

Research on the "Internet +" urban classified garbage recovery and transportation system framework

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Abstract: The recycling and transportation of urban living waste is one of the common basic tasks to ensure the normal operation of the city. Aiming at the acceleration of urbanization and the increasing quantity of living waste, this paper proposes an "Internet +" urban garbage classification recycling and transportation system solution. According to Shanghai promoting the living garbage classification reduction method, researched the source of waste classification, the middle classification of transportation and the terminal classification of disposal. Intellectualized and information of garbage classification and transportation system, and innovative research on intelligent dustbin waste source and public areas of the city garbage classification recycling bins. Trying to establish technical constraints, and the combination of human motivation behavior and the whole society living garbage classification system, build large data frame of urban living garbage, preliminarily laid the garbage classification and recycling wisdom based on technology and management.

Introduction

Along with the acceleration of urbanization, the production of household waste has also increased, which has brought great burden to the garbage collection and transportation, affecting the harmonious development of economy, environment and society. 《The report on the assessment of municipal household waste management in 2015》 shows that China's per capita living garbage day transportation amount averaged 1.12 kg in recent years, located at a higher level, has become a "junk siege" phenomenon which is one of the most serious countries[1]. The classification and disposal of municipal household waste can effectively reduce the problem, and realize the reduction, resource and harmless of life garbage. According to《survey report on the classification of household garbage classification in Shanghai》, 98.9% of the public are willing to conduct garbage classification, which is not willing to take up only 1.1%, but the actual participation rate is low[2]

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and the correct classification rate is low. Therefore, systematic, high-level, and system-wide taxonomy and related facilities are urgently needed. Premier Li on the 12th in the third session of the National People's Congress put forward to make "Internet +" plan of action, to promote the mobile Internet, cloud computing, big data, combined with modern manufacturing industries[3], which promoted the change of the environmental protection industry, under the development trend, the national pilot cities have "Internet+" garbage classification, and various places have different classification standards, classification and uneven levels of execution and disposal. For example, Ningbo use the combined means of Internet and information technology to monitor real-time about the garbage collector system[4], It shows unique advantage in the raise level of the classification of garbage collector path, planning, reduce the transportation cost; Tianjin eco-city adopts the intelligent classification platform, according to the "district shunt, the residents sub-bag, the street sub-box"[5] way classification collection; Guangzhou also explore an effective mode in garbage sorting work, with the support of Internet technology, the corresponding reward method is applied to the behavior of residents classified garbage[6], the model is significant in improving rate of garbage sorting results.

In 2014, the Approval of the municipal government in Shanghai promotes the living garbage classification reduction method for garbage classification request [7]: living garbage can be divided into four kinds: kitchen waste, recycling, hazardous waste and other waste. At present a lot of rubbish collector system are in domestic applications, but it is difficult to ensure that the garbage from the output, the transportation to the disposal of the whole process not be mixed, most of the garbage collection or trash pickup system classified collection containers still belongs to the traditional way, and for the whole industry chain classification recycling network and information management platform of constructing the lack of complete practice, and junk information management of the whole process has been an important guarantee to achieve economic, social, scientific development, and improve the basic requirement of people's living environment, but also an important content of government's work[8]. According to 《living garbage classification system implementation project》 in March 2017, by the end of 2020, the garbage sorting relevant laws, regulations and standard system will be set up , garbage amount is rising in our country, if not effectively solve the problem of classification, the city is difficult to step out of the dilemmas of "junk siege" phenomenon .

I believed that "Internet +" urban living waste sorting recycling and transportation system, is one of the effective measures to ease the "garbage siege" phenomenon, by the participation of residents, environmental protection enterprises and governments, the system which is based on the passive way of existing urban garbage sorting recycling on humanistic education and awarding will Improve with modern technology and management of urban living garbage recycling[9], waste classification garbage classification, as a whole to promote transportation, implementing garbage on the traceability and big data applications has the positive significance, and play an active role for wisdom urban construction.

Overview of "Internet +" Recycling and transportation System for Urban Household Waste

Internet and city life garbage sorting and recycling system model Integrated Internet technology, sensor technology, information and communication technology and GPS position

technology and applied to the construction of municipal solid waste industry chain recycling network and information management platform[10] (refer with: Fig1), The system includes the classification of the garbage about source collection, the middle transportation and terminal disposal, to achieve real-time monitoring of urban living waste recycling, clearing deployment and information management. According to the classification and quantity of garbage generated in different regions, the system adopts the principle of "local conditions" to distinguish the residents' community and the urban public street [11].

The study of the system model combines the hardware aspects of the garbage collection container settings and software information management platform, in particular, the garbage collection container settings within the system, in line with the "living garbage classification system implementation plan" in the garbage classification phase convergence Of the terminal processing facilities, and with the use of renewable resources recycling system. Which has the following functions: ① To achieve the classification of the garbage about source collection, middle transportation and terminal disposal which includes intelligent processing and information tracking management; ②To realize the collection, analysis and accumulation of information and data in all links; ③To realize the intelligent deployment of garbage trucks.



Fig1 "Internet +" urban classified garbage recovery and transportation system model

The Composition of "Internet +" Recycling and transportation System for Urban Living Waste

Classification of Collection from Source. The forefront of "Internet +" Recycling and transportation System for Urban Living Waste is the source of waste classified collection, in this phase consists of a residential area and urban public area, in residential area, it adopt the intelligent dustbin which is researched independently, design drawings and the real figure (refer with: Fig2), green, blue, red, black respectively for kitchen waste, recycling waste, hazardous waste and other waste, raspberry pie, cameras, motor driver suit, batteries and other components are installed on intelligent dustbin, (refer with: Fig3).The dustbin's design combined with QR code identification, embedded development, sensor, information communication, database management and other application of the key technologies. The resident's QR code, name and other personal information by the system administrator, database has the function of security encryption, nontechnical people don't have the access to get, it ensured the privacy of residents to some extent.



Fig2 Design and physical figure of intelligent trash can



Fig3 Intelligent trash part of the electronic control components

a—42V stepper motor b—89C51 single chip development board c—Raspberry pi and camera

The classification and collection of garbage in public areas of the city is completed, and a kind of intelligent garbage sorting box (refer with: Fig4) is set up, and three separate boxes are set in parallel in the box, (refer with: Table 1). In addition, the recycle bin is equipped with garbage infrared sensor, weighing device, Wi-Fi communication device, garbage compression device, solar power supply device, etc. When recycling bins in the infrared sensors induction to the recycling bins for full load, will trigger the compression mechanism of garbage is compressed and recorded to the waste weight data in the cabinet, and through the Wi-Fi communication device, the full information, types of waste, recycling bins, waste weight data, location and time data will be sent to the cloud server. Finally, the cloud server notifies the nearest controller to carry out the classification and transportation of the garbage collection.

Table1 the set of intelligent classification and recycling trash can

| Name of the internal box body | The first recycle bin | The second recycle bin | The third recycle bin |
|-------------------------------|--|---|-----------------------|
| Drop shape | circular | Narrow rectangle | Width of a rectangle |
| The type of garbage collected | Plastic bottles, cans and other bottles of garbage | Recycle newspaper and other paper trash | Other rubbish |
| Internal mechanical structure | Bottles of fine crusher | Non condensing mechanism | Garbage compressor |



Fig4 Garbage classification and collection bins

Middle Classification and Transportation. In the middle of the sorting and clearing, small garbage sorting trucks and large garbage sorting trucks are set up, two types of clear vehicles are set on the sensor, electronic tags and wireless communication module, facilities and data of the docking station is controlled within the system. Small garbage truck is responsible for the classification and removal of garbage in residential areas and the public areas in the jurisdiction, and transportation to the intelligent garbage collection station, Large-scale garbage truck is designed in a closed compartment, responsible for the garbage collection station to the garbage disposal plant.

Recycling station equipped with the corresponding garbage disposal device (garbage machine sorting device, dry garbage compression device, wet garbage biochemical treatment device), and data reading device (electronic tag reader), and a data transmitting / receiving device (wireless communication module). The staff of the control room in the station can supervise and control the whole process of garbage compression, loading and transportation through the system of garbage collection and monitoring system and GPS positioning system. When the compressed garbage in the smart garbage collection station is in full load, it will send a request for clearance to the cloud server via the Internet. Then the cloud server dispatch center will send clear order, location and clearance route to the large garbage truck driver for completing the clearance.

This process will focus on the inefficient and laborious problems of waste disposal and removal, meanwhile, incorporate the efficient dispatch and management of garbage clearance trucks into the system to save the maintenance costs of enterprises and municipalities as soon as possible.

Terminal Classification of Disposal. The four types of garbage can be classified and disposed (refer with: Fig5), and the dry waste is put into the mechanical sorting platform for sorting, and some valuable recyclables (such as jars) are collected and sent to the recycling company. The rest of the garbage is compressed into the compressor, kitchen waste is put into the wet garbage biochemical processing device in the recycling station, disposal residue after biochemical treatment is put into the garbage disposal plant, hazardous waste for special treatment.

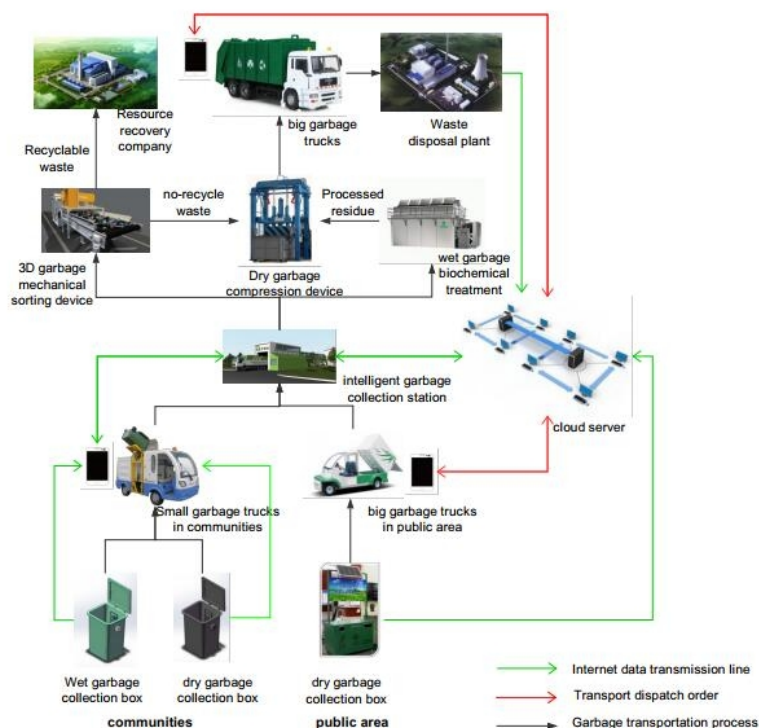


Fig5 Internet + urban garbage sorting and clearing business model

The Design of municipal solid waste sorting and recycling platform

The Design target of municipal solid waste sorting and recycling platform. In view of the demand of information management system of environmental protection department, a kind of garbage collection platform is put forward, starting from its function, it display an Internet plus city life garbage recycling platform through several modules such as: the work module, information collection module, information transmission module, information processing module and the information application module. The recycling garbage classification platform is based on computer network technology, GPS Technology (Global Positioning System), database technology, mobile communication technology and other information technology, the classification of city life garbage collection, classification and collection, classification of information processing as the main body of management and comprehensive management platform. The platform uses Apache server, PHP language, MySQL database development, APP client, Web services provided by the Apache server, MySQL database to provide service for the background, without complex equipment extra, only the use of intelligent mobile phone usually, and the PC machine, the use and cost of development and maintenance cost is on a very low level.

Structuring of Garbage Collection Platform. Through the data gathering, collation, collection, analysis the data of the whole process of the generation, collection, transportation and disposal of the city life garbage, the platform constructs the residential area intelligent garbage box system and public street garbage box classification system, providing data environment for recycling garbage platform. Intelligent residential garbage box system is mainly used to gather the residents' garbage classification data, display basic information, residents delivery log, integral evaluation, abnormal delivery records and reminder delivery trash records, the platform logical

model is shown below (refer with: Fig6). Residents through credit card identification, smart metering and other measures put garbage recycling station intelligent real-time data to the cloud statistics. The main function of the data platform is to receive the data information of the intelligent garbage bins, and calculate and analyze the data at different levels through the cloud server. The intelligent system functions of public street garbage box are as follows: the stock sensing unit in the recycle bin records the garbage weight data, it will return the full load information, the garbage weight data, the location and time of the recycle bin to the cloud server, through the Wi-Fi communication device, when the recycle bin is full load. Then the cloud server will notice the nearest staff via the Internet to remove the garbage in the dustbin.

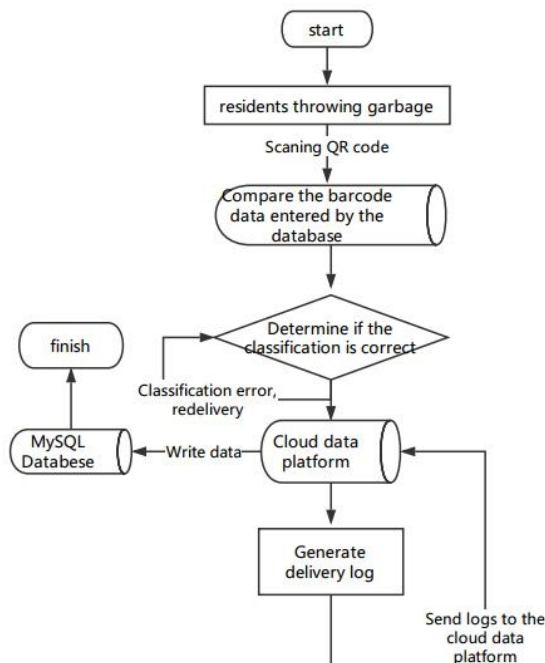


Fig6 model of urban household garbage classification and recycling platform

Operation Flow of Garbage Classification and Recycling Platform. For example, the intelligent dustbin which used in residential area, first of all, should have the function of classifying the garbage, residents threw the garbage according to the types of garbage and tag. When residents are throwing garbage, the QR code is scanned by the camera on the right side of intelligent recycling bin, data collection is completed, and the camera shot a photograph as a record. The smart bin's raspberry pie analyzed the collected image data and turned the image information into digital information. After the QR code was verified by intelligent garbage collection box, it automatically opened the lid of the box and maintains the opening status for 10s, and then, it automatically closed the lid and finished the release. The system will automatically feedback record information to the cloud database and analyze the aggregated data to form the integral according to the qr code information. The garbage collection platform will be able to manage integrate and remind Abnormal delivery records. According to the garbage delivery record of the community, the system automatically generates the pie chart of the integral evaluation and the column chart of the daily clearance, it helped the transportation department to improve efficiency(refer with: Fig7), the garbage classification recovery platform in PC. The cloud server gathered, counted and managed the city's garbage delivery records, and generated relevant charts to provide data support for the construction of smart cities.

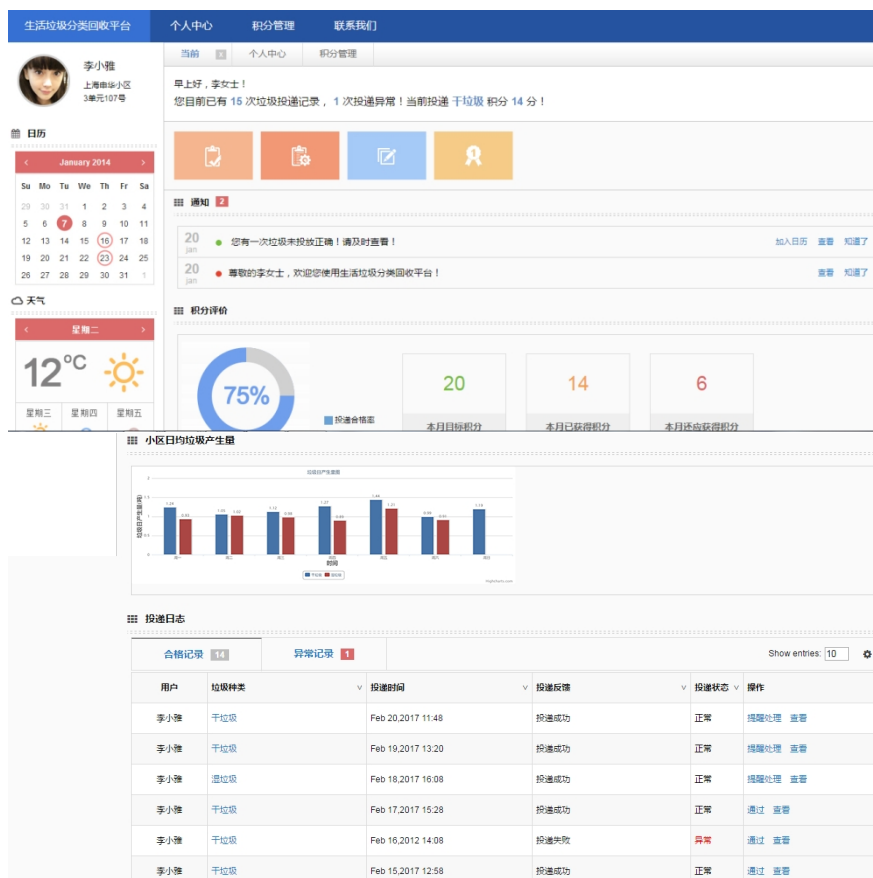


Fig7 PC side of the garbage collection and recycling platform

Advantages and risks of system platform construction

The “Internet +” urban household garbage classification recovery and transportation system is based on the urban garbage quartering method, and establishes the urban household garbage full industrial chain classified recovery network and information management platform. The use of technical constraints and artificial incentives has changed the primary stage of source-classification and residents’ aware of classification. The intelligent dustbin in the development research is used to track the behavior of the residents' garbage disposal in real time. The development of intelligent garbage in the public area of the city, in the promotion of garbage classification, can also effectively reduce the garbage collection frequency. The development of the smart classification dustbin in the public area, not only can promote garbage classification, but also effectively reduce the garbage collection frequency. Integrated with “Internet +”, the system can realize real-time interaction of data, master the current situation of garbage classification and recycling in urban areas, and interact with cloud server; Connect many environmental management departments with users to realize the share of garbage collection, transportation and disposal information, and open the barrier of information transmission; There will also be a more reasonable allocation of limited social resources.

About the risks of the construction of the system platform, mainly from two aspects, one is the urban household garbage classification recycling and transportation system operation management, another one is household garbage classification architecture. The risk of system operation management comes from the system itself, such as the distribution of location about garbage collection containers in the Source-separated garbage classification period, which may affect the

collection; the setting of power and selection about intelligent dustbin in severe conditions such as strong wind. The risk of platform structure comes from the component and architecture: such as inaccurate grasp of household garbage recycling system platform during the requirements phase, errors of the program during design phase, introduction of implementation, the risks during maintenance phase, and the address information about residents etc.

In view of the risks in classification system about operation management and structure, circumvention measures can be taken: such as the risk assessment of the system before, during design and after the event; Sorting and summarizing the whole process plan and result of garbage source-classification, middle-clearance and terminal- disposal; Prevention of possible risks to the system or platform.

Conclusion

①The research of this system preliminarily discussed integration of embedded development technology, database management technology, data communication, computer network technology, mechanical principle etc. And applied to the structure of “Internet +” urban household garbage classification recovery and transportation system.

② It preliminarily provided an intelligent and informative garbage classification and transportation system solution, and realizes the classification and recycling of municipal household refuse by means of technical means.

③The research of this system has preliminarily laid down the technology and management foundation of garbage effective classification and intelligent recycling. When it comes to adaptability and convenience due to the limitations of technology, the system will take Process optimization.

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Reference

- [1] Sun Xudong. *Household Garbage Classification Model and Its Collection and Transportation Facilities Construction in Sino-Singapore Tianjin Eco-city*[J]. Environmental health engineering, 2016, (02):90-92.
- [2] Li Zhicheng. *The System Network Research and Application of ZigBee Protocol*[J]. Network security technology and application, 2016, (04):102.
- [3] Liang Qin, He Xinwa, Liu Jiaxian, Feng Xianchao, Huang Zhanpeng, Qi mingming and Li Xinyu. *The Exploration of The Intelligent Garbage Classification Management System Based on the Network*[J]. Information and computer, 2015, (23):50-51.
- [4] Cen Mingcong. *Research on Strategy of Dic Company Based on “Internet+ ”*[D]. University of Electronic Science and Technology of China, 2015.
- [5] Chen Dongmei, Wang Hongyu. *Brief Talk on the Importance of Garbage Classification in*

- Colleges[J]*. Journal of Liaoning administration institute, 2015, (11):76-81.
- [6] *Assessment Report on the Status of Chinese Municipal Solid Waste Management[J]*. China Resources Comprehensive Utilization. 2015, (05):11-13.
- [7] Deng Hongchao. *The Study of Bonus Points System by Household Garbage Sorting and Recycling in China[D]*. Guangxi Normal University, 2015.
- [8] Huang Juntong, Cui Linjie. *Chinese and South Korean Garbage Classification Experience to China's Enlightenment[J]*. Science and Technology Innovation Herald, 2015, (03):110.
- [9] Luo xiaorui. *Research on Status and Countermeasure About Urban Sorting Collection of Household Waste[J]*. Jiangxi building materials, 2014, (17):283.
- [10] Li Xiuli, Zhou Mingyuan, Fan Li, Yu Lin. *Study on the Separation and Recovery System for Municipal Solid Waste Based on the Internet of Things[J]*. Industrial safety and environmental protection, 2014, (07):64-66.
- [11] Zhou chunying, Lin wanxia, Jia Weiguo, Ma Longhua. *International Comparison of Disposal of Urban Household Waste and Three-dimensional Management Method in China[J]*. Journal of Anhui Agri.SCI.2014, 42(18):5916-5917, 5927.