facilitate users to understand the status of the robot in real time, and perform task allocation and monitoring. The design and research of airport intelligent distribution robots can not only improve the efficiency of airport logistics distribution, reduce costs, and improve service quality, but also promote the innovative application of Internet of Things technology in the airport field and promote the sustainable development of the logistics industry.

## 2 Development background and existing problems of airport intelligent distribution

### 2.1 Characteristics of airport smart distribution under the Internet of Things

The application of IoT technology in the field of smart airport distribution is developing rapidly, and this trend is particularly obvious in China. With the rapid development of the air transportation industry, the airport has become an important hub for regional development. The development of IoT technology provides airports with new ways to improve operational support capabilities. In addition, the airport, as a distribution center for the flow of people, logistics, and information, has become an ideal practical scenario for IoT technology innovation. The application of IoT technology in airports covers the perception layer (such as sensors), network layer (such as communication modules), system layer (such as platform, operating system) and application layer (such as intelligent terminals and integrated applications) [2]. The development of these technologies is promoting the deepening of the application of the Internet of Things in the airport field.

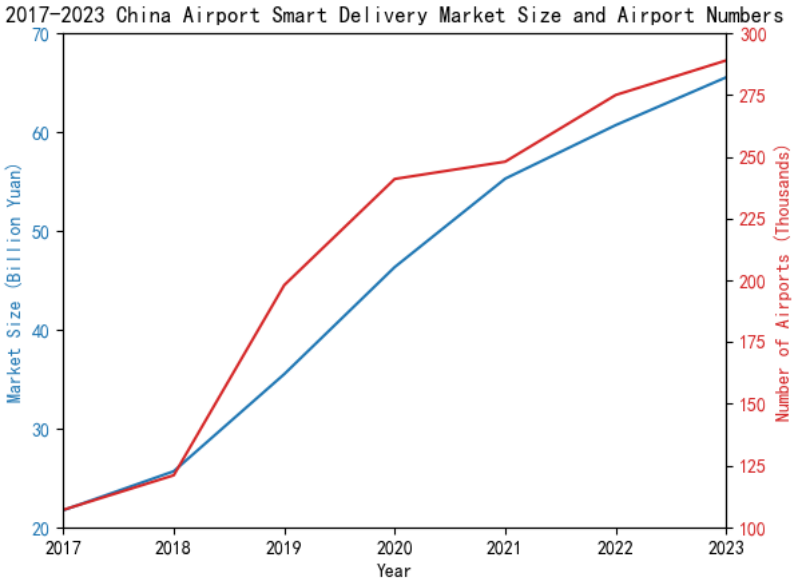


**Fig. 1.** Trend chart of airport smart distribution market size and number of airports in China from 2017 to 2023.

The Chinese government attaches great importance to the application of Internet of Things technology in the airport field. In the "Three-Year Action Plan for the Construction of New Internet of Things Infrastructure (2021-2023)", it emphasizes the role of Internet of Things technology in promoting the development of the digital economy and empowering the transformation and upgrading of traditional industries. important role [3]. Beijing

Capital Airport proposed the overall idea of "one core and two wings", Guangzhou Baiyun Airport proposed the construction of "Four Ones" project, and Shenzhen Bao'an Airport cooperated with Huawei to create a new model of smart airports. IoT technology, especially radio frequency identification technology (RFID), is increasingly used in baggage handling. For example, Shanghai Hongqiao Airport uses RFID technology for baggage tracking, which significantly improves the baggage identification rate.

In the field of airport intelligent distribution, the application of IoT technology not only improves operational efficiency, but also provides strong support for the airport's intelligent transformation through technological innovation and policy support. With the continuous development and application of technology, it is expected that IoT technology will play a greater role in airport management and services in the future.

### 2.2 Design methods and content of airport intelligent delivery robots

Airport smart distribution robots can be combined with automated smart warehousing systems to realize unmanned entry and exit of goods. For example, unmanned forklifts, environmental monitoring systems and intelligent dispatching systems are introduced to improve the efficiency of automatic operations and the level of logistics intelligence. For operations such as baggage handling, an intelligent handling system can be designed to identify, capture and stack baggage of different shapes, sizes and materials, thereby improving handling efficiency and accuracy.

In the "14th Five-Year Plan", the construction of smart airports was further deepened, and it was clearly proposed to form a modern comprehensive airport system with complete layout, intelligence and efficiency [4]. Various provinces and cities in China have promulgated relevant policies to support smart airports and smart transportation, promoting the further improvement of the layout of the smart airport industry. The design methods and content of airport intelligent distribution robots are constantly developing with policy support and technological innovation, aiming to improve the efficiency and accuracy of airport logistics, and at the same time comply with the country's overall plan and development direction for the construction of smart airports.

According to the "Robot+" Application Action Implementation Plan issued by 17 departments including the Ministry of Industry and Information Technology, the application of robot technology in various industries is encouraged, including the field of airport intelligent distribution. In order to maximize the transportation efficiency of the airport, it is first necessary to analyze the existing processes of airport logistics and identify bottlenecks and inefficient links in the distribution process. Determine the basic functional requirements of the robot, such as automatic navigation, cargo identification and loading, path planning, etc. In terms of system architecture design, appropriate sensors (such as lidar, cameras, ultrasonic sensors, etc.) are selected to build the robot's perception system to ensure efficient transmission of data between different components [5]. Develop automatic navigation and path planning algorithms to ensure that robots move efficiently and safely in complex environments. Finally, based on the test results and user feedback, the robot's hardware and software are upgraded and iterated to ensure that the robot meets all preset performance indicators.

### 2.3 Realization of design innovation points

1. Integrated application of Internet of Things technology: The design of the airport intelligent distribution robot proposed in this article combines Internet of Things technology and robotics technology. Through the collaborative work of the perception layer,

transmission layer and application layer, the robot realizes the intelligent perception of the airport logistics environment. , real-time transmission and processing of information.

2. Autonomous navigation and path planning: Using Internet of Things technology, delivery robots can achieve autonomous navigation and dynamic path planning in the complex environment of the airport, effectively avoiding obstacles and improving delivery efficiency.

3. Cargo identification and intelligent loading and unloading: Through Internet of Things technology, robots can identify different types of goods and automatically select appropriate loading and unloading methods based on the characteristics of the goods, improving the accuracy of cargo handling.

4. Stable communication system: The designed airport intelligent distribution robot adopts stable communication technology to ensure reliable communication between the robot and the control center, other robots and airport systems in the airport environment, reducing the risk of communication failures.

Table 2. Technical applications of innovation points in the design of airport intelligent distribution robots

| serial number | Technical Support | Specific applications of design innovation points |
|---|---|---|
| 1 | Integrated application of Internet of Things technology | The robot is equipped with a variety of sensors, such as cameras and lidar, and realizes data fusion through the Internet of Things platform to support intelligent perception and decision-making. |
| 2 | Autonomous navigation and path planning | Leverage IoT to connect to airport Wi-Fi, access maps and flight information, machines People independently plan the best route and dynamically adjust to avoid obstacles. |
| 3 | Cargo identification and intelligent loading and unloading | The goods are identified through barcode scanning or RFID, and the loading and unloading method is automatically selected according to the preset algorithm. The robot gently handles fragile items or the robotic arm handles heavy goods. |
| 4 | Stable communication system | Equipped with 5G or dedicated wireless network to ensure stable connections with airport control systems and other robots, the robots support real-time data exchange and task coordination. |

**Fig. 2.** Technical applications of innovation points in the design of airport intelligent distribution robots

## 3 Implementation of internet of things technology in airport intelligent distribution robots

### 3.1 RFID technology application

The robot is equipped with a variety of sensors, such as ultrasonic sensors, temperature sensors, etc. These sensors are used to collect environmental information and monitor the status of cargo. For example, lidar can be used to measure the distance of the surrounding environment, cameras can be used to identify objects and obstacles, ultrasonic sensors can be used to detect ground conditions, and temperature sensors can be used to monitor cargo. temperature. Use radio frequency identification technology (RFID) for cargo tracking and management. By attaching RFID tags to goods, robots can read label information from a long distance and realize automatic identification and tracking of goods. This improves recognition efficiency and accuracy and reduces manual intervention.

### 3.2 Wireless communication technology

Wireless communication technologies such as Wi-Fi, Bluetooth, and 5G are used to ensure real-time data exchange between the robot, the control center, and the user terminal. The robot can connect to the airport's LAN via Wi-Fi to achieve real-time communication with the control center; communicate with other robots or devices at short distances via Bluetooth; and achieve remote monitoring and control via the 5G network. Implement data encryption and identity verification during the communication process to ensure the security of data transmission. For example, the SSL/TLS protocol can be used to encrypt data for transmission, and digital certificates can be used for identity verification to prevent data from being intercepted and tampered with [6].

### 3.3 User interface design

Use big data analysis and artificial intelligence algorithms to process the collected data to optimize the robot's decision-making and operation. At the same time, an intuitive and easy-to-use user interface is developed to enable users to monitor the status of the robot in real time, assign tasks and issue control instructions. In the design of this project, a web interface or mobile application can be developed, through which users can view the robot's position, status, power and other information, and send control instructions, such as start, stop, charge, etc.

## 4 Specific applications of Internet of Things technology in the airport intelligent distribution robot project

It can be seen from the above applications that IoT technology can provide comprehensive support for the airport intelligent distribution robot project, from terrain route planning to energy management, improve the intelligence level and operating efficiency of the robot, and also provide opportunities for the digital transformation and intelligent upgrade of the airport. Help. With the continuous advancement of Internet of Things technology, the application of intelligent distribution robots in airports will be more extensive and in-depth in the future.

### 4.1 Application of Internet of Things combined with virtual reality technology in airport terrain route planning

Using Internet of Things technology, airport intelligent distribution robots can collect airport terrain data through various sensors (such as lidar, cameras, etc.), including ground flatness, slope, turning radius and other information [7]. Based on the collected terrain data, virtual reality technology is used to build a three-dimensional terrain model of the airport to provide a real navigation environment for the robot. In the virtual environment, a simulation test of path planning is conducted based on the size and motion characteristics of the robot to ensure that the planned path is feasible in the actual environment. The airport environment data, such as flight information, baggage handling point changes, etc., are updated in real time through Internet of Things technology, so that the virtual reality model can reflect the latest airport status, allowing for dynamic path planning.

Use virtual reality technology to simulate various airport facilities, such as boarding gates, luggage carousels, security check areas, etc., to help robots better understand and adapt to the airport environment. Various scenarios at the airport are simulated in the virtual environment, such as the flow of people during peak hours, special weather conditions, etc.,

to train the robot's ability to cope in complex environments. Use virtual reality technology to simulate the robot's interaction with airport staff and passengers, and optimize the robot's user interface and interaction process. Various emergency plans can also be simulated in the virtual environment, such as baggage system failures, flight delays, etc., to train the robot's rapid response capabilities in emergency situations.

### 4.2 Application of Internet of Things technology in airport scenarios and facility settings

Through the Internet of Things technology, the video surveillance system in the airport is integrated with the robot system. The robot can obtain surveillance video in real time to identify abnormal situations or assist navigation. Install RFID tags on luggage, and the robot can automatically identify and track the luggage by reading the RFID tag information. Combining machine vision and artificial intelligence algorithms, it can realize intelligent control of the lighting system in the airport, automatically adjust the lighting intensity according to time and ambient light, and save energy; it can also synchronize intelligent sorting of luggage to improve sorting efficiency.

The application of 5G technology has improved the management level of airport facilities and equipment. In terms of video surveillance equipment, boarding bridge equipment and baggage sorting equipment, the integration of 5G and the Internet of Things makes the management of robots more efficient. In the future, if you want to build a "future airport digital platform" based on the concept of "ecology", you need to integrate resources such as the Internet of Things (IoT), big data + AI, video cloud, GIS (geographic information system) and integrated communications (ICP). Through these technical means, airport intelligent distribution robots can better respond to emergencies such as flight delays and improve passenger experience [8]. With the continuous advancement of technology and the deepening of its application, it is expected that IoT technology will play a greater role in airport management and airport intelligent distribution robot services.

### 4.3 Application of Internet of Things technology in airport mechanism linkage optimization

Through digital twin technology, an intelligent robot management platform with perception, analysis and decision-making capabilities is built. This platform integrates building automation systems, including HVAC, lighting, elevators, luggage systems and other diversified products to achieve a smart terminal that is green, low-carbon, safe and comfortable, and reduces costs and increases efficiency. The real airport and application scenarios are virtually replicated, and facilities and equipment can be displayed and interacted with in the platform in the form of virtual identities. The platform integrates 9 smart applications such as water use, electricity use, air conditioning

## 5 Conclusion

With the development of Internet of Things technology, research on the design of airport intelligent distribution robots has become an important direction for the intelligent transformation of airport logistics. The robot design proposed in this article combines the Internet of Things and robotics technology. The delivery robot can realize autonomous navigation and dynamic path planning in the complex airport environment, effectively avoid obstacles, improve delivery efficiency, and automatically select appropriate loading and unloading methods based on the characteristics of the goods. Improved cargo handling

accuracy and efficiency. Assisted by stable communication technology, the robot can ensure reliable communication with the control center, other robots and airport systems in the airport environment, reducing the risk of communication failure [10]. The robot can adapt to different airport environments and cargo types, and has strong environmental adaptability and task processing capabilities. Despite challenges such as environmental complexity, cargo diversity, and communication stability, it is expected that IoT technology will play a greater role in airport management and services with technological innovation and system optimization.

## References

1. Xi Chongbin. The value and development of Internet of Vehicles and vehicle-road collaboration technology in the implementation of autonomous driving applications - Interview with Zhang Liandong, director of the complete machine product line of CITIC Zhilian Technology Co., Ltd. [J]. Logistics Technology and Application, 2024(03) :126-129.
2. Guan Guan, Li Jiali, Xiong Zezhu. Discussion on the design and application of smart airports based on Internet of Things technology [J]. Architectural Electrical, 2023(12):40-44.
3. Zhang Hong, Zheng Weiling, Yin Chunrong, etc. Application of narrowband Internet of Things technology in the construction of airport smart areas [J]. Internet of Things Technology, 2020(10):95-98.
4. Jiang Xinsheng. A brief discussion on the exploration and practice of Pudong Airport smart field construction [J]. Civil Aviation Management, 2019(5):45-48.
5. Li Wenjun. Analysis of the application of Internet of Things technology in smart airports [J]. Digital Communications World, 2021(3):170-171.
6. Luo Huan, Huang Zelong. Terminal development trends based on passenger experience and new technology application [J]. Journal of Architecture, 2019(09):12-17.
7. Zhang Shuaishuai. Baggage handling AGV design based on "smart airport" [D]. Kunming University of Science and Technology, 2022.10.
8. Fu Yu. ICS independent baggage handling system in the context of smart airports [J]. Equipment Management and Maintenance, 2022(13):144-146.
9. Fatma Achour; Chaima Bejaoui; Anis Jedid.Semantic structure for describing IoT system:application for smart home and smart airport[J].International Journal of Metadata, Semantics and Ontologies(1).
10. P.Deepa T.Pradeepa.P Dr.IoT based Smart Passenger Surveillance System for Airport[J].International Journal of Engineering & Technology(4.5).