GARBAGE CLASSIFICATION MANAGEMENT SYSTEM

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Abstract

Dengan mempercepatkan proses urbanisasi, isu pengelasan sisa telah menjadi faktor kunci dalam mempromosikan pembangunan lestari. Kaedah pengelasan sisa manual tradisional mempunyai kecekapan rendah dan kadar ralat tinggi, terutamanya apabila menangani sisa yang kompleks dan bercampur, di mana ketepatan sukar dipastikan. Untuk menyelesaikan masalah ini, kajian ini mencadangkan dan melaksanakan satu sistem pengelasan sisa pintar berdasarkan model pembelajaran mendalam ResNet-18. Sistem ini mengelaskan sisa secara automatik melalui teknologi pengenalan imej, meningkatkan kecekapan pengelasan dan mengurangkan kesilapan manusia. Ia menyokong operasi dwibahasa bahasa Cina dan Inggeris, serta menyediakan fungsi rekod sejarah pengelasan, yang seterusnya meningkatkan pengalaman pengguna. Melalui eksperimen, sistem ini menunjukkan prestasi yang baik dari segi ketepatan pengelasan, kelajuan tindak balas dan interaksi pengguna, serta mampu memenuhi keperluan sebenar pengelasan sisa harian. Sistem ini bukan sahaja mempunyai kadar ketepatan yang tinggi, tetapi juga mempunyai kebolehperluasan yang kuat, menyediakan sokongan teknikal untuk pembinaan kecerdasan dan informasi pengelasan sisa pada masa depan.

Kata kunci : Pengelasan sisa , Pembangunan lestar , Urbanisasi , Model pembelajaran mendalam (ResNet-18).

Abstract

As urbanization accelerates quickly, waste classification has also become a critical factor in promoting sustainable development. The traditional manual waste classification approach is not effective and has a high rate of errors, and it is difficult to ensure accuracy, especially when dealing with complex and mixed waste. To address this issue, this research proposes and constructs an intelligent waste classification system based on the ResNet-18 deep learning model. The system classifies wastes automatically by adopting image recognition technology and thereby improving the efficiency of classification and reducing human errors. It both facilitates Chinese and English operation and provides a function of classification history records, enhancing the user experience as well. The system has achieved good performance in terms of classification precision, response speed and user interaction during experiments, and can meet the real requirements of daily waste classification. Not only does the system have a

good accuracy rate, but it also has good scalability, and it can support technical work on intelligent and information-based construction of waste classification in the future.

Keywords : Waste classification, Sustainable development, Urbanization, Deep learning model (ResNet-18).

1.0 INTRODUCTION

With the fast pace of urbanization, waste classification has become a critical challenge in sustainable development. With accelerating urbanization, waste diversity is increasing. Traditional waste classification systems relying mainly on human judgment have reduced efficiency and accuracy. They tend to be more faulty, especially when dealing with complex and mixed waste. Human errors not only diminish the value of recyclable waste but also increase the burden for landfills and incinerators, leading to higher processing costs and potential pollution of the environment. Therefore, improving accuracy and efficiency in waste sorting mechanisms, better still in the initial sorting stage, is of great significance (Fotovvatikhah et al., 2025).

To overcome the low efficiency and high errors of the traditional manual sorting, artificial intelligence has been introduced into the waste image recognition and classification process in recent years. Deep learning-based image classification technology has great potential (He et al., 2016). In this project, a smart waste classification system based on the ResNet-18 neural network structure will be developed. The system sorts waste automatically based on image recognition technology, with higher efficiency in processing, reduced errors from human involvement, and increased public participation in environmental protection activities (Yang et al., 2021).

This study uses the ResNet-18 model for image classification. Capitalizing on its ability to efficiently address the problem of the vanishing gradient in deep neural networks, waste image classification becomes more accurate. The system not only supports multilingual functionality (Chinese and English) but also has a function for querying the historical record, which enhances the applicability and user experience of the system (Kang et al., 2020).

2.0 LITERATURE REVIE

Waste management has become increasingly important, and intelligent classification technology has also emerged as a mainstay to counterbalance the inefficiency and high error rate of traditional manual classification (Chacón-Albero et al., 2025). To counterbalance this, various waste classification models based on computer vision and deep learning have been proposed in diverse domains such as mobile apps and web systems (Islam et al., 2025). In this chapter, we elaborate on three common waste classification systems, i.e., open-source Garbage-

classification-web, object localization-based Trash AI, and light iOS application DeepWaste. Through comparison of their function implementation, technical structure, and user experience, we can better realize the advantages and disadvantages of existing systems and provide valuable technical references for this project (Ahmed Khan et al., 2024).

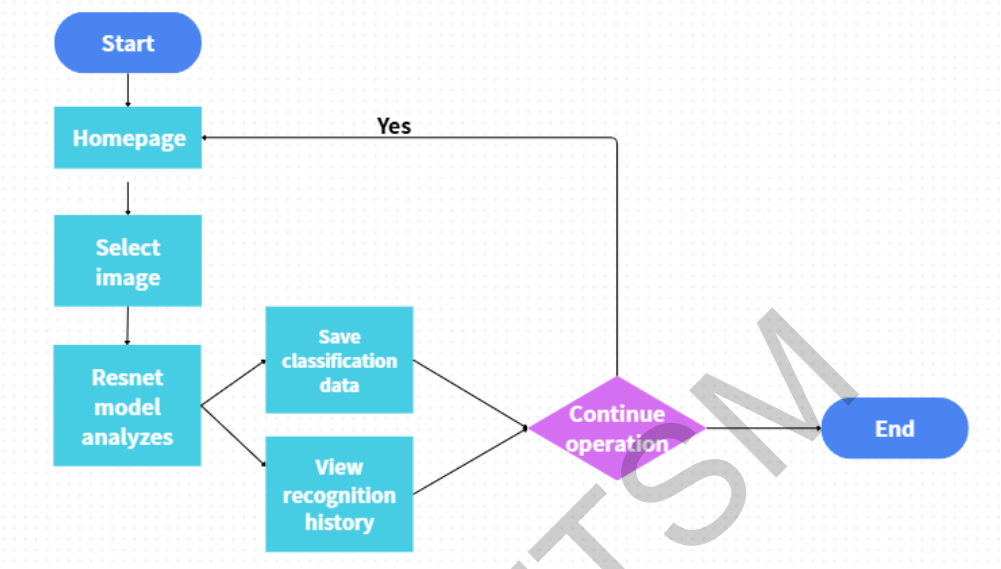
Table 1 System comparison

Platform	Problem Solution	Advantage	Disadvantage
garbage-classification-web	Classifies uploaded images into 6 types	Open-source, flexible deployment	No multilingual support, no history feature
Trash AI	Detects and localizes multiple waste items	Bounding boxes, suitable for demonstrations	No bilingual support, minimal interaction
DeepWaste	The short videos show the cooking steps and help users to quills.	Easy to use, lightweight, fast processing	Limited features, no web version, no history
ResNet-18 Web Classification System	Automatically classifies waste images	Bilingual support, history tracking, user-friendly interface	No object detection, accuracy needs improvement

3.0 METHODOLOGY

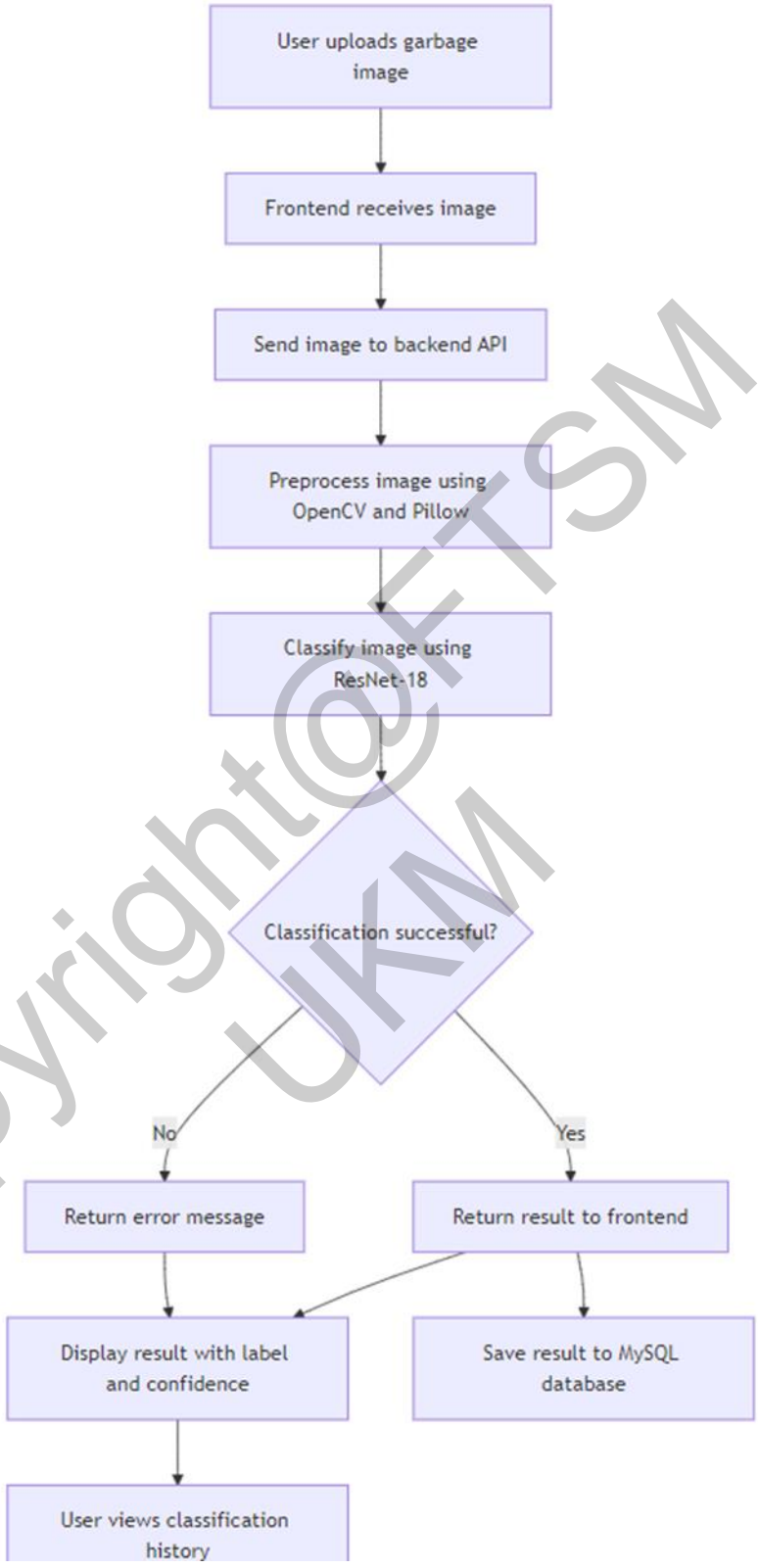
This project adopts a modular iterative development strategy, combining deep learning image classification models with modern Web technologies to ensure the comprehensiveness of system functions and the smoothness of user experience (Dingseyr et al., 2012). The front-end of the system uses the Vue.js framework for interactive design, the back-end uses Flask to build a lightweight server, and MySQL is employed as the database for data storage and management. The focus of the system design is not only on improving classification accuracy but also on enhancing user interaction experience, especially the functions of multilingual support and historical record viewing (He et al., 2016).

The flowchart outlines the complete operational process of the smart waste classification system: After system startup, users are directed to the homepage where they can either upload images or take photos directly. The system analyzes the images through its model and outputs classification results while saving the recognition data. Users can view newly created recognition history records and choose to either initiate new recognition tasks or end the session. The process concludes with logout, forming a closed-loop operation chain from login and recognition to data storage.



FIigure 1 Overall system flow

The flowchart illustrates the workflow of the intelligent waste classification system: After a user uploads a garbage image, the frontend sends it to the backend API. The backend processes the image using OpenCV and Pillow for preprocessing and classifies it using the ResNet-18 model. If the classification is successful, the system returns the result—including the category label and confidence score—to the frontend for display, while also storing the record in a MySQL database. If the classification fails, an error message is returned. Users can review past classification results in the history section, completing a closed-loop process from upload and recognition to storage.

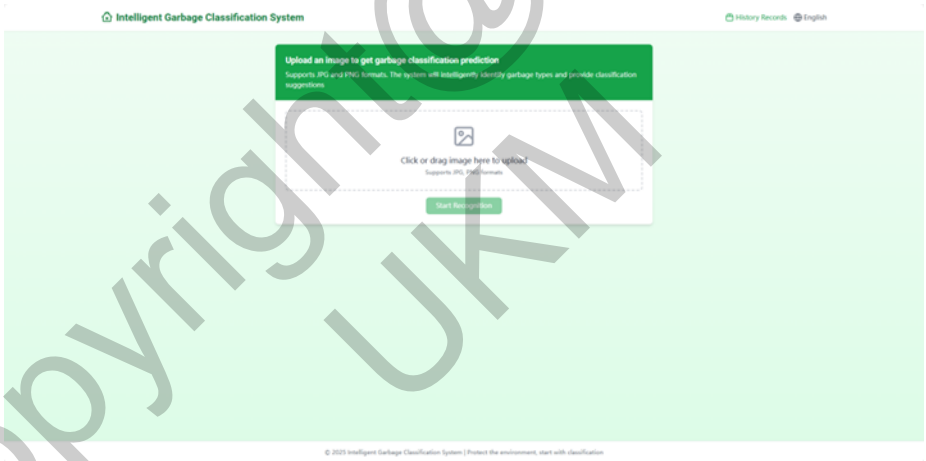


FIigure 2 Flow Chart

4.0 RESULTS

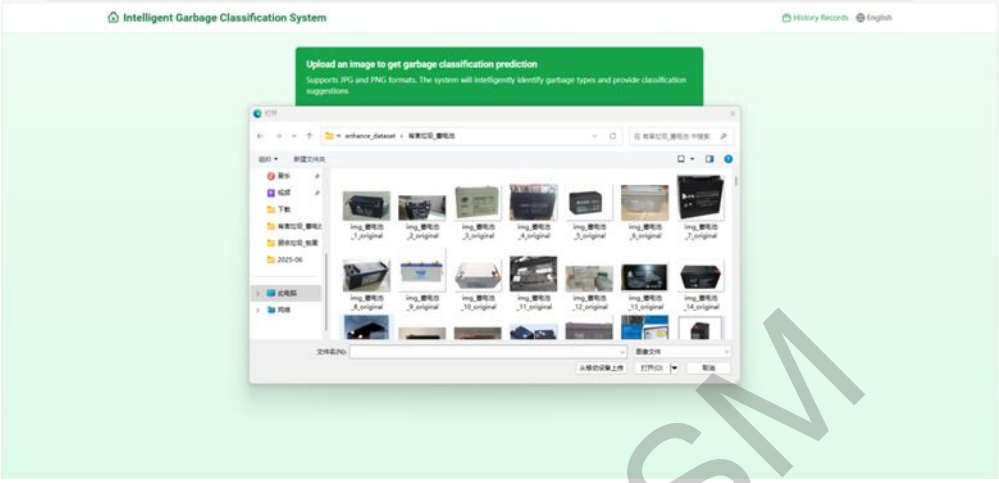
After the integration of the front - end and back - end of the system, a complete teaching file management function has been realized, including modules such as course allocation, file upload, file viewing, commenting, searching, and version control. The user operations are smooth, the interface is simple and intuitive, batch operations and status highlighting are supported, which effectively improves the efficiency of teaching task delivery.

This is the operation interface of the Intelligent Garbage Classification System. The interface design is simple and clear. At the top, there are entry points for functions like "History Records" and "English (to switch the language to English)". The core area guides users to upload images in JPG or PNG format. By clicking the "Start Recognition" button, the system can use intelligent technology to identify the type of garbage and provide accurate classification suggestions, facilitating efficient and scientific garbage classification and practicing the concept of environmental protection. At the bottom, there is also a copyright notice and an environmental protection slogan “Protect the environment, start with classification”, providing a convenient digital solution for garbage classification in terms of both functions and concepts.



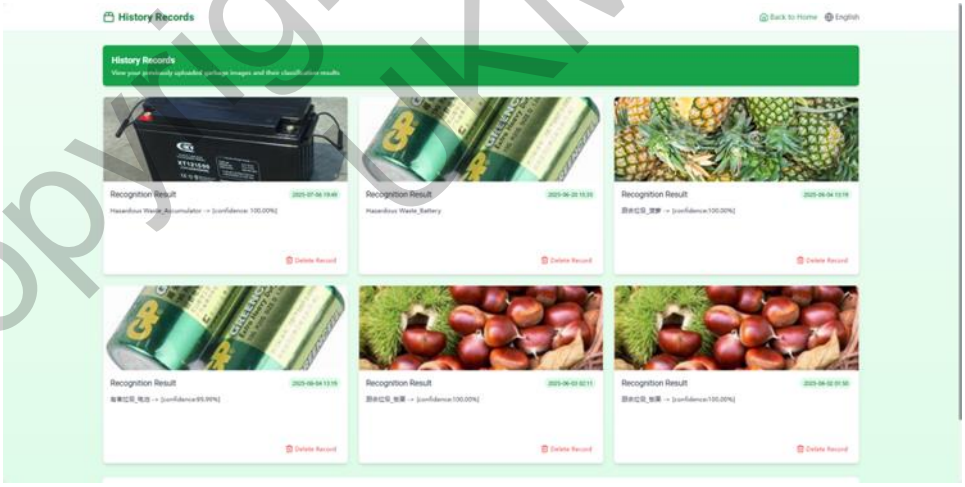
FIigure 3 Homepage

This is the file upload page of the Intelligent Garbage Classification System. The green prompt bar at the top guides users to upload an image for garbage classification prediction. It supports JPG and PNG formats, and the system will intelligently identify the garbage type and provide classification suggestions. A local file selection window pops up in the middle, displaying various files related to different devices, making it convenient for users to select the garbage images to be recognized and facilitating the efficient completion of garbage classification operations.



FIigure 4 Upload Page

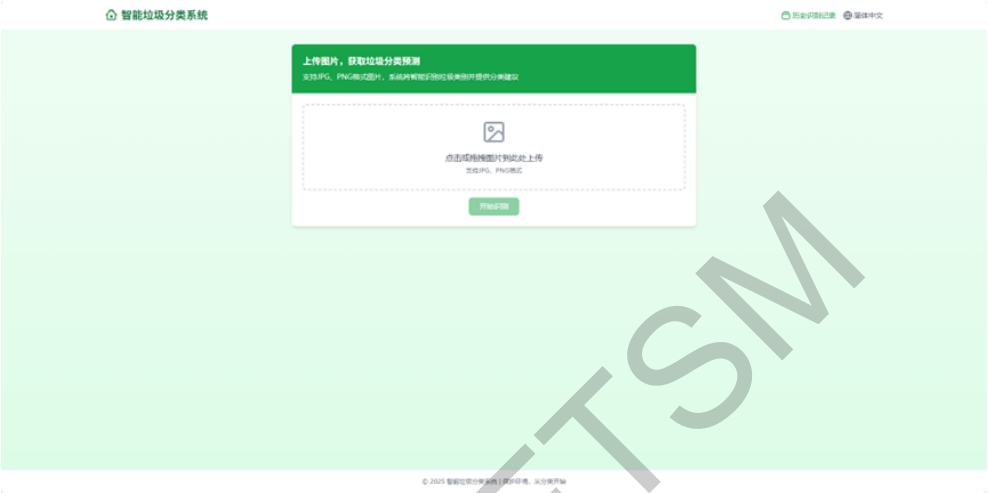
This is the Historical Classification Records page of the Intelligent Garbage Classification System. It displays images of garbage that have been previously identified. Next to each image, the recognition result and date are labeled, and there is a “Delete Record” button, allowing users to manage historical classification information easily. At the top, users can “Back to Home” to return to the main page or switch the language to “English”, helping them trace back and review the historical operations of garbage classification.



FIigure 5 Historical Classification Records

This is the operation interface of the Intelligent Garbage Classification System, supporting Chinese - English interface switching. At the top, you can switch between the “Intelligent Garbage Classification System” in Chinese and the English mode. The core function is to upload images in JPG or PNG format. Click “Start Recognition”, and the system will intelligently identify the garbage type and provide classification suggestions, facilitating

environmental - friendly garbage classification. There is copyright and other information at the bottom.



FIigure 6 Chinese-English interface switching

This chapter introduces the smart waste classification system, featuring an intuitive interface that allows users to upload JPG/PNG images for AI-powered waste recognition and classification suggestions. It includes a file upload guide, historical records with deletion options, and bilingual (Chinese/English) support, providing an efficient digital solution for eco-friendly waste sorting.

5.0 CONCLUSION

This project has successfully developed an efficient and accurate intelligent waste classification system using ResNet-18-based deep learning technology. The system not only supports bilingual operations in Chinese and English but also features a historical record query function, which enhances user interaction experience and system usability (Goodfellow et al., 2016). Although the system's performance degrades when the quality of waste images is poor or the hardware performance is low, the robustness and response speed of the system can be effectively improved in the future by further optimizing the model and enhancing image processing capabilities. The system provides technical support for the intelligent and information-based development of waste classification and has broad application prospects (LeCun et al., 2015).

Despite the good results achieved by the system in waste classification, there is still room for further improvement. In the future, the practical application effect of the system can be further enhanced by introducing more advanced image processing technologies, improving the system's response speed, and enhancing the scalability of the model. In addition, cloud

deployment, multilingual support, and enhanced user interaction functions will be the main development trends of the system (Simonyan & Zisserman, 2014).

6.0 REFERENCES

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