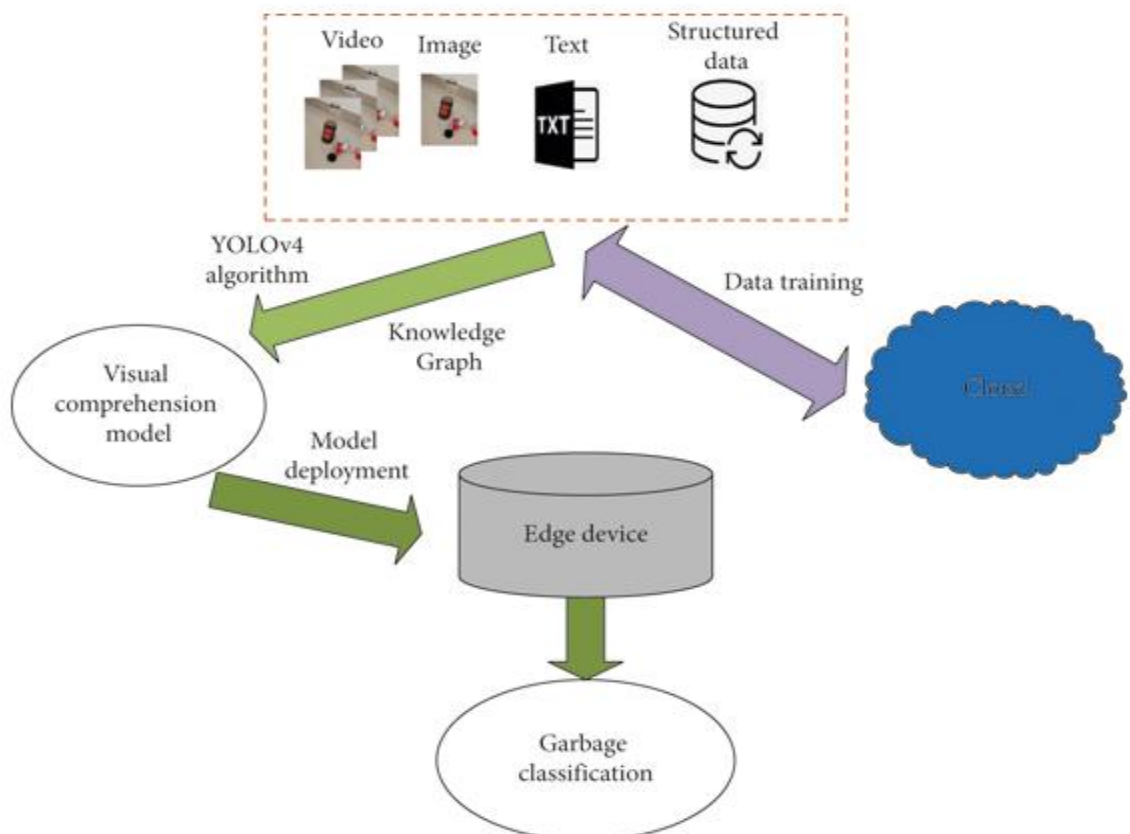


# Project report

## Format

### INTELLIGENT GARBAGE CLASSIFICATION USING DEEP LEARNING



## **INTRODUCTION**

To simplify the process, we propose an intelligent waste material classification system, which is developed by using the 50-layer residual net pre-train (ResNet-50) Convolutional Neural Network model which is a machine learning tool and serves as the extractor, and Support Vector Machine (SVM) which is used to classify.

### **Overview**

1. Garbage classification has always been an important issue in environmental protection, resource recycling and social livelihood.
2. In order to improve the efficiency of front-end garbage collection, an automatic garbage classification system is proposed based on deep learning.
3. Firstly, the overall system of the garbage bin is designed, including the hardware structure and the mobile app.
4. Secondly, the proposed garbage classification algorithm is based on ResNet-34 algorithm, and its network structure is further optimized by three aspects, including the multi feature fusion of input images, the feature reuse of the residual unit, and the design of a new activation function.
5. Finally, the superiority of the proposed classification algorithm is verified with the constructed garbage data.
6. The classification accuracy of the proposed algorithm is enhanced by 1.01%.
7. The experimental results show that the classification accuracy is as high as 99%, the classification cycle of the system is as quick as 0.95 s.

### **PURPOSE**

Garbage Recycling and Sorting manually has been a huge challenge. Manual mistakes of mixing various garbage categories leads to contamination of recyclable garbage at the recycling facility. As per CA recycle only 60-70 of recyclable garbage gets recycled rest goes to landfills.

- Main motivation for this project is to solve the problem in my apartment community where people fail to discard trash properly in the corresponding dumpster based on category.
- Is there way people could be rewarded for properly disposing trash by generating some value out of it? There seems to be smart trash bins by Indian startup[2] which rewards users for recycling bottles with 15 minutes of free WIFI.
- However here in USA we may find difficult to attract people with free WiFi,so we can use revenue generated by recycling trash or CA redemption's to give away free power ball tickets.
- The purpose of the project is to create a deep learning model that can classify various types of garbage and also extract features from the labels or signs on the garbage like CA recycle, return credit that can potentially generate some revenue by directing these items to Recycling center.
- Our model takes image as input and provides classification material type of cardboard, glass, metal, paper, plastic and trash.

This is further labeled by extracting any text features like UPC, recycle, reuse and CA CRV redemption. we will be using multiple models using the same data set to extract different features to achieve higher accuracy.

## **2.LITERATURE SURVEY**

To simplify the process, we propose an intelligent waste material classification system, which is developed by using the 50-layer residual net pre-train (ResNet-50) **Convolutional Neural Network model** which is a machine learning tool and serves as the extractor, and Support Vector Machine (SVM) which is used to classify the waste into different groups/types such as glass, metal, paper, and plastic etc.

Further data augmentation techniques were applied to the collected dataset to increase the number of images so that the proposed CNN model can work efficiently. The augmentation technique was used to improve the accuracy of the designed models. Sometimes the result of an appropriate deep learning model was not satisfactory. In such a case, the problem did not lie in the deep learning model but in the image dataset. When a deep learning model is trained on a small

dataset, the results of the model will always be unsatisfactory. Improving the accuracy and the performance of the deep learning model could be done either by collecting various images or using the augmentation technique. The data augmentation increases the size of the image dataset. Augmentation techniques like rotation, brightness, zoom and flip were used on the experiment dataset.

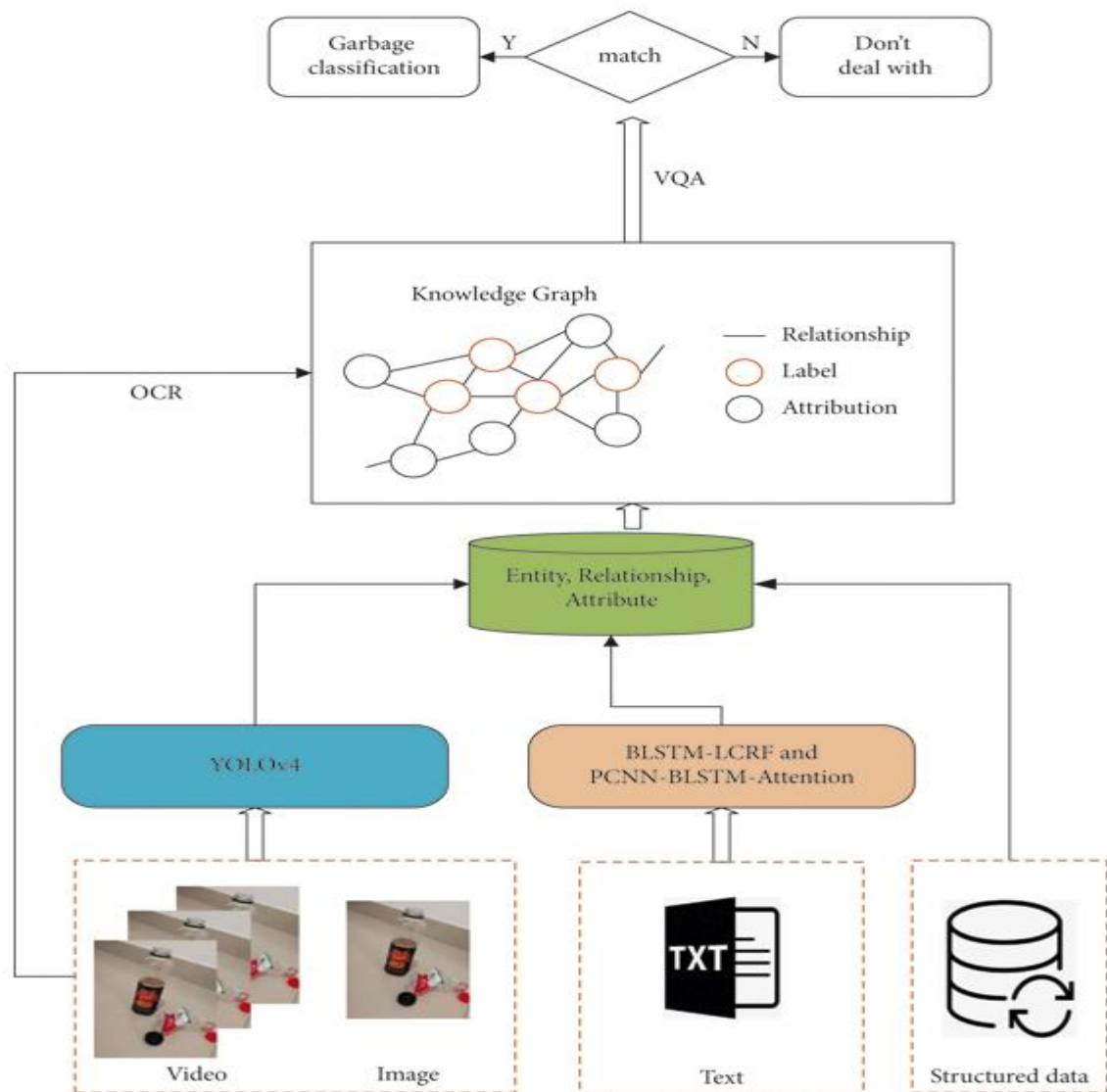
### **Problems with garbage separation**

Failing to segregate trade waste properly means that it will end up mixed in landfills the same way it was mixed in your bins. Waste items like food scraps, paper and liquid waste can mix and decompose, releasing run-off into the soil and harmful gas into the atmosphere

### **Proposed Solutions**

The CNN1 model has three convolution layers and max pool layers as shown in the block diagram. One dropout layer is used to avoid overfitting. The flattening layer is used to flatten the input. The dense layer is the regularly deeply connected and frequently used layer. There are two dense layers used in CNN1. the layer-wise description of the CNN1 model. The  $224 \times 224 \times 3$  sized images were used as the input to the proposed CNN1. In the convolution layer, the size of the filter was  $3 \times 3$  and the number of the filter was 16. The output of the first convolution layer was  $224 \times 224 \times 16$ . The max pool layer was used to reduce the size of the image. In the max pool layer, the  $2 \times 2$  sized filter was used. The maxpool layer converted the input image size  $224 \times 224 \times 16$  into  $112 \times 112 \times 16$ . The  $112 \times 112 \times 16$  sized image passed through the 2nd convolution layer from the max pool layer. The 2nd convolution layer had a  $3 \times 3$  size filter and the number of the filter was 32. The output of the 2nd convolution layer was  $112 \times 112 \times 32$ . The 2nd maxpool layer reduced the size of the image from  $112 \times 112 \times 32$  to  $56 \times 56 \times 32$ . The output of the 2nd maxpool layer was then passed through the 3rd convolution layer. The 3rd convolution layer used 64 filters. Therefore, the output of the 3rd convolution layer was  $56 \times 56 \times 64$ . The 3rd maxpool layer converted the output image size of the 3rd convolution layer into  $28 \times 28 \times 64$ . The output of the 3rd maxpool layer was passed through the dropout and flatten layers. The dropout ratio of the dropout layer was 0.4. The dropout ratio of 0.4 describes that the 40% features out of total extracting features are neglected. The dense layer performed some operations on the input and returned the output.

### 3.THEORITICAL ANAYSIS



### Hardware and software designing

The proposed solution is a *Smart Bin*, which uses image classification for dumping the waste into either bio-degradable or non-biodegradable sections of the bin. It has a separating disk supported with an axel on the motor, which then rotates to up the detected segment. This model is currently based on the segregation of one entity at a time. Its implementation will help us understand and tackle the problem of multiple entity segregation.

### 4.ADVANTAGES AND DISADVANTEGES FOR INTELLIGENT GARBAGE CLASSIFICATION

#### Advantages of intellegent garbage system

- More Efficient Collection. ...
- Less Air Pollution & Traffic Congestion. ...
- Get an Innovative Smart Bin from Smart City
- Improved Community Safety. Smart bins have advanced features, which provide additional security and protection for the overall community. ...
- Implement Data-Driven Collection Routes. ...
- Save Time & Reduce Costs. ...
- Reduce Co2 Emissions & Traffic Congestion. ...
- Reduce Overflowing Bin Complaints. ...
- Understand Waste Generation Patterns.

#### Disadvantages of intelligent garbage system

- Air contamination
- Water contamination
- Bad impact on human health
- Impact on animal and marine life
- Disease carrying pests
- Adversely effect the local economy

## **5.APPLICATIONS**

Environmental impact assessment: By analyzing the composition of waste in different locations, the system can aid in understanding the environmental impact of different regions and help develop targeted waste reduction and recycling initiatives.

1. Smart homes and offices: Intelligent garbage classification systems can be integrated into household or office waste bins. This can help individuals and businesses to sort their waste more efficiently and encourage environmentally responsible behaviors.
2. Internet of Things (IoT) integration: The system can be connected to IoT devices to gather real-time data on waste generation and

recycling rates, enabling data-driven decision-making for waste management.

3. Waste-to-energy optimization: By accurately sorting waste, the system can help optimize waste-to-energy processes, ensuring that the appropriate waste materials are used for energy generation.
4. Support for waste pickers: In regions where waste pickers are involved in recycling activities, the system can aid them by identifying valuable recyclable materials, which can increase their efficiency and income.
5. Green certifications: Businesses and industries seeking to achieve green certifications can use intelligent garbage classification systems as part of their sustainability efforts, demonstrating their commitment to responsible waste management practices.

Waste sorting and recycling: The system can be deployed in recycling centers or waste processing facilities to automatically sort different types of garbage, such as paper, plastic, glass, metal, and organic waste. This automation can significantly speed up the recycling process and improve the quality of recycled materials.

6. Smart bins: Intelligent garbage classification systems can be integrated into public trash bins. These smart bins can recognize and sort waste on-site, encouraging people to dispose of their waste properly and promoting recycling habits among the public.
7. Waste auditing and monitoring: Municipalities and waste management companies can use the system to monitor the types and quantities of waste generated in different areas. This data can help in planning and optimizing waste collection routes and resource allocation.
8. Educational tool: The system can be utilized in educational settings, such as schools and community centers, to teach people about proper waste sorting and recycling practices. Interactive displays or mobile

apps can engage users and provide feedback on their waste disposal habits.

Overall, an intelligent garbage classification system can have a transformative impact on waste management, leading to reduced environmental pollution, improved recycling rates, and better resource utilization.

## **6.RESULT**

intelligent garbage classification systems were being developed and deployed in various places around the world. These systems typically utilize advanced technologies such as artificial intelligence, computer vision, and machine learning to automatically identify and sort different types of waste, facilitating more efficient recycling and waste management processes.

For the latest information on the "Intelligent Garbage Classification System" or any other topic, I recommend checking recent news sources or conducting a search on the internet for up-to-date information.



## **7.CONCLUSION**

The intelligent garbage classification system is a significant technological advancement aimed at automating and optimizing the waste sorting process. Through the integration of artificial intelligence, computer vision, and machine learning, this system enables the efficient identification and segregation of different types of waste materials.

The main benefits of such a system are:

### **1. Environmental Impact:**

By accurately sorting recyclables from non-recyclables, the system reduces the amount of waste sent to landfills, minimizing environmental pollution and conserving natural resources.

### **2. Resource Efficiency:**

The intelligent garbage classification system helps in recycling more effectively, as sorted waste can be channeled back into the production cycle, reducing the need for raw materials and lowering energy consumption.

### **3. Cost Savings:**

Implementing this system can lead to cost savings for waste management authorities by optimizing waste processing operations and reducing the need for manual sorting.

### **4. Public Awareness:**

The system also plays a role in raising public awareness about recycling and environmental conservation, as people witness the benefits of responsible waste disposal.

### **Scalability and Accessibility:**

The technology can be implemented in various settings, from households to industrial facilities, and its integration with Internet of Things (IoT) devices and cloud-based platforms makes it highly scalable and accessible.

In conclusion, the intelligent garbage classification system represents a promising solution to address the challenges posed by increasing waste generation and the need for sustainable waste management practices. By

harnessing the power of artificial intelligence, this technology has the potential to revolutionize waste sorting, recycling, and resource utilization, contributing to a cleaner and greener environment for future generations.

## **8.FUTURE SCOPE**

The future scope of an intelligent garbage classification system is promising and offers numerous opportunities for advancements in waste management and environmental sustainability. Here are some potential areas of development and application for such a system:

### **1. Enhanced Accuracy:**

Continuous improvements in machine learning and artificial intelligence algorithms will lead to even higher accuracy in classifying different types of waste. This will reduce the chances of misclassification and ensure better waste segregation.

### **2. Integration with Smart Bins:**

Intelligent garbage classification systems can be integrated into smart bins, allowing for real-time data collection and analysis. These smart bins can automatically sort waste and provide valuable information to waste management authorities.

### **3. IoT Integration:**

Internet of Things (IoT) devices can be incorporated into the system to monitor garbage levels, optimize waste collection routes, and trigger alerts when bins are full, reducing unnecessary trips and fuel consumption.

### **4. Cloud-Based Solutions:**

Cloud computing can enable centralized data storage and analysis, allowing multiple waste management facilities to benefit from shared insights and best practices.

### **5. Robotics and Automation:**

Robotics can play a significant role in waste sorting processes. Automated robotic arms can handle the physical separation of waste into different categories, further reducing the need for human intervention and minimizing health risks.

## 6. Mobile Applications:

Developing mobile applications for citizens to identify and segregate waste correctly can foster a sense of environmental responsibility and encourage active participation in waste management efforts.

## Public Awareness and Education:

Investing in public awareness campaigns and educational programs can help citizens understand the importance of proper waste disposal and motivate them to use the intelligent garbage classification system effectively.

## 7. Waste-to-Energy Conversion:

Intelligent garbage classification can also be coupled with waste-to-energy technologies, such as incineration or anaerobic digestion, to convert certain types of waste into energy or valuable byproducts.

## 8. Municipal Integration:

Governments and municipalities can incorporate intelligent garbage classification data into their overall urban planning and waste management strategies, leading to more efficient resource allocation and environmental conservation.

## 9. Global Adoption:

As environmental concerns continue to rise, there is potential for the widespread adoption of intelligent garbage classification systems worldwide. Governments and international organizations may collaborate to standardize waste classification practices and incentivize their implementation.

## 10. Recycling and Circular Economy:

Intelligent waste classification can bolster recycling efforts by ensuring that recyclable materials are separated efficiently. This can contribute to the development of a circular economy, where waste is minimized, and resources are reused.

Overall, the future of intelligent garbage classification systems is bright, with the potential to revolutionize waste management practices, reduce environmental pollution, and contribute to a more sustainable future. However, it will require ongoing research, development, and collaboration between various stakeholders to realize its full potential.

