Computer Vision Based Garbage Detection, Cleanliness and Monitoring System

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ABSTRACT-* The Computer Vision Based Garbage Detection & Cleanliness Monitoring System is a web-based application developed to automate the classification of garbage using deep learning and computer vision techniques. The system enables users to register, log in, upload garbage images, and receive instant predictions of the waste category along with a confidence score. A Convolutional Neural Network (CNN) model is trained using the Garbage Classification V2 dataset to identify different types of waste such as plastic, paper, cardboard, glass, metal, battery, and biological waste. The application is developed using Python, Flask, TensorFlow/Keras, OpenCV, HTML, CSS, JavaScript, and SQLite for efficient data management. Prediction results are stored in the database and displayed through a history page and dashboard for future analysis. The proposed system provides an accurate, user-friendly, and cost-effective solution for automated waste classification, supporting improved cleanliness monitoring, efficient waste management, and environmentally sustainable practices.

KEYWORDS: Computer Vision, Garbage Detection, Garbage Classification, Cleanliness Monitoring, Convolutional Neural Network (CNN), Deep Learning, Image Processing, Waste Management, TensorFlow, Flask.

INTRODUCTION

Effective waste management plays a vital role in maintaining a clean and healthy environment. With advancements in Computer Vision and Deep Learning, automated garbage classification has become an efficient solution for waste segregation. This project combines image processing and Convolutional Neural Networks (CNNs) to accurately identify different types of garbage from uploaded images. The proposed system not only improves the efficiency of waste classification but also supports cleanliness monitoring by providing a fast, reliable, and intelligent solution for sustainable waste management.

LITERATURE SURVEY

Garbage management has gained significant attention in recent years due to increasing urbanization and environmental concerns. A computer vision-based garbage detection system is designed to automatically identify and classify different types of waste using image processing and deep learning techniques. The core concept of the proposed system is to automate waste classification by analyzing uploaded garbage images and accurately predicting their categories. By integrating Computer Vision, Convolutional Neural Networks (CNNs), and web technologies, the system improves waste segregation, cleanliness monitoring, and supports efficient and sustainable waste management practices.

RELATED WORK

Several researchers have contributed to the development of automated waste management systems to improve garbage classification, recycling, and environmental cleanliness. Early research in this domain focused on traditional waste segregation methods that relied on manual sorting and basic image processing techniques. These approaches were time-consuming, less accurate, and required significant human intervention. With the advancement of Computer Vision and Deep Learning, modern garbage detection systems use Convolutional Neural Networks (CNNs) to automatically classify waste images with higher accuracy and efficiency, providing a more intelligent and reliable solution for waste management

EXISTING SYSTEM

The existing waste management systems mostly depend on manual waste segregation and human inspection, making the process time-consuming and prone to errors. Traditional methods require individuals to identify and separate different types of garbage, which often results in incorrect waste classification and inefficient recycling. Many existing systems lack automation, real-time analysis, and intelligent decision-making capabilities. They also do not provide accurate prediction results or maintain a history of classified waste for monitoring purposes. As a result, these systems are less efficient, require significant human effort, and are not suitable for large-scale waste management. The proposed system addresses these limitations by using Computer Vision and Convolutional Neural Networks (CNNs) to automatically classify garbage images with high accuracy and support effective cleanliness monitoring.

PROPOSED SYSTEM

The proposed system implements a Computer Vision and Convolutional Neural Network (CNN)-based approach for automatic garbage classification and cleanliness monitoring. It allows users to upload garbage images through a web application, where the images are preprocessed and analyzed by the trained CNN model.

The system accurately classifies the garbage into different waste categories and displays the prediction along with the confidence score. All prediction details are securely stored in an SQLite database for future reference and analysis. The application also provides a dashboard and history page to monitor previous predictions, making waste management more efficient, accurate, and user-friendly.

The system reduces manual effort, improves waste segregation, and supports environmentally sustainable cleanliness monitoring.

SYSTEM ARCHITECTURE

The architecture of the Computer Vision Based Garbage Detection & Cleanliness Monitoring System consists of a user interface, image upload module, image preprocessing module, CNN-based classification model, SQLite database, and result display module. The user uploads a garbage image through the web application, and the image is preprocessed before being sent to the trained CNN model for classification.

The CNN model analyzes the image and predicts the appropriate garbage category along with a confidence score. The prediction details are stored in the SQLite database and displayed on the prediction page, while the dashboard and history modules provide access to previous predictions and statistical summaries. This architecture ensures accurate, efficient, and user-friendly garbage classification, supporting effective waste management and cleanliness monitoring.

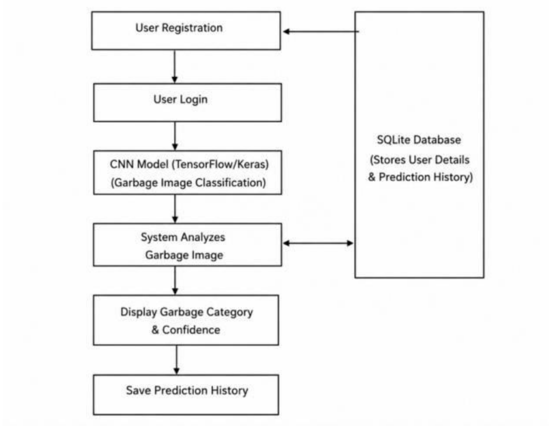

Fig 1: System Architecture

METHODOLOGY DESCRIPTION

The methodology of the Computer Vision Based Garbage Detection & Cleanliness Monitoring System is designed to automatically classify garbage images using deep learning and computer vision techniques. The system follows a structured approach that includes user registration and login, image acquisition through image upload, image preprocessing, garbage classification using a Convolutional Neural Network (CNN), prediction generation, database storage, and result visualization. This methodology ensures accurate garbage classification, efficient prediction, and reliable cleanliness monitoring through an easy-to-use web-based application.

RESULTS AND DISCUSSION

Fig2: Home page

The home page of the Computer Vision Based Garbage Detection & Cleanliness Monitoring System serves as the main interface through which users interact with the application. It is designed to be simple, user-friendly, and responsive, providing quick access to features such as user registration, login, image upload, prediction, dashboard, and history. The home page offers an overview of the system and guides users through the garbage classification process, ensuring a smooth and efficient user experience.

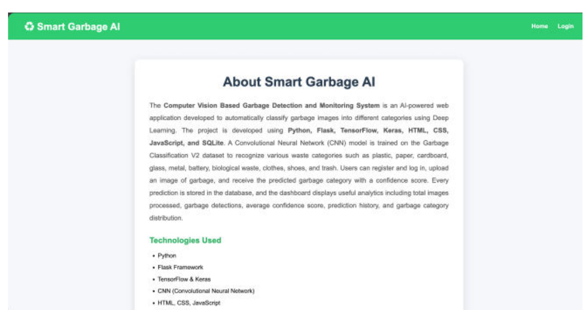

Fig 3: About Module

The About page introduces the Computer Vision Based Garbage Detection and Cleanliness Monitoring System, explaining its purpose, features, and technologies used. It highlights how the system utilizes CNN-based image classification to identify garbage categories accurately, supporting efficient waste management

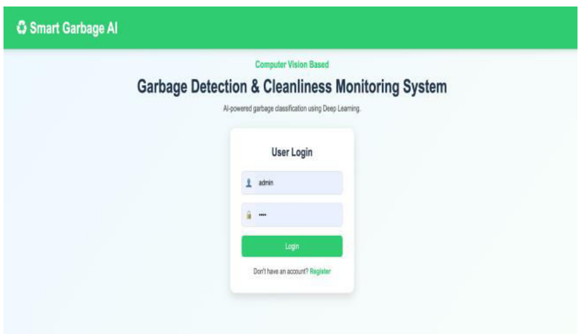

Fig 4: Login Page

The Login page allows registered users to securely access the garbage detection system. Users enter their credentials to upload garbage images, view prediction results, access the dashboard, and review their prediction history. authentication.

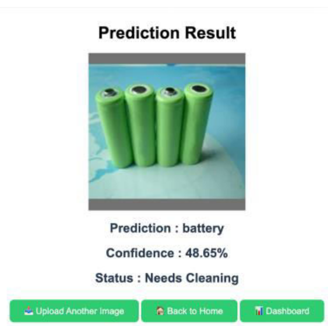

Fig 5: Prediction Page

The Prediction page displays the garbage classification result generated by the trained CNN model after analyzing the uploaded image. It shows the predicted waste category, confidence score, and classification status, enabling users to identify garbage accurately and efficiently.

CONCLUSION

The Computer Vision Based Garbage Detection & Cleanliness Monitoring System successfully automates garbage classification using CNN-based deep learning. It provides accurate predictions, simplifies waste identification, reduces manual effort, and supports efficient waste management, contributing to improved cleanliness and environmental sustainability.

FUTURE SCOPE

The proposed Computer Vision Based Garbage Detection & Cleanliness Monitoring System can be enhanced by integrating real-time camera-based garbage detection using advanced object detection models such as YOLO or EfficientDet. Future versions can support IoT-enabled smart bins for automatic waste monitoring and notifications. Cloud integration can enable centralized storage and remote access to prediction data. A mobile application can improve accessibility for users, while expanding the dataset and using more advanced deep learning models can further increase classification accuracy. These enhancements will make the system more intelligent, scalable, and suitable for smart city waste management applications.

REFERENCES

[1] D. P. Harini, "Electronic Health Record Stage Identification using Principal Component Analysis," *Machine Intelligence Research,* vol. 18, no. 01, pp. 864- 873, 17 8 2024.

[2] D. P. Harini, "Two Level Intrusion Detection For Detecting Intruders in Multitier Web Applications," *International Journal of Engineering & Science Research,* vol. 3, no. 9, pp. 472-478, 2013.

[3] D. P. Harini, "Analyze and Predict of Human Cyber Attackers using Artificial Neural Network," *Journal of Basic Science and Engineering,* vol. 21, no. 1, pp. 1529 - 1536, 8 7 2024.

[4] Simonyan, K., & Zisserman, A. (2015). Very Deep Convolutional Networks for Large-Scale Image Recognition. International Conference on Learning Representations (ICLR).

[5]Krizhevsky, A., Sutskever, I., & Hinton, G. E. (2012). ImageNet Classification with Deep Convolutional Neural Networks. Advances in Neural Information Processing Systems (NeurIPS).

[6] Parkhi,Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You Only Look Once: Unified, Real-Time Object Detection. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

[7] Szegedy, C., Liu, W., Jia, Y., et al. (2015). Going Deeper with Convolutions. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

[8] Tan, M., & Le, Q. V. (2019). EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks. International Conference on Machine Learning (ICML).

[8]LeCun, Y., Bottou, L., Bengio, Y., & Haffner, P. (1998). Gradient-Based Learning Applied to Document Recognition. Proceedings of the IEEE.

[10] Dosovitskiy, A., Beyer, L., Kolesnikov, A., et al. (2021). An Image is Worth 16×16 Words: Transformers for Image Recognition at Scale. International Conference on Learning Representations (ICLR).

[11] Deng, J., Dong, W., Socher, R., Li, L. J., Li, K., & Fei-Fei, L. (2009). ImageNet: A Large-Scale Hierarchical Image Database. IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

[12]Bradski, G. (2000). The OpenCV Library. Dr. Dobb's Journal of Software Tools.

[13]Abadi, M., Agarwal, A., Barham, P., et al. (2016). TensorFlow: Large-Scale Machine Learning on Heterogeneous Distributed Systems. arXiv preprint arXiv:1603.04467.

[14] Chollet, F. (2015). Keras. GitHub Repository.

[15] Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.

[16] Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer.

[17]Szeliski, R. (2022). Computer Vision: Algorithms and Applications (2nd Edition). Springer.

[18]Russell, S., & Norvig, P. (2021). Artificial Intelligence: A Modern Approach (4th Edition). Pearson.

[19] Pedregosa, F., Varoquaux, G., Gramfort, A., et al. (2011). Scikit-learn: Machine Learning in Python. Journal of Machine Learning Research, 12, 2825–2830.

[20]Otsu, N. (1979). A Threshold Selection Method from Gray-Level Histograms. IEEE Transactions on Systems, Man, and Cybernetics, 9(1), 62–66.