Smart Relocation System

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Abstract. With the increase of social mobility, the relocation of work and living places has become the norm in people's daily life. However, the current level of informatization in the handling industry is generally low. If users want to know the progress of the porter age, they can only go to the site in person; after the porter age is completed, if they want to find the items, they need to search through the piles of boxes. It is even impossible to know the detailed location of the items. So there is an urgent need for an intelligent system that can comprehensively control the entire handling process from inventory, porter age to item positioning. The intelligent handling system designed in this paper uses the Internet of Things, network communication, artificial intelligence, cloud computing and other technologies, which can sensitively capture the packed items to improve the packing efficiency, quickly and accurately identify the name of the item to facilitate searching, and establish multi-level tags to store item information and achieve fuzzy matching, and encryption at each stage to ensure user privacy.

Keywords: Object recognition, Fuzzy matching, Convolutional neural network, Internet of Things

1. Introduction

With the advancement of science and technology, social mobility has increased, and relocation has become the norm in people's daily lives. For this reason, intelligent handling systems have developed rapidly, and relatively mature handling systems such as Cainiao Logistics, JD Logistics, and Cargo Lalla have emerged. But unfortunately, after previous market research, the head enterprise handling systems including "CHINAANT" and "cargo pulling" still have problems such as low level of informationization, poor control of items, and difficulties for users to find items. Based on this, this article proposes a cloud-based intelligent handling system that combines AI intelligence and Internet of Things technology to carry out informatization management of the entire handling process.

1.1 Quick Registration for Relocation Items

During the relocation process, the complicated and trivial items often make people unable to start. It is a very tedious and time-consuming process to rely on manpower to register the items during the removal process. The relocation of small families is still difficult to record. For large companies or laboratories, The situation will only become more serious due to the large number of departments involved and the more diverse types of items.
1.2 For finding Items Quickly After Arriving at the Destination
Since multiple people pack and carry items together during the relocation, users can only rely on the information recorded during packing when looking for items, and this information is often very simple, and the items will be randomly placed in the container for unified porterage, which makes it extremely difficult to find an item after arriving at the destination.

1.3 For Controlling Items at Any Time During Porterage
Because of the lack of informatized records for the entire porterage process, the removal company is solely responsible for the porterage process, so once the items are lost, it is extremely difficult to retrieve them. If the lost items are important documents or experimental materials, the losses caused will be difficult to count.

2. Design Drawing of Smart Relocation System
Based on the above-mentioned problems in relocation, this paper designs a set of systems that can realize smart handling, which provides greater convenience for people’s relocation work. This system mainly combines AI intelligence and Internet of Things technology to carry out information management for the entire porterage process. The system is divided into three parts: terminal interaction, information collection, and cloud processing. The system provides a convenient and fast retrieval service on the terminal. Users can quickly query the box where the item is located on the mobile phone APP or PC web page. With the help of fuzzy matching technology, only some features of the item can be successfully retrieved. In response to the increasingly serious problem of user privacy leakage, the system strongly encrypts data in the information collection part. After the data arrives in the cloud, it is encrypted and stored. At the same time, the identity of visitors is strictly restricted to minimize the risk of leakage. This system builds an item recognition model based on convolutional neural network in the cloud, combining text recognition OCR technology and color perception technology, and extracts characteristic information such as type, text, and color from the acquired image data. After the cloud processing system integrates the data, it returns the list of items in the box to the terminal display interface.

![Figure 1. Design drawing of smart relocation system](image)

The hardware part of this system is mainly composed of Raspberry Pi, camera module, GPS module and wireless network card module. Raspberry Pi 3B+ is the main control module, Raspberry Pi 3 Model B+ uses a 64-bit 4-core ARM Cortex-A53 CPU processor, which can meet the needs of the system. The camera module adopts the aoni C30 camera, which facilitates the rapid recording of relevant image data, which perfectly meets the needs of the system for capturing item feature information. The GPS module adopts the ATK-NEO-6M-V23 module, the module adopts the L80-39 module solution, adopts the NMEA-0183 protocol, integrates a small GPS antenna interface, has the advantages of ultra-low power consumption, fast positioning, etc., which can meet the needs of
providing item location Information needs. The wireless network card module adopts the wireless network card EDUP EP-N8508GS module that comes with the Raspberry Pi 3B+ development board for data transmission and interaction to the cloud platform. In addition, there are LED lights and buzzers to achieve alarm functions.

3. Design of Smart Relocation System

3.1 Design of Information Collection Link

The information collection link needs to realize the sensitive capture of the items put into the box. It also needs to capture quickly and accurately without omissions. This article mainly uses camera motion detection technology to achieve the above goals. At present, the commonly used techniques for detecting moving targets are: background difference method \(^1\), optical flow method and frame difference method. Because the camera is in a static state in the actual application of this system, the background difference method is used to detect moving targets. The function code is implemented using the relevant functions provided by the opencv-python library.

First of all, image preprocessing is required. This step mainly performs grayscale processing and Gaussian filtering on the image. Because each input video will produce noise due to natural vibration, lighting changes, or the camera itself. The use of Gaussian filtering to smooth the noise is to avoid detecting it during motion and tracking. Next, background modeling is performed. The main function of the background is to judge whether there are moving objects as a basis for comparison. After the system is turned on, the gray value of the first 50 frames of pictures is counted, and interval statistics are performed to obtain a statistically significant Initial background. Then, foreground extraction is required. After the gray scale conversion and smoothing of the frame are completed, the difference with the background frame can be calculated and a difference image can be obtained. It is also necessary to apply a threshold to obtain a black-and-white image, and then dilate the image. From the normalization of holes and defects, the specific threshold is obtained through statistics. The last is the sensitivity setting. In this step, setting the threshold is required. When the area of the moving foreground area is larger than this value, it is considered that there is currently an object in motion. The image at this time is taken and uploaded to the cloud.

3.2 Design of Information Collection Link

The cloud server mainly stores the uploaded item pictures and performs item recognition. Here, it mainly relies on the use of convolutional neural network to train an item recognition model. At present, convolutional neural network technology \(^2\) is a hot topic in neural network \(^3\) research. It is relatively mature in itself. When used in image recognition, its accuracy has reached or surpassed the human level. But it has to be pointed out , when processing complex category images, the recognition rate of large deep convolutional neural networks will be reduced. And when a large number of samples are used for training, the training time of traditional large deep convolutional neural networks will be too long, if the sample loss rate increases, there will be a problem of reduced robustness. In response to the above problems, this article optimizes the traditional large deep convolutional neural network, and uses an improved model of the CNN\(^4\) model (CNN is the abbreviation of large deep convolutional neural network) to achieve intelligent identification of items. The function code is implemented using related functions provided by the tensorflow-python library. The main details of the technology are as follows:

Increase the input sample size. The traditional CNN is the LeNet-5 network, and its input sample size is 28*28, but the accuracy of the data set it processes is not high. Therefore, the accuracy of the recognition of complex categories of data such as images of daily necessities will decrease. In order to improve its recognition efficiency, the size of the input sample should be expanded here, and considering that it will cause a sharp increase in the amount of calculation when it is too large, it is difficult to achieve. Therefore, we finally locate the size of the input sample 256*256.
Increase network depth. The traditional model structure of CNN is input-convolutional layer-pooling layer-convolutional layer-pooling layer-fully connected layer-output. The hidden layer contains two convolutional layers. Deepening the hidden layer structure and increasing the number of convolutional layers will increase the recognition rate of training, but it will also increase the computational complexity of model training. Therefore, after comprehensive consideration, we have adopted the input -Convolutional layer-Pooling layer-Convolutional layer-Pooling layer-Convolutional layer-Pooling layer-Fully connected layer-Output construction. The activation function used here is the relu function. After passing through the convolutional layer and the pooling layer, its output is 60*4*4, so we integrate the data into a complete feature again through the fully connected layer, so that the output layer corresponds to the type of item one-to-one.

Training data preprocessing. In the specific process of training, this article uses the ImageNet data set. Taking into account the actual situation of the relocation, this article screens the original data set to eliminate unnecessary data such as animals and plants. A total of 30 categories are used and 30,000 are attacked. Images for training. The image definition in ImageNet is different, but the input layer of the model requires a fixed input dimension. Therefore, this article preprocesses the data before training and adjusts its format to 256*256 pixels. The specific method is to first adjust the short side size to 256 pixels, and then take the 256 pixel size part in the middle of the long side as the final image. At the same time, in order to speed up the convergence of the subsequent model, we also centralize the image.

In the process of model training, we divide the training set and the test set according to 8:2, and select 900 pictures of each item as the training set to build the model for iterative training, and 100 pictures as the test set to test the model result. At the same time, 20 photos taken of on-site objects were added as a follow-up test set. The results show that after 10 iterations of training, the accuracy of the test set is 97% and 95%. It can be seen that the accuracy of the model is high, and it meets the basic requirements of moving items identification.

3.3 Terminal Interaction Design
In practical applications, it may be difficult for users to accurately input item information during item retrieval, and the item identification module of the system may also contain certain errors. Therefore, for the convenience of user retrieval, fuzzy matching technology [5] is used here. When users are searching for items, they do not need to enter the complete item name, and the precise search for items can be achieved only through keywords. Combining the functions of color recognition and text recognition at the same time, users can find corresponding items by searching for keywords in the name of a book or the color of clothes. At the same time, in order to facilitate the user's retrieval of items, this article also establishes a logical rule library. When the user is looking for an item, the logical rule library established by the system will recommend some related items for him. For example, when searching for a mouse, the logic rule library will recommend keyboards and other items for it, as shown in the figure below.
In terms of security, this article has three main considerations. The first is to ensure that the data is not stolen during the process of transmitting the user’s item image to the server. The second is to ensure the privacy of the data when the user’s information is stored in the database. Third, to ensure the safety of items during porterage to prevent loss.

In terms of transmission, we use the ssl protocol[6] for encrypted transmission. ssl is a secure socket protocol, which is a protocol that provides security and data integrity guarantee for network communication. The protocol is between the transport layer and the application layer. Encrypt the network link between. The protocol is divided into two layers. The first layer is the SSL recording protocol, which is based on a reliable transmission protocol and provides data encapsulation, compression, encryption and other functions for high-level protocols. The second layer is the SSL handshake protocol. Mainly perform an identity authentication, negotiate encryption algorithm and exchange keys for both parties before transmission. Using this protocol well guarantees the data security of user data during transmission, and effectively avoids security risks such as man-in-the-middle attacks[7].

At the same time, we use the hash algorithm[8] to calculate the user's product information through the hash to obtain the hash value, and then store the value in the database. The Hsah algorithm is a conversion algorithm that can convert the target text into an irreversible hash string of the same length. In this way, even a person with database permissions cannot know the user's private item information.

Finally, we also installed a GPS module on the box to obtain the location of the box in real time, which has achieved the purpose of ensuring the safety of the contents in the box during porterage.

3.4 Software design
At the same time, this article also developed an Android APP for the secondary system. The App is developed based on Android Studio, and its main body is to access the built-in website through the webview control[9]. The front-end of the website is written based on the Jquery framework, and the back-end uses php for interaction, and uses SQL-related functions to achieve normal interaction with the database. Finally, when the user opens the APP and successfully logs in, he can obtain the time, location, starting point and other information of his related items in real time, and he can also modify part of his information, such as binding and releasing the tote Wait.

The item search interface uses Ajax to interact with the database. At the same time, the database side stores the item information with three-level tags, so that users can search for items through fuzzy matching, either directly using the name field of the item for searching, or Use additional information
such as color and text to search for items. The retrieved item information is set using bootstrap method[10], and the related items of this item will be retrieved automatically after clicking. The interface of the APP is shown in the figure below.

**Figure 4.** Android APP interface

4. **Function operation results**

The function of item recognition is first shown here. The related information can be obtained from the image data of the item after neural network recognition.

**Figure 5.** Information recognition

When the identified item data is stored in the database, it will be hash encrypted, and the login information of the account will also be encrypted to ensure the security of personal data.

**Figure 6.** Data after hash calculation
After the user uses the App to search for items, the App will perform fuzzy matching based on the information given by the user to list related items. When the user clicks on an item's information, the App will guess and recommend the related items that the user needs based on the built-in association library. For example, when the user is looking for toothpaste, the location of the toothbrush will be recommended for the user. This can effectively facilitate the user's search.

5. Conclusion
At present, we can check that many handling companies have formed a systematic process, but the current handling system still relies on manpower to remember the loaded items. It can only be regarded as the transition from manual to intelligent, which cannot represent intelligent, let alone Internet of Things. This is why the “move once and lose once” has become the norm for the handling company.

The current intelligent handling system has not officially appeared in the market, but with the continuous development of artificial intelligence, the technology of item recognition is constantly improving. In the next few years, the intelligent handling system will surely appear and be applied to various handling companies and wider. In the application place, the perfect fit of "end + platform + real-time viewing" is truly realized, a real intelligent handling platform is built, the closure of handling and item information is broken, and the vision of complete integrated marketing.

The intelligent handling system in this article can also be applied to different scenarios according to the size of the box. Large boxes can be used for porterage, and small boxes can be used as storage boxes, so that item information can be accurately known regardless of item porterage or storage. This shows that the intelligent handling system has a huge market prospect.

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