DMDY: Detection of Marine Debris Using YOLOv5

Arpitha P K, Aishwarya S S, Asha B, Anusha C V and Dr. AshwinKumar U Motagi

School of CSE, REVA University, Bangalore, India

arpi2205@gmail.com, ssaishwarya229@gmail.com, ashabejawada@gmail.com, anushacv123@gmail.com, ashwinkumar.um@reva.edu.in

Abstract.

The Industrial revolution has led to a drastic change in human lives. It has served as both boon and bane to us. It was a great form of prosperity to humans. But with this prosperity it also carried so much pollution which led to environmental degradation. One of these pollutants is marine waste that is segregated into oceans in large volumes. The goal of this paper is to discuss one effective methodology which can be implemented to reduce marine waste by detection of plastic in the ocean. This can be called marine debris detection. The method here used is improvised YOLOv5 which is a fast and effective method to get the trained model of the objects we need to detect. It can efficiently detect the waste present in the ocean water which helps to eradicate the waste sooner at a faster pace. It is also possible to bring up more effective methods for the same cause to ensure the detection can happen more accurately. As compared to earlier models our work is able to depict the image of floating plastic on a water surface even if the object is transparent with a high accuracy rate. This helps in the reduction of plastic waste in the water.

Keywords. YOLOv5, marine debris, environmental degradation, plastic, industrial revolution, floating waste, ocean water, detection

1. INTRODUCTION

The industrial revolution has led to many changes in human lives. The main impact of the industrial revolution is the environmental crisis. When an environmental crisis occurs, it is very difficult to adapt to the current living situation and also move towards sustainable development. Sustainable development refers to the future world where the future human life needs to sustain with currently available resources. But the major problem is with the increase in population day by day how to move towards sustainable living. Not only population but there are many other concerns too, such as, change the earth's climate or even the rapid changing technology, these changes have a great impact on human health.

But technology has proved itself that it cannot only be a bane but also a boon to society. There are many technologies which have a bad effect on the environment such as smartphones or laptops which produce a lot of non-biodegradable waste. But if we look into the other side of the wall we find that we have many technologies to protect the environment such as monitoring pollution levels in air, water or soil, we have navigation, automation, quantum computing to manage any sort of emergency crisis in the environment.

Marine debris is the major cause of water pollution. The main cause of marine debris is dumping and littering debris into marine areas. Another big cause is careless or improper disposal of waste. This waste causes severe injury and even leads to death of marine species. Debris is manmade which reaches the ocean in many ways. It is very natural that with increase in human population there is also a very rapid increase of waste. But where does all this waste be managed? Some of the waste could be buried underground which is called waste dumping. But with such a huge population all the waste cannot be buried into the soil. Most of our waste is settled under the sea bed causing huge pollution in oceans and other water bodies. These wastes are usually called marine debris. They can enter into the ocean knowingly or unknowingly by human means. Due to this, there is a huge risk for all the marine life under the ocean. The main purpose of this article is to share knowledge regarding how we can tackle this issue using marine debris detection method.

2. LITERATURE SURVEY

In this paper, to measure water quality various debris which is floating can be used as one type of visual index. The debris which is floating has a great impact on the quality of water and the evaluation of the environment. Some sources of garbage in water are domestic garbage, plastic bags, bottles, and many more. The images are captured, filtered, and analyzed, and then from that texture, color, shape, and other features are extracted. Implementation of real-time floating debris detection and to improve the ability of extraction FMA (feature map attention)-the YOLOv5 object detection algorithm is used. This method is more effective for automatic monitoring of debris that is floating which saves a lot of work. Further work mentioned in this paper is detecting blurred and dense objects by the semi-supervised learning method and increasing the robustness of the model [1]. In this paper, a Vision-based water surface garbage capture robot was developed to tackle water surface pollution. This method was more specific to improving detection scales and real-time detection performance in dynamic aquatic environments. By capturing robots there may be a reduction in labor volume of workers, applied to clean up water surface garbage and improve the water ecological environment. In this primary task for capture robots are detection of garbage, capturing and then collecting the garbage. For object detection, CNN is utilized, for detection of floating garbage a modified YOLOv3 algorithm is used, and finally by K-Means clustering water surface garbage is clustered [2]. The paper talks about classifying micro plastics and counting them automatically using a Computer Vision-based system. Due to plastics' durability, it is difficult to manage and is a serious issue nowadays, and handling million tons of plastic in the sea is the biggest current environmental problem. Computer Vision-based systems can automatically count and distinguish different microplastics into five different visual classes. Different characteristics of a few images are collected from samples and then followed by steps which include segmentation step based on Sauvola threshold method followed by feature extraction and classification step and this is evaluated by deep learning approach. By this method, the time taken is half when compared to segregating normally. Further work which the author mentioned was to apply this method for large datasets which is an expensive task [3]. In this paper, the author has specified the use of Raman Spectroscopy to detect microplastics underwater as plastics have become widely applicable in every aspect of modern-day life. By Raman Spectroscopy they were able to extract the chemical structure of objects by collecting various spectral signatures. Raman Spectroscopy focuses on changes in the intensity of light. The first step in the methodology was pulverizing plastics and then collecting the plastic samples to retrieve spectral signatures and at last, using partial least squares discriminant analysis samples were classified. Further work mentioned in the paper was how a change in the environment can affect the performance of the method [4]. The biggest growth factor which is contributing to environmental pollution is plastic waste. Plastics are widely used all over the world and are indispensable. Based on characteristic fluorescent behavior plastics are detected and identified in this paper under tap water. Using fluorescent light highly sensitive plastic images were detected as it will be difficult to detect plastic with higher water depths. In this paper, they have detected plastic using a simple model by just using fluorescent light by which it emits photons, and these incident photons are slightly transmitted, absorbed, and reflected. When a photon is absorbed, some atomic conversions take place, and this fluorescent photon is reemitted. By these, plastics are identified and detected in the water. In this method, real plastic sample identification is limited to methods whose thickness of the plastic is unknown. Further work mentioned is the detection of micro plastics in water and then distinguishing the impurities into organic and inorganic components [5]. In this paper, the author used hyperspectral imaging-based proximal sensing technologies. In this, they differentiate the industrial and household plastic wastes which become a basic mandatory step in their successful application. Two-linear-spectrometer apparatus is used to get hyperspectral images to form that they are extracting using near-infrared reflectance spectra of polymers. This results in the identification of polymers being very rapid and reliable. This became sensor design and technology application as well as in the marine ecosystem it made a foundation for intensive radiative transfer modeling of plastics [6]. The author has enumerated different types of debris here. Bottom trawling, pole trawling, videography, and submersibles are 4 different methods used to investigate debris during oceanographic cruises from 1993 to 1998. Hydrodynamic Methodologies, as well as anthropic factors, took a very important part in the result which caused variable results. Per hectare there were 200 pieces of debris and also its concentration is huge in some areas. Here they used a videography method using a towed camera which failed. And also faced some problems like positioning, speed, and altitude as well as detecting small debris was difficult [7].

3. METHODOLOGY

According to many papers surveyed there were several methodologies related to this work. After a detailed study of this work, the methodology chosen for this work was the YOLOv5 algorithm which uses pyTorch framework to detect objects.

In section *A.* we discuss the dataset and its processing. Section *B.* discusses the steps included in the preparation of data like Annotations and aligns the dataset with respect to work. Section *C.* contains the details of the modeling of the YOLO algorithm and the importance of the version of the algorithm used. Section *D.* is the alternative methodology, its advantages, and disadvantages.

A. The dataset:

Plastic pollution in the marine environment is causing major concerns. The plastic bags and plastic bottle pictures were manually taken for the preparation of the dataset.

B. Preparation of dataset:

The dataset which is manually collected was labeled using the roboflow website and then a data augmentation method was used for the preparation of the dataset such that the dataset was increased by slightly modifying the existing pictures. The dataset included plastic bags and plastic bottles. The dataset was divided into train, test, and validation. The train/test split percentage was set as 70%, 20% and 10%. The total training images were used to train the model, validation was used to validate if the model is working and testing images were used to test if the images are getting detected.

C. Modeling:

YOLO stands for you only look once. This method which just looks once means that the propagation is only once through the neural network. Any algorithm contains its own backbone for the purpose of pre-training the classes for future prediction. The algorithm used to achieve our goal is the YOLOv5 model which has PyTorch architecture. It is one of the best choices among any other architecture which has reusability. It contains tensors and optimizers for the dimensionality of an object. Optimizers can be used to alter the weights and biases so that by editing the internal parameters we can reduce errors.

In this algorithm, the backbone is the bounding boxes which are very precise and accurate. This extracts the rich characteristics of our input image such as plastic which is a transparent object. Now let's look into the neck of the model. The neck of the YOLO v5 model is the identification of objects using the pre-trained model and configuration file. Pre-trained model is nothing but the trained model of real-world day-to-day objects. It can be cat or dog object detection. We also have feature pyramids that are used in object scaling. Object scaling is nothing but the identification of the same object in different shapes and sizes. This helps in the recognition of unseen data. When it comes to the head of the model this is the final destination that the model reaches. Here the parameters included will be anchor boxes, class probabilities, bounding boxes, and object detection scores. These parameters help in cost function or loss function to generate the loss.

The optimization function in the YOLO algorithm is of 2 types. One is SGD and the other is Adam. SGD is the default optimization function.

Adaptive Moment Estimation (Adam) – This type of optimization learning rates are calculated for each epoch. The learning rate of an object can be the features that the model learns during its training.

$$mt = \beta 1 mt-1 + (1 - \beta 1)gt \quad (1)$$

$$vt = \beta 2 vt-1 + (1 - \beta 2)g^2 t \quad (2)$$

mt and vt are evaluations of mean and the uncenteredvariance of the gradients. β1 and β2 control the decay rates of variance of gradients. As mt and vt are initialized as vectors of 0's, we observe that they are biased to 0, especially during theinitial period, and when the decay rates are small. Here small in the sense β1 and β2 are close to one.

In YOLOv5 the activation functions used are leaky ReLU and sigmoid functions. An activation function is used to decide whether the neuron should be activated or not. Leaky ReLU comes under the middle layer or hidden layer. The final detection layer includes sigmoid activation.

The YOLOv5 model used here is an improvised model which detects transparent plastic debris in the ocean with much higher rates of accuracy as compared to the model in [1]. The model is trained by giving 200 epochs which gave satisfying results of accuracy of around 96%. By altering the optimizers the current model performs more efficiently as compared to the earlier versions of YOLO.

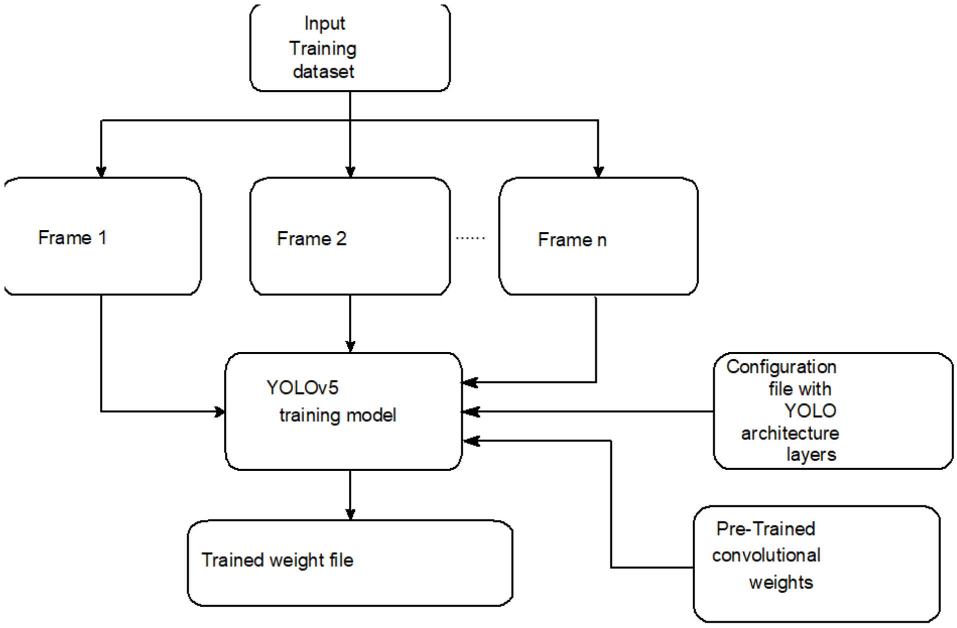

Fig- 1: Workflow Model

Fig-1 represents the workflow model of our research work.

D. Alternative methodology:

We can use other versions of the YOLO algorithm. The main positive side of this algorithm is it is updated every day and has the flexibility of different versions. This work can also use the YOLOv3 algorithm for the prediction of marine debris. The YOLOv3 algorithm uses darknet architecture for the prediction of concerns. Detection of small objects is quite difficult in version 3 of YOLO. Therefore version 5 outraces this.

4. Experimental Results

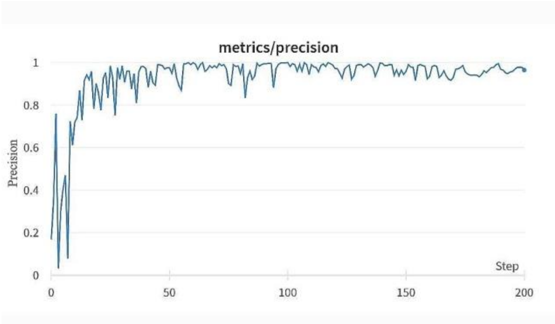

Fig-2: Precision Graph

Fig-2 tells about metrics precision. These curves are in a zig-zag format which goes up and down frequently. This represents the readability of the input image. The parameters true positive (TP), true negative (TN), false positive (FN), false negative (FN) are used to compare results of input images at each epoch. The x-axis represents the step which means a number of epochs. The y-axis represents precision which represents how accurately the object was recognized at every epoch.

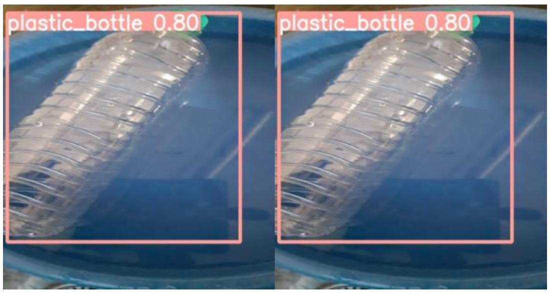

Fig- 3: Test Image Output

Fig.-3 represents the depiction of plastic bag and plastic bottle.

5. Conclusion

Finally, in this project, we conclude that we can use the YOLOv5 algorithm to solve the problem statement that is to detect plastic present in marines. This project will help us to approach sustainable development. The YOLOv5 algorithm uses pyTorch architecture which uses fewer weights and is more feasible. Hence, we can conclude to use this algorithm on this project to work efficiently. The result of the project is as expected. The model is detecting the required object but further micro plastics can be focused more as objects for detection.

6. REFERENCES

[1] Feng Lin, Tian Hou, Qiannan Jin, and Aiju You, “Improved YOLO Based Detection Algorithm for Floating Debris in Waterway”, 2021

[2] Xiali Li, Manjun Tian, Shihan Kong, Licheng Wu and Junzhi Yu, “A modified YOLOv3 detection method for vision-based water surface garbage capture robot”, 2020.

[3] Javier Lorenzo-Navarro, Modesto Castrillon-Santana, Enrico Santesarti, Maria De Marsico, Ico Martinez, Eugenio Raymond May Gomez and Alicia Herrera "SMACC: A System for microplastics Automatic Counting and Classification", 2019

[4] Emilie M. H. Dahl, Andreas O. R. Stien, Asgeir J. Sorensen and Emlyn John Davies Title “Identification of marine plastics using Raman Spectroscopy “, 2019

[5] Maximilian Wohlschlager and Martin Versen, “Detection of plastics in water based on their fluorescence behaviour”,2019

[6] Macro Balsi, Salvatore Esposito, Monica Moroni, “Hyperspectral characterization of marine plastic litters”, 2018

[7] F. Galgani, B. Andral, “Methods for evaluating debris on the deep-sea floor”, 1998

[8] Ashwin Kumar U.M, Anand Kumar K.R , “Data Preparation by CFS: An Essential Approach for Decision Making Using C 4.5 for Medical Data Mining”, 2013

Biographies

Photograph

Author Name received the bachelor's degree in computer engineering from Cankaya University in 2010, the master's degree in computer engineering from Gazi University in 2014, and the philosophy of doctorate degree in Electrical-Electronics & Computer Engineering from Duzce University in 2017, respectively. He is currently working as an Assistant Professor at the Department of Computer Engineering, Faculty of Engineering, Duzce University. His research areas include mobile security, deep learning, and social network analysis. He has been serving as a reviewer for many highly-respected journals.