Trash Detection for Ocean Cleanup Robot using Remotely Operated Vehicle (ROV)

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Abstract

Human-made debris is frequently dumped into naturally occurring aquatic ecosystems, such as rivers and oceans. Finding marine trash in rivers and oceans is crucial so that its effects on the ecosystem can be recognized and minimized. The manual measurement of the amount of debris in the oceans is labor-intensive, time-consuming, and has a small covering area. The underwater vehicle such as Remotely Operated Vehicle (ROV) can be utilized for surveys. The unstructured character of the seabed terrain poses the main obstacle to underwater image-based detection. Therefore, it is crucial to have a robust feature identification system in circumstances like these. Hence, This study removes the need for trash manual sampling by using an autonomous method using neural networks and computer vision models using ROV. In addition, It is observed that our proposed network, achieved an overall accuracy of 93.9 % for correct detections.

1. Introduction

Trash detection for ocean cleanup is an important problem that has received increasing attention in recent years due to the negative impacts of marine litter on the environment and wildlife. One potential solution to this problem is the use of remotely operated vehicles (ROVs) equipped with trash detection capabilities to identify and collect trash in the ocean. One approach to trash detection for ROVs is to use the Robot Operating System (ROS) and the You Only Look Once (YOLO) algorithm. ROS is an open-source software platform for robotics that provides a framework for building, integrating, and running robotic applications.

YOLO is a real-time object detection algorithm that can be used to identify objects in images and videos. It divides an input image into a grid of cells and uses convolutional neural networks (CNNs) to predict the presence and location of objects within each cell. YOLO is fast and accurate, making it well-suited for use in robotics applications.

Overall, the use of an ROV for trash detection in the ocean offers the potential to significantly improve the efficiency and effectiveness of ocean cleanup efforts, helping to protect marine ecosystems and wildlife from the harmful effects of marine litter and plastic pollution.

In this paper, the authors propose the use of an ROV for trash detection in the ocean, with the aim of improving the efficiency and effectiveness of ocean cleanup efforts. The ROV is equipped with various sensors and cameras, which are used to detect and classify different types of trash and debris. The authors also present a system for controlling the ROV and processing the sensor data, as well as a set of experiments to evaluate the performance of the proposed system.

2. Proposed Scheme

In the proposed method for trash detection using an ROV and YOLO, the authors may have used a trash dataset to train the YOLO object detection model. A dataset is a collection of data that is used to train, validate, and test machine learning models.

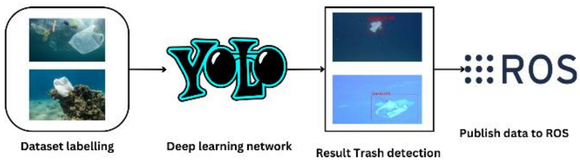

Figure 1. System Block Diagram

As shown in Fig. 1 to create the trash dataset, the authors have collected a set of images that contain different types of trash and debris, such as plastic bottles, bags, and other common types of marine litter. They may have then annotated these images by drawing bounding boxes around each instance of trash and labeling each bounding box with the corresponding class (e.g., "plastic bottle," "plastic bag," etc.).

Once the trash dataset has been created and annotated, it can be used to train the YOLO object detection model. During training, the model is fed the annotated images and learns to predict the bounding boxes and class probabilities for each instance of trash in the image.

The authors are publishing the bounding box results (i.e., the location and dimensions of the detected trash) to ROS. This could allow the ROV to access the bounding box information and use it to navigate and interact with the detected trash. Publishing the bounding box results to ROS may involve creating a message type that defines the data structure for the bounding box information (e.g., the x and y coordinates of the top-left corner of the bounding box, the width and height of the bounding box, and the class label). The YOLO object detection model would then generate bounding box data and publish it to ROS as a message of this type. By publishing the bounding box results to ROS, the authors may have provided a way for the ROV to access and use this information in real-time, enabling it to navigate and interact with the detected trash more effectively. This, in turn, may help to improve the efficiency and effectiveness of ocean cleanup efforts.

2.1. Robot Operating System (ROS)

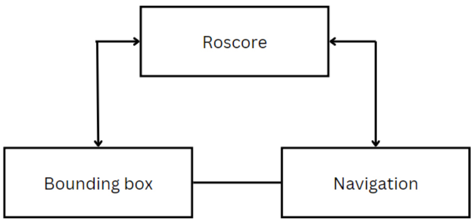

Figure 2. Result trash detection

As shown in Fig. 2, the data from bounding box that contain the location x,y will be published into ROS framework for further processing such as autonomous navigation, Integrating ROS could provide a number of benefits, including improved communication, sensor integration, and navigation and control capabilities. This could help to improve the efficiency and effectiveness of the system in detecting and interacting with trash and debris in the ocean.

3. Experiment

It sounds like the authors of the paper have conducted experiments to evaluate the performance of their proposed system for trash detection using YOLO. The result found that the system performed the best among the different methods author compared it to. There are several ways in which the authors might have measured the performance of their proposed system. As shown in Fig. 2, Some common evaluation metrics for object detection include accuracy and loss. These metrics measure the accuracy of the object detection model, as well as its ability to detect all instances of the target objects (i.e., trash and debris in this case).

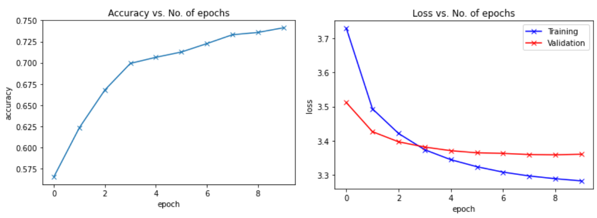

Figure 3. System Block Diagram

The authors may have also evaluated the performance of their system in terms of its speed and efficiency, for example, by measuring the frame rate at which the system is able to process and classify images. This is important in real-time applications, such as trash detection using an ROV, where the system needs to be able to operate quickly and efficiently. Overall, the results of the authors' experiments suggest that their proposed system for trash detection using an ROV and YOLO is effective and performs well compared to other methods. This may be a promising approach for improving the efficiency and effectiveness of ocean cleanup efforts.

Figure 4. Result trash detection

Acknowledgement

This research was supported by the MSIT(Ministry of Science and ICT), Korea, under the Grand Information Technology Research Center support program (IITP-2023-2020-0-01612) supervised by the IITP(Institute for Information & communications Technology Planning & Evaluation) and by Priority Research Centers Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology"(2018R1A6A1A03024003).

References

[1] Armitage S, Awty-Carroll K, Clewley D, Martinez-Vicente V. Detection and Classification of Floating Plastic Litter Using a Vessel-Mounted Video Camera and Deep Learning. Remote Sensing. 2022; 14(14):3425.

[2] G. SaiTeja and P. S, "Design and Simulation of an Autonomous Surface Vehicle for Trash Collection using ROS," 2021 IEEE 9th Region 10 Humanitarian Technology Conference (R10-HTC), 2021, pp. 1-6,

[3] Martínez-Vicente V, Clark JR, Corradi P, Aliani S, Arias M, Bochow M, Bonnery G, Cole M, Cózar A, Donnelly R, Echevarría F, Galgani F, Garaba SP, Goddijn-Murphy L, Lebreton L, Leslie HA, Lindeque PK, Maximenko N, Martin-Lauzer F-R, Moller D, Murphy P, Palombi L, Raimondi V, Reisser J, Romero L, Simis SGH, Sterckx S, Thompson RC, Topouzelis KN, van Sebille E, Veiga JM, Vethaak AD. Measuring Marine Plastic Debris from Space: Initial Assessment of Observation Requirements. Remote Sensing. 2019; 11(20):2443.