Design and development of a domestic garbage removal management platform based on the Internet of Things

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Abstract. In order to meet the demand of intelligent city for domestic garbage classification and effective transportation, this paper discusses the overall scheme of the domestic garbage classification management system based on the "four classifications" standard of domestic garbage, using the characteristics of the Internet of Things and the existing intelligent garbage classification equipment. Subsequently, an intelligent domestic waste removal and transportation plan was proposed, and a new model of domestic garbage intelligent removal was established. Through the development of mobile terminals and the design of the background management system, an intelligent domestic garbage removal management platform is built, which improves the efficiency of transportation and realizes the intelligent management of domestic garbage classification and transportation.

1. Introduction
With the advancement of the concept of sustainable economic and social development, the classification and utilization of domestic garbage as resources is not only the demand of circular economy at the present stage, but also the need of green development [1]. However, most of the city's clearing trucks still transport all kinds of garbage together, which restricts the development of harmless garbage treatment. In order to avoid secondary pollution during garbage removal and reduce the cost of garbage classification and treatment, the domestic garbage removal management platform takes intelligent garbage classification equipment as the application core, integrates cutting-edge technologies such as the Internet of Things, big data and multi-objective information management, combines the demand of urban domestic garbage collection and transportation, creates a new mode of garbage classification and transportation, and makes garbage collection and transportation more intelligent and efficient[2].

2. Domestic garbage classification standards and removal requirements
According to the classification standard of domestic garbage, the domestic garbage is divided into four categories: recyclable garbage; other garbage; kitchen waste and hazardous garbage, which are referred to as "Four classifications".

The four categories are the standards that best match the actual disposal of household garbage at present, and were determined after extensive public consultation. The separating hazardous garbage is to prevent environmental pollution; the separating recyclables is to maximize resource recycling; and separating wet and dry is for the efficient use of kitchen garbage and more efficient incineration of other garbage[3].
At present, garbage classification fails to cover the whole life cycle of domestic garbage, and is only limited to the two links of classified delivery and classified treatment. The classified delivery and classified treatment of domestic garbage put forward the requirements of sorting transportation and transportation supervision for the garbage[4]. "Four classifications" of garbage need to use different vehicles for transport to avoid the mixed pollution of classified domestic garbage. It not only improves the collection and transportation efficiency of the clearing trucks, but also reduces the cost of garbage separation and treatment.

3. Domestic garbage removal management platform

3.1. Overall design of domestic garbage classification management system

The Internet of Things (IOT) technology has the characteristics of interconnecting devices, multiple interaction modes and intelligent management of the whole process, etc[5]. The domestic garbage classification management system is divided into three layers by using the characteristics of IOT: user layer, network layer and device layer. The user layer includes households, system administrators and cleaning staff; the network layer includes mobile terminals, terminals and databases; the device layer covers the site management system and the removal management platform. The site management system completes the front-end intelligent classification of domestic garbage according to the "four classification" standards. The cleaning staff uses the removal management platform to classify and transport the garbage, while the network layer realizes data sharing at each layer. The whole system realizes the overall process monitoring and intelligent management of classification and transportation, improving the efficiency and quality of domestic garbage classification and transportation. The Overall design of domestic garbage classification management system is shown in Figure 1.

![Figure 1. General design of domestic garbage classification management system](image)

3.2. Domestic garbage removal mode

The intelligent domestic garbage removal mode can be divided into three parts, namely the Vehicle dispatch management part, the navigation path optimization part and the sorting and recycling part. Among them, the vehicle dispatch management part is divided into four types of removal units according to the type of garbage removal. The removal unit is composed of a cleaning truck and a mobile terminal, which sends the domestic waste to the corresponding garbage recycle bin based on the removal mode. So it realizes the effective cleaning and transportation of domestic garbage. The framework of the intelligent domestic garbage removal model is shown in Figure 2.
When receiving the clearing task, the removal unit will arrive at the station to be processed in the light of the navigation prompts of the mobile terminal, and then go to the garbage recycle bin in the designated area to complete the whole clearing task. The removal management platform uses positioning technology to monitor the removal of garbage in real time, thus reducing secondary pollution during the transfer process and avoiding the mixed transport of classified domestic garbage[6].

3.3. Garbage Removal workflow
The removal unit completes the clearing work with the help of the removal management platform.

First, the removal unit obtains the corresponding account permissions according to the clearing type, and completes the login verification through the mobile terminal. When it logs in successfully, it browses the task list and selects clearing tasks based on its processing power, geographic location, and task content. After the removal unit accepts the task, the mobile terminal will obtain the optimal clearing route plan and task list by the removal management platform. It can view the clearing route through the mobile terminal and complete the route navigation according to the positioning system. The removal unit arrives at the task location to collect garbage. When the task is completed, the garbage site will feedback the garbage clean up status to the removal management platform. At the same time, the mobile terminal will automatically prompt the removal unit for the next task and navigate intelligently. Finally, this process is repeated until all tasks are completed. The entire garbage removal workflow can refer to the following flowchart.

4. The removal management platform software development
The removal management platform software is a cleaning and navigation tool jointly developed based on the Android development platform and Baidu Map SDK kit, which can improve the efficiency of removal unit and realize intelligent navigation of classified cleaning and transportation[7]. Through the information interaction between the removal management platform software and the removal management platform, the removal unit can complete tasks in accordance with the clearing process[8].
4.1. The removal management platform program development

4.1.1. Task selection. After successfully logging in to the removal management platform, the removal unit can browse the task list and select clearing tasks based on its processing power, geographic location, and task content. The following is part of the code for the task selection operation.

```java
public void onClick(View arg0) {
    if (BaiduNaviManagerFactory.getBaiduNaviManager().isInitEd()) {
        T1Node = new BNRoutePlanNode.Builder()
            .latitude(30.54654614081967).longitude(114.29714039621769)
            .name("site 111").description("site 111")
            .coordinateType(BNRoutePlanNode.CoordinateType.WGS84)
            .build();
        list.add(T1Node);
        mRecyclerView.setAdapter(mAdapter = new HomeAdapter());
    }
}
```

4.1.2. Path planning. After the task of the removal unit is selected, it is submitted to the removal management platform. The platform uses the multi-passage path planning interface provided by the Baidu map API to calculate the sequence of multiple destinations/routes, so as to obtain the best route for clearing and help the removal unit to complete the route planning. The following is part of the code for path planning[9].

```java
BaiduNaviManagerFactory.getRoutePlanManager().routeplanToNavi(list,
    IBNRoutePlanManager.RoutePlanPreference.ROUTE_PLAN_PREFERENCE_DEFAULT, null,
    new Handler(Looper.getMainLooper())
    {
        @Override
        public void handleMessage(Message msg)
        {
            switch (msg.what)
            {
                case IBNRoutePlanManager.MSG_NAVI_ROUTE_PLAN_START:
                    Toast.makeText(DemoNaviActivity.this.getApplicationContext(), "Start ",
                        Toast.LENGTH_SHORT).show();
                    break;
            }
        }
    }
```

4.2. Design of software interface of removal management platform

4.2.1. Login and task screens. The login interface includes functions such as account and password login, user registration, and password retrieval. In the task interface, the removal unit can view the current pending clearing tasks in real time and change tasks according to its own clearing situation. The login interface and task selection interface are shown in Figure 4 and Figure 5 respectively.

![Figure 4. Display diagram of task interface](image1)

![Figure 5. Display diagram of login interface](image2)

4.2.2. Route selection and navigation interface In the route selection interface, the removal unit can select the route based on the distance, time, traffic situation and other information. In the navigation interface, the removal unit can obtain prompts such as driving direction, distance and road section...
information. The route selection and navigation interface are shown in Figure 6 and Figure 7 respectively.

5. Background management system for the removal management platform

5.1. Removal management platform database

This platform uses MySQL database. The database contains information about the removal unit, task information, garbage site information, and trash bin information[10]. The field table of the removal unit is shown in Table 1.

| Field name     | Type           | null | Main key |
|----------------|----------------|------|----------|
| Car_ ID        | int (11)       | No   | Yes      |
| Car_type       | varchar(64)    | No   | No       |
| Station_addr   | varchar(128)   | No   | No       |
| Recycle_bin    | varchar(128)   | No   | No       |
| People_Num     | varchar(64)    | No   | No       |
| Work_Time      | datetime       | No   | No       |
| Reflash_Time   | datetime       | No   | No       |
| Total_usage    | varchar(64)    | No   | No       |

5.2. Background management system design

The background management system is a multi-objective information management system based on the Django framework, which realizes the real-time monitoring of removal unit and the visualization of data. After logging into the Background management system, the system administrator can monitor the indicators of each module and grasp the current working status of multiple removal units in real time [11].

5.2.1. Operation Monitoring The system administrator use the function of operation monitoring to realize the path tracking of the clearing trucks, the display of the task list, the statistics and analysis of the daily report data and the station distribution of the removal, so as to help the operation
management staff make decisions in the daily clearing tasks, personnel assignment and site management. The operation monitoring is shown in Figure 8.

Figure 8. The operation monitoring interface

5.2.2. Data Panel  The data panel is the most complex and involving the most data in the comprehensive data display of the data board. It mainly focuses on the comprehensive data of garbage removal, the type of garbage data, and the period of removal. The data panel is shown in Figure 9.

Figure 9. The data panel interface
6. Conclusion
In order to solve the problem of mixed domestic garbage removal, this paper proposes a solution to build a management platform for domestic garbage removal. First, it introduces the domestic garbage removal mode and discusses the removal process. Secondly, through software development, database construction and background management system design, the construction of the removal management platform is completed. Finally, the removal management platform analyzes the clearing data and instructs the removal unit to complete the clearing tasks, achieving the purpose of improving the efficiency of garbage removal and reducing the secondary pollution in the garbage removal process.

Acknowledgments
This article is sponsored by The Open Project of Wuhan Research Institute of Jianghan University (NO.IWHS20191010), The Natural Science Foundation of Hubei Province (NO.2020CFB456).

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