Proposal project: Bottle Sorter

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Abstract

In this study, we present a comprehensive solution to efficiently sort and collect PET and glass bottles in industrial and recycling environments. We face two fundamental challenges: bottle detection and classification using computer vision, followed by collection optimization using a robotic arm with reinforcement learning techniques. The first step is to deploy a computer vision system that uses cameras to detect and classify bottles into two main categories. Second, a robotic arm with reinforcement learning capabilities optimizes the bottle collection process.

Index Terms

Bottle Classification, PET Bottles, Glass Bottles, Computer Vision, Reinforcement Learning, Robotic Arm, Efficient Collection, Waste Management, Recycling, Industrial Automation

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I. Introduction

Effective waste management and recycling has become important in the context of environmental sustainability and resource conservation. Among the various recyclable materials, plastics, especially PET (polyethylene terephthalate) and glass bottles make up a significant portion of the waste stream. Automating bottle identification, sorting and collection is critical to streamlining recycling processes and minimizing environmental impact.

To address this challenge, our project introduces an innovative approach that combines advanced computer vision techniques with the adaptive capabilities of reinforcement learning. Our main goal is to improve the efficiency of bottle sorting and collection in industrial and recycling environments. By leveraging computer vision technology, we achieve accurate bottle classification, distinguishing between PET bottles and glass bottles, laying the foundation for proper waste classification.

The second phase of our project involves integrating the robotic arm with reinforcement learning capabilities. This intelligent robotic arm automatically optimizes the collection process, continuously adjusting its actions to collect bottles efficiently. Through an interdisciplinary approach combining computer vision, robotics and machine learning, our project aims to reduce operating costs, improve sustainability and promote automation of sorting and collection. collect waste. This promises significant contributions to the ongoing transformation of the recycling industry. In this article, we provide an overview of the methods, technologies, and expected impact of our research and development efforts.

II. Objectives

1) Building a classification system:
Create a computer vision system capable of detecting and classifying PET or glass bottles, with the additional aspect of assessing the quality percentage of PET bottles.

2) Collection optimization:
Integrate a robotic arm with reinforcement learning to efficiently collect bottles taking into account their quality percentage.

3) Promote sustainability:
Contribute to effective waste management by sorting PET bottles based on their quality, promoting sustainability and resource conservation in industrial and recycling environments.

III. Development

A. Supervised Learning

Supervised learning is a subcategory of machine learning and artificial intelligence that relies on labeled data sets to train algorithms, accurately classify data, or predict outcomes. The goal of our project is to classify bottles into two main categories: PET and glass, and evaluate the quality percentage of PET bottles. By using labeled data to classify each PET or glass bottle, and providing quality percentages for PET bottles, our model learns to recognize patterns associated with each bottle type, enables accurate classification and quality assessment during the recycling process. PET bottles with a quality ratio between 90 and 100% will be considered for recycling, while bottles with a lower quality ratio will be sent to another recycling process.

B. Unsupervised Learning

Unsupervised learning is a technique in which the system learns on its own to identify patterns and similarities in data without receiving labeled examples. In our project, this technique is applied in the bottle detection and clustering phase. Instead of feeding the system labels indicating which bottles are PET and which are glass, we let the system analyze bottle characteristics and group those that have similarities. This is achieved through clustering techniques, where the system independently searches for patterns and similarities in the data without explicit instructions. Unsupervised learning is still important to optimize the efficiency of the classification process, as the system can differentiate bottles without the need for labels first, thereby improving the accuracy of identifying what the bottle is made of. different materials.

C. Reinforcement Learning

In our machine learning project to improve the efficiency of a robotic arm to collect plastic bottles, reinforcement learning will be used. The robot is trained to determine the shortest path to the target bottle while taking into account the quality percentage of the PET bottle. Through repeated trial and error, the robot will receive rewards or punishments based on its actions. Initially, the robot's actions are random, but over time it learns to make decisions that minimize the distance from the bottle and take into account the quality aspect. Reinforcement learning algorithms, such as deep reinforcement learning, are applied to optimize the robot's decision-making process. As the robot gains experience, it will adapt and become increasingly proficient at effectively navigating the environment and retrieving plastic bottles, improving overall efficiency.

IV. Conclusion

In summary, this project presents an innovative approach to address the critical need for effective waste management and recycling. By combining computer vision for bottle sorting, quality assessment, and reinforcement learning to optimize collection, we have demonstrated a promising solution that significantly improves the recycling process mechanism.

Through the application of supervised learning, we enable our system to accurately distinguish between PET bottles and glass bottles, as well as evaluate the quality of PET bottles, ensuring material classification and recycling is appropriate. At the same time, unsupervised learning contributes to improving the efficiency of bottle detection by allowing the system to automatically identify patterns and similarities between bottles. Our interdisciplinary approach has the potential to revolutionize the recycling industry by reducing operating costs, promoting sustainability and improving waste sorting and collection processes. It represents a significant step forward in the field of automation, contributing to environmental protection and efficient use of resources. As we move forward, the innovation and real-world implementation of this technology could have a significant impact on waste management, in line with the global goal of a sustainable and eco-friendly future. Environmentally friendly combined with recycling of PET bottles based on quality.

V. Appendix

Notebook on Kaggle:

Bootle dataset

https://www.kaggle.com/code/catunima/classification-final2-0-vgg

Bottle dataset 2

https://github.com/AgaMiko/waste-datasets-review

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