Review on Visual Based Trash Detection and Classification for Trash Bin Robot

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ABSTRACT

Waste or trash management is receiving increased attention for intelligent and sustainable development. The daily increase in solid waste in all environments endangers both human and animal health and life. The primary aim is to introduce a way in which garbage can becollected and disposed efficiently. The robot will be automatic and it can also be controlled manually. We can rely on this robot to detect and classify waste based on its type. There is one robotic arm which picks up the waste and dispenses it in the respective basket based on its type. There will be 2 different baskets for bio and non-biodegradable wastes. The cameraplaced on the robot detects the waste. It will have an electronic mechanism by which the robot can dispense its collected garbage to the dispensing point. The robot has installed batteries in which there is no fuel or electricity required to complete the operation.

INTRODUCTION

Waste management is a big issue globally and it needs serious attention. A growing population and economy means increased volumes of waste generated. The more the waste generated, the more polluted our surroundings become. So here we propose a waste detection and classification system. This robot detects waste and classifies them. Deep learning and machine learning is used for image detection and classification. There are different types of wastes both biodegradable and non biodegradable. It is important that wesort these as we can recycle the non biodegradable. The robot detects the waste and automatically sorts it as biodegradable and non biodegradable.

LITERATURE SURVEY

Ching-Chang Wong, Chi-Yi Tsai, Ren-Jie Chen, Shao-Yu Chien, Yi-He Yang, Shang- Wen Wong, and Chun-An Yeh [1], In this paper, a bin pick-and-place system based on robot operating system (ROS) is implemented to make a six-degree-of-freedom (6-DOF) robot manipulator to complete multiple pick-and-place tasks. The proposed system uses ROS to integrate an object perception module and a pick-and-place module, where the former uses an RGB-D camera to capture images inside the bin, and the latter controls a 6-DOF robot manipulator and two self-made vacuum tools. To estimate the pose of the targetobject, a YOLOv4 object detector is implemented, and an object sorting method is proposed to find the target object in the image. Then, a pose estimation method based on computer aided design (CAD) is proposed to estimate the pose of target object. To perform the object pick-and-place operations, a coordinate transformation node is designed to transfer the poseof the target object into the workspace. Then, a link distance-based bin collision avoidancemethod is proposed to avoid collisions. Finally, the angle of the 1-DOF vacuum tool and the picking and placement poses of the robot manipulator are obtained from the result of the bin collision avoidance and the pose of the target object. In this study, a total of ten ROSnodes are designed, and the solutions that make each function easier to implement and reproduce are proposed. In the experiments, we set up four experiments with two task typesand two object types to verify the effectiveness of the implemented bin pick-and-place system.

N. Shirakura, T. Kiyokawa, H. Kumamoto, J. Takamatsu and T. Ogasawara [2], This paper aims to address the critical issue of marine debris by developing a novel system that combines Unmanned Aerial Vehicles (UAV) and Unmanned Underwater Vehicles (UUV).The system includes a Graphical User Interface (GUI) for user-friendly operation. The UAVare equipped with sensors for aerial detection, while UUVs are designed for underwater debris collection. The GUI simplifies the control process, allowing users to monitor and guide the vehicles effectively. This integrated approach offers a promising solution for the efficient removal of marine debris, contributing to the preservation of aquatic ecosystems and marine life. The UAV are equipped with advanced sensors, including high-resolution cameras and environmental sensors, enabling them to conduct aerial surveys of coastal areas and open waters. These UAVs autonomously identify and pinpoint areas with high concentrations of marine debris, providing real-time data to the operator via the GUI. The UUVs, on the other hand, are specially designed to perform underwater debris collection tasks. They are equipped with specialized gripping mechanisms and storage compartmentsfor securely capturing and storing debris. The GUI offers a user-friendly interface that allows operators to remotely control the UUVs' movements and collection actions, ensuring precise and efficient removal of marine debris from the ocean floor.

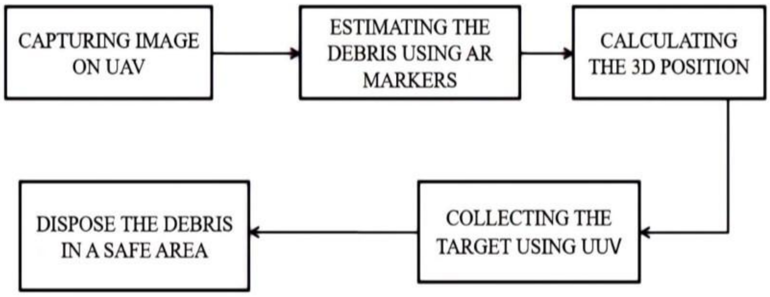

Fig 1 : Block Diagram

E. Likotiko, Y. Matsuda and K. Yasumoto [3], Much garbage is produced daily in homes due to living activities, including cooking and eating. Therefore, garbage must be adequately managed for human well-being and environmental protection. In the standard municipal garbage management system, households are responsible for sorting and managing garbage produced in their home. However, it is hard to depend solely on public awareness to provide the correct garbage management at the source. Therefore, an automation tool that can reflect the home's daily life and understand households' routine behaviour of garbage disposal wouldbe necessary to influence behaviour change on garbage disposal and increase home monitoringfor the case of elderly anomaly detection and healthy living.

Furthermore, it would improve garbage management services through proper garbage separation practices for the well-being of people and the environment. We propose a newly designed and developed smart garbage bin system (SGBS) embedded with multiple sensors to identify the garbage contents disposed of. The SGBS architecture comprised two subsystems. The first subsystem is the smart garbage bin (SGB), embedded with DHT22 (temperature and humidity) and MQ135 gas sensors to know the conditions and identify the disposed garbage content since garbage contents have different shapes and moisture. Therefore, the type of garbage content affects the humidity and air quality found in the smart bin. Also, the SGB is embedded with ToF (time of flight) and load cell sensors to detect the new garbage content disposed of each time. Then, data are updated and stored in the cloud via a Wi-Fi gateway. The second subsystem is a garbage annotation mobile application (GAA). The GAA interface consists of 8 garbage categories and 25 garbage content identities, providing an easy way for household users to annotate garbage content they dispose of daily using a handy smartphone.

Supriya V. Mahadevkar, Bharti Khemani, Shruti Patil, Keta Kotecha, Deepali R. Vora, Ajith Abraham, and Lubna Abdelkareim Gabralla [4], Computer applications have considerably shifted from single data processing to machine learning in recent years due to the accessibilityand availability of massive volumes of data obtained through the internet and various sources.

Machine learning is automating human assistance by training an algorithm on relevant data. Supervised, Unsupervised, and Reinforcement Learning are the three fundamental categories of machine learning techniques. In this paper, we have discussed the different learning styles used in the field of Computer vision, Deep Learning, Neural networks, and machine learning.

Some of the most recent applications of machine learning in computer vision include object identification, object classification, and extracting usable information from images, graphic documents, and videos. Some machine learning techniques frequently include zero-shot learning, active learning, contrastive learning, self supervised learning, life-long learning, semi-supervised learning, ensemble learning, sequential learning, and multi-view learning used in computer vision until now.

There is a lack of systematic reviews about all learning styles. This paper presents literature analysis of how different machine learning styles evolved in the field of Artificial Intelligence (AI) for computer vision. This research examines and evaluates machine learning applications in computer vision and future forecasting. This paper will be helpful for researchers working with learning styles as it gives a deep insight into future directions.

Paper Comparison

AUTHOR &DATE	PURPOSE	DIFFERENCES
Ching-Chang Wong, Chi-Yi Tsai,Ren-Jie Chen, Shao-Yu Chien, Yi- He Yang, Shang-Wen Wong, and Chun-An Yeh 2022	The proposed system aims for fast and flexible development, demonstrating its capability through a detailed flow chart and computational graphs of ROS nodes.	The paper describes a ROS-based bin pick-and-place system, integrating RGB-D camera, robot manipulator, and object perception modules. It emphasizes modularity and flexibility, using YOLOv4 for object detection and implementing collision avoidance strategies. The system demonstrates good performance in experiments with different task types and object types.
N. Shirakura, T.Kiyokawa, H. Kumamoto, J.Takamatsu and T. Ogasawara 2021	The aim is likely to propose an integrated system that efficiently collects marine debris, utilizing advanced technology for environmental monitoring and cleanup. The GUI would simplify the operation of the UAV-UUV collaboration for effective marinedebris management.	The paper focuses on a semi- automatic system for collecting floating marine debris using a combination of UAV and UUV. It introduces a coordinate transformation method, a GUI for 3D position estimation, and a controller for UUV tele-operation. The study includes simulation and real-robot experiments, indicating improved efficiency with UAV-UUV cooperation.
E. Likotiko, Y. Matsuda and K. Yasumoto 2022	The paper may delve into the design, implementation, and evaluation of such a system, showcasing the potential benefits in terms of cost reduction, environmental impact, and operational efficiency in waste disposal processes.	The paper presents a smart garbage bin system (SGBS) equipped with sensors for household garbage classification. It includes a garbage annotation mobile app and a machine learning model for content estimation. The SGBS achieved high accuracy in classifying kitchen waste, paper/softbox contents, and overall garbage categories. Futurework involves event-based detection and expanding experiments to different types of garbage.
Supriya V. Mahadevkar, Bharti Khemani, Shruti Patil, Keta Kotecha, Deepali R. Vora, Ajith Abraham, and Lubna AbdelkareimGabralla 2022	The paper likely aims to discuss different techniques, meth- odologies, and trends in machine learning as they relate to comp-uter vision applications. Additio- nally, it may explore the current state of the art, challenges, and propose potential future direc- tions for research and develop-pment in this interdisciplinary domain.	The paper conducts an in-depth review of machine learning techniques applied in computer vision applications. It presents findings from a systematic literature review, discussing learning types, feature extraction techniques,methodologies, datasets, application domains, and challenges. The article also explores future possibilities and research directions in machine learning for computer vision.

CONCLUSION

In conclusion, the robotic waste identification system employs deep learning with a dataset containing images and corresponding text files for categories and bounding box locations. Theexperiment involves training and testing for both bio and non-biodegradable wastes, aiming to enhance generalization through data augmentation. The ESP32 microcontroller, equipped withbuilt-in WiFi, serves as the main controller. The robotic arm relies on 5 servo motors, while two motors and a motor driver facilitate overall robot movement. An ultrasonic sensor monitorsbin capacity, and a camera captures images for PC-based image processing, enabling waste classification as either bio or non-biodegradable. This integrated system demonstrates a comprehensive approach to automated waste sorting.

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