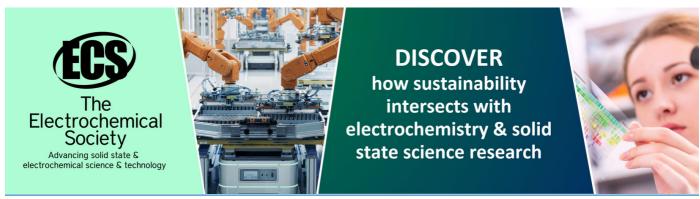**PAPER • OPEN ACCESS**

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The integration and development trend of China's 5G technology and smart cleaning

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Abstract. China's 5G development has achieved a significant leap from the conceptual level to the application level from technical testing and pilot implementation in 2018 to official commercial use in 2019. In 2020, China will accelerate the application of new technologies such as 4K/8K, VR/AR, and increase the supply of high-end information services. At present, the works in this field stay in the imagination of 5G smart and clean level, talking about the grounded products under the 4G foundation, and fail to reflect the technological attributes of China's 5G application. This article further analyzes the latest applications and development trends of 5G technology in the field of smart cleaning, which is an important theoretical basis for promoting the intelligent and modern development of China's cleaning industry, and will help the development of smart cleaning industry and the construction of smart cities in China.

1. Introduction

With the sustained and stable development of China's economy and science and technology, the general environment of China's service industry is good, and it has gradually become the largest industry in the national economy. People's requirements for cleaning quality and efficiency are increasing day by day. This time needs the emergence of new cleaning products, the integration of 5G technology smart cleaning products just meet this demand, thereby improving people's level of cleanliness. Under the background of "Internet + 5G", the cleaning industry is facing some problems, such as the aging of practitioners, the mismatch between labor costs and labor achievements, and so on. [1] The upgrading of new technologies will certainly bring about revolutionary changes. It is imperative to promote the development of urban intelligent cleaning system.

The twenties of the 21 century is an era in which intelligent technology is very popular. The era of intelligent science and technology that strips away repetitive and monotonous manual labor and improves the quality of human life and production efficiency has come. The development of smart clean technology is only a microcosm of it. Whether it is cleaning streets, tidying up rooms, or sorting garbage, more advanced means can be used. The era of artificial intelligence instead of simple manpower is coming, using intelligent algorithms to plan cleaning methods, using machine work to save labor costs, liberating human hands, and purifying living space.

2. Overview of China's 5G smart clean

2019 is regarded by the world as the first year of global 5G. Under the leadership of Huawei, ZTE and other companies, China's 5G construction progress far exceeds that of other countries, such as the United States, ranked first in the world. China has invested a lot of money to support

the research and development of 5G network technology, and 5G spectrum planning has been issued one after another, laying a solid foundation for the leading development of China's 5G. As of October 2020, the construction of 5G base stations in China has exceeded 500,000, the number of 5G users is increasing, and the number of terminal connections is more than 100 million. From chip manufacturers to hardware equipment suppliers, they are also accelerating production, carrying out research and development of 5G technology according to different paths, and promoting the process of industrial commercialization. 5G will extend mobile connectivity technology, AI, XR technology, wearable technology, PC, Internet of vehicles, IoT and other technologies to facilitate industrial layout.

5G provides technical support for IoE smart life scenarios, and remote control of terminal devices becomes a reality. With the promotion of high-quality development, China has deeply adjusted the existing industrial structure, the service industry is rising rapidly, and the producer service industry presents the dual characteristics of integration and digitalization. The commercial use of terminals such as the Internet of things, drones, VR and 3D scanners will be further accelerated, and 5G will bring broad prospects for the joint layout of the entire industry chain. There is a huge space for development in China's clean market, and it is particularly important to improve the specific application of 5G technology in the field of intelligent cleaning.

The era of 5G intelligent cleaning has come. 5G plays a large role mainly because of its large bandwidth, wide connectivity, low latency three characteristics. The integration and innovation of "5G + smart cleaning" is not only the inevitable trend of industrial development, but also an important driving force to promote the transformation between new and old models.

3. 5G technology application

The high integration of intelligent cleaning and 5G technology is the visual realization of social needs and an important link in the construction of smart cities. Intelligent clean products need to integrate information technology means such as the Internet of Things, database, artificial intelligence, cloud computing, etc., to realize the dynamic collection and data analysis of multi-dimensional data such as people, vehicles, public facilities, real-time status, etc. and combined with cross-regional data sharing, intelligent cleaning processing to meet the needs of the public for intelligent camps.

3.1. Combination of Al technology and 5G

5G technology is the foundation of the Internet of Everything, and Al is a tool to achieve the Intelligence of Everything. The two combine deeply, promote each other, and form an alternating upward trend. 5G provides an intelligent cornerstone for the comprehensive introduction of AI capabilities into the network, to drive the intelligent and clean humanized experience in a more intelligent way. Due to the excellent ability of 5G network with low latency and high bandwidth, it provides a new growth space for Al. In the face of the huge cleaning market and the urgent demand of the people for new technologies, the combination of Al and 5G technology will show great potential in the field of intelligent cleaning, and will be superimposed step by step to form a continuous driving force for innovation and promote the wide application of intelligent cleaning.

3.2. Navigation and path planning

Intelligent cleaning equipment needs accurate location service. At present, China has just completed the layout of the global positioning system of Beidou satellite. BeiDou Navigation Satellite System combined with 5G technology makes the positioning accuracy higher. The development of 5G communication technology provides a great imagination space for the society of the Internet of Everything. Many intelligent products need high-precision positioning and navigation. 5G technology will provide more reliable and cost-saving satellite navigation and positioning services for all mankind to meet the specific individual needs of the products. The application of 5G technology in path planning realizes the automatic regulation of intelligent cleaning equipment, standardizes the working path of intelligent floor-sweeping robot, and improves the living standard of residents to a new level.

3.3. Machine learning and big data

Through machine learning, constantly improve the equipment algorithm, standardize the smart cleaning service information system, build and improve the intelligent clean technology innovation system, make the equipment mine the hidden rules from a large number of sample data, and predict and classify them. Machine learning will simulate the human way of thinking to solve problems, so as to achieve intelligent service.

While ensuring the authenticity of big data in the intelligent cleaning system, the system administrator will improve the management system, strengthen the management and control of data, realize the combination of equipment learning system and 5G technology, and use the cloud big data platform for data processing. Through the intelligent processing of the data, the whole process is more efficient and convenient, so that the equipment can better understand the specific operation direction of the data, achieve intelligent behavior, improve the degree of intelligence of the system.

3.4. Sensing technology

Through infrared distance sensors, 360-degree rotation cameras and light sensors and other sensing devices, we can realize the perception of the environment, so that we can automatically avoid obstacles and identify intelligently. The integrated application of 5G and sensing equipment makes the performance of sensing equipment to the extreme. While the machine perceives the surrounding environment, it can realize the intelligent response with the help of 5G technology, which makes the information transmission more efficient. 5G supports faster communication response and higher-density terminal access, and devices in the Internet of Things connect more smoothly. The operator can observe the operation of all the equipment through the display screen in the control center, and realize the remote control of the computer.

4. Integration of 5G and intelligent cleaning

With the arrival of the 5G era, many industries will usher in the rapid development, and the cleaning industry will inevitably change from the traditional property cleaning mode to the smart cleaning mode in the technological revolution of the Internet of Things. Intelligent cleaning equipment integrates 5G communication technology, provides strong cleaning hardware support for 5G era, and realizes smart cleaning in all directions.

4.1. Unmanned road sweeping vehicles

A new round of innovation in the sanitation industry has been ready to start, and road cleaning is becoming more and more intelligent. The gradual maturity of 5G technology has promoted the development of unmanned road cleaning, and the intelligence level of the sanitation industry has been further improved. Unmanned road sweeps have been put into use in central cities such as Beijing and Shanghai. The unmanned road sweeper adopts advanced technology for remote control, and realizes the precise connection between the 5G network and the unmanned road sweeper through the body camera and 5G high-speed transmission means.

The audio, video and other data collected by the vehicle on the road can be synchronized with the cloud in real time, which processes the field data with AI algorithm, and quickly synchronizes the data analysis results to the vehicle, so as to achieve accurate operation and complete the real-time guidance and interaction between the remote operator and the intelligent equipment of the vehicle. As a mobile intelligent terminal, driverless sweeper has unlimited working time, which greatly improves the cleaning efficiency. At the same time, the driverless sweeper can avoid manual operation errors and greatly reduce the probability of accidents, while the 5G network can ensure the real-time and efficient operation of the equipment needed in the cleaning process.

4.2. Medical disinfection robot

With the outbreak of COVID-19, disinfection and epidemic prevention has become extremely important. The use of 5G medical disinfection robot provides great convenience for medical staff. Medical disinfection robot is an intelligent disinfection equipment with multi-functions, such as autonomous positioning and navigation, multi-mode disinfection, friendly human-

computer interaction, intelligent scheduling management and so on. The robot integrates 5G module, sensor module and other automatic operation module, which can sense the concentration of environmental disinfectant in real time, independently judge whether the disinfection effect is up to the standard, and intelligently plan the disinfection strategy. It provides omni-directional and efficient disinfection and sterilization guarantee for hospital environment.

Medical disinfection robot has the characteristics of intelligent, efficient, safe and easy to use, which makes the disinfection work quantifiable, measurable and intelligent, and provides strong support for modern hospital infection prevention and control. The robot can replace the medical staff to disinfect the isolation ward and the infected area, realize the elimination and unmanned killing in the isolation area, protect the health care workers in an all-round way, and minimize the risk of cross-infection in the medical process. [2]

4.3. Cleaning robot

4.3.1. Intelligent cleaning robot.[3] The intelligent robot adopts the combination of cleaning + vacuuming + dust cloth, which greatly improves the effect and efficiency of dust removal. The robot can independently plan the cleaning trajectory, realize the orderly cleaning of each floor, navigate to the next floor independently after cleaning, work continuously for more than 8 hours, and can ensure the continuous cleaning work in the form of independent charging, thus achieving the cleaning effect of long time and autonomy. In addition, through the big data platform, users can observe the life of robot consumables, life and health reports, and monitor the operation of the robot in real time, making the management more intelligent and convenient.

These changes reflect the efficient service experience that cleaning robots bring to the cleaning industry and customers. In the future, with the deep integration of 5G technology and intelligent cleaning robot, it will further release the landing value of cleaning robot, bring more high-quality service experience for customers, and promote the upgrading of intelligent cleaning service.

4.3.2. Home sweeping robot. With the promotion and application of smart home, the household cleaning needs of users are also changing, and people pursue more convenient and effective cleaning tools. The popularity of floor-sweeping robots enables people to enjoy the convenience of intelligent cleaning at home.

The floor-sweeping robot has a variety of motion sensors to extract complex spatial features to support the high-speed operation of the visual navigation system. The high process chip in the robot can make use of the low time delay of 5G technology and simulate the neural network algorithm through the visual sensor to make it more intelligent, accurate and efficient. On the mobile terminal, the user can locate the robot in real time, control the working path of the robot, and realize remote operation.

4.4. Garbage sorting and recycling system

In recent years, the standard of garbage classification has been improved, and the garbage classification and recycling system arises at the historic moment. 5G + garbage sorting system combines intelligent recycling terminal with big data operation platform to lead a new mode of garbage classification. The intelligent dustbin has the functions of real-time monitoring, intelligent weighing, remote control, face recognition, voice recognition, overflow reminder and so on. The face recognition and speech recognition functions of the system can assist the government to implement the regulatory functions. Automatic weighing and remote cloud operation can achieve human-computer interaction, remind garbage overflow, and complete automatic classification and recycling.

The change of residents' clean life caused by the application of 5G technology is essentially a process from quantitative change to qualitative change. The scheme of using public network to realize the Internet of Everything will be widely used. The large-scale promotion of unmanned road sweeping vehicles, intelligent cleaning robots and other equipment shows that smart cleaning can optimize the cleaning workflow and bring convenience for enterprises and

individuals on the basis of improving work efficiency and service quality.

5. 5G smart clean development trend

The development of 5G technology will lead to the upgrading of both supply and demand, which will not only profoundly affect the human way of life, but also change the material production process and the mode of economic development, and provide technical support for the intelligent life scene of the Internet of Everything. [4] At present, the construction of 5G biosphere in China is not yet perfect, and it will be upgraded in both industry and consumption in the future, led by new technology, promote the digital transformation of the integrated cleaning industry, and bring a more convenient and faster new model of the Internet of Things.

5.1. Broaden the scope of smart cleaning applications

With the continuous integration and development of 5G + intelligent cleaning, intelligent unmanned cleaning equipment is used more widely. Intelligent cleaning equipment can replace manual work in dangerous environment such as high altitude, confined space, pipeline and so on, and create a safe and healthy working environment for cleaning workers, so as to reduce the labor safety risk of cleaning personnel. Therefore, it can be predicted that smart cleaning will become the future development direction of the cleaning industry.

5.2. Optimize the user service experience

The advantage of smart cleaning lies in stability, which can reduce the arbitrariness of manual labor and the volatility of working state, and maintain the same level for a long time.

5.2.1. Strengthen the ability of information service, through data presentation service. Personalized cleaning service can be provided through intelligent means to quantify and control the cleaning quality. For example, many companies have adopted real-time air quality information broadcast. The air quality of the toilet and the bacterial content of the carpet before and after cleaning can also be measured, so the control means of cleaning quality can be changed from artificial inspection to objective data monitoring and provided to users.

5.2.2. Provide interactive cleaning services to give users a sense of participation. In the past, there are some problems in the traditional workflow, such as too many links, slow response and so on. If the merchant provides 5G smart cleaning service, if the customer is not satisfied with the sanitary condition, they can give feedback through video, voice and other channels. After the user feedback is received and analyzed by the intelligent cleaning system, instructions are issued directly to solve the user's problems. In this way, customers have a sense of participation and control, saving a lot of time and manpower occupied by the traditional information transmission.

Due to the high density of 5G base stations, the interconnection of IoT devices is very convenient. Smart cleaning provides an extremely effective solution to solve the "pain points" of industries such as the aging population and limited working time in the cleaning industry. When cleaning services in different scenarios are applied on a large scale, it will lead to a new industrial service model, and promote the formation of new consumption patterns, and finally form a win-win situation.

6. Conclusion

Smart cleaning, as a new operation mode of urban cleaning system, has entered thousands of households. Smart cleaning will help the government to further improve the ability of urban health governance and build a smart city in an all-round way. [5] At that time, most residents can get rid of the single boring cleaning labor, enjoy the intelligent cleaning services driven by 5G technology, and promote the upgrading of brand-new industrial services to achieve harmonious development.

The integrated application of 5G technology and smart cleaning will promote the innovation and upgrading of cleaning sharing mode, accelerate, deepen and promote the automation of cleaning operation, and strengthen the risk control of intelligent cleaning products. bring

incomparable convenience and efficiency. Although the breadth and depth of application of 5G artificial intelligence is limited at present, with the development and practical accumulation of 5G network technology, 5G technology will be the core driving force of clean method sharing and mode transformation. The intelligent cleaning under 5G technology will be updated with the continuous innovation of science and technology, meet the increasing cleaning needs of people, and improve the construction of smart cities.

In short, the great era of intelligent liberation of manpower has come, and the exploration of smart cleaning by 5G technology developers will not stop. From the application of intelligent cleaning equipment to smart cleaning management, 5G technology is ushering in a new era of smart cleaning.

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