Deep-Learning Based Fish Species Classification

Artificial Neural Networks Term Paper

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Deep-Learning Based Sea Species Classification

Abstract:

This term project focuses on the development and implementation of an artificial intelligence (AI) model for the classification of seafood among nine local fish species. The YOLOv8 object detection algorithm and Roboflow data preprocessing service was used to create an efficient and accurate model.
Performance tests of the trained model were conducted on the test datasets, demonstrating its accuracy and robustness in classifying the various local fish species. The project contributes to the growing field of AI applications in fish hunting, offering a practical solution in automating fish species classification tasks for hunters.

Keywords: AI, YOLOv8, Roboflow, Seafood Classification, Local Fish Species, Object Detection, Fish Hunting

Introduction

This project addresses the application of AI in the field of fish hunting, specifically focusing on the development of a model for the classification of local fish species. Utilizing the YOLOv8 object detection algorithm and Roboflow preprocessing service, it is aimed to create an effective and accurate classification system for consumers.

The dataset used in this project was derived from another article published in Izmir University of Economics [1], providing a various collection of samples representing nine local fish species. The YOLOv8 algorithm, known for its real-time object detection capabilities, was chosen to enable the model to accurately identify and classify fish species. Additionally, Roboflow played a critical role in preparing the dataset, contributing to enhanced model generalization and performance.

The project's significance lies in its potential to streamline and automate fish species classification, offering practical applications for fish hunters and contributing to the expanding landscape of AI in hunting.

Related Works

In 2020, a study was conducted by Izmir University of Economics [1], where pictures of various local seafood were taken, and several image processing algorithms were employed.
A similar academic work was held in 2017[2]. The research primarily focuses on the species composition and distribution of fish, crucial biological aspects essential for detailed fisheries analysis using conventional deep convolutional neural networks (CNN)

Project Implementation

Dataset Preparation

The project started by creating a Roboflow project, which acted as a central hub for organizing, labelling and classifying the dataset efficiently. Photos of each species (see *Figure 1*) were uploaded systematically into the project, preparing for later tasks of labelling and classifying (see *Table 1*).

Table 1: Used Fish species and their photo count.

Fish Species	**Photo count**
Black Sea Sprat (Tirsi)	50
Gilt-Head Bream (Çupra)	50
Horse Mackerel (İstavrit)	50
Red Mullet (Kırmızı Kefal)	50
Red Sea Bream (Mercan)	50
Sea Bass (Levrek)	50
Shrimp (karides)	50
Striped Red Mullet (tekir)	50
Trout (Alabalık)	30

Figure 1: Photos of several fish species

Inside the Roboflow project, each fish photo went through classification and labelling (see *Figure 2*). This step provides the essential information needed to train the YOLOv8 model. After creating classes for nine different fish species, each photo was labeled. The labelling process aimed to capture the outlines of fish in photos.

Figure 2: Roboflow Interface

Model Training

The annotated dataset, once ready, was then divided into 3 different parts. 70% of the data was labelled for training, 20% for validation, and the remaining 10% for testing (see Figure 3). This division aims to balance the tasks of training the model, validating its performance, and evaluating how well it works. After that, dataset is converted into YOLOv8 format and an API key is created to download the dataset inside the program.

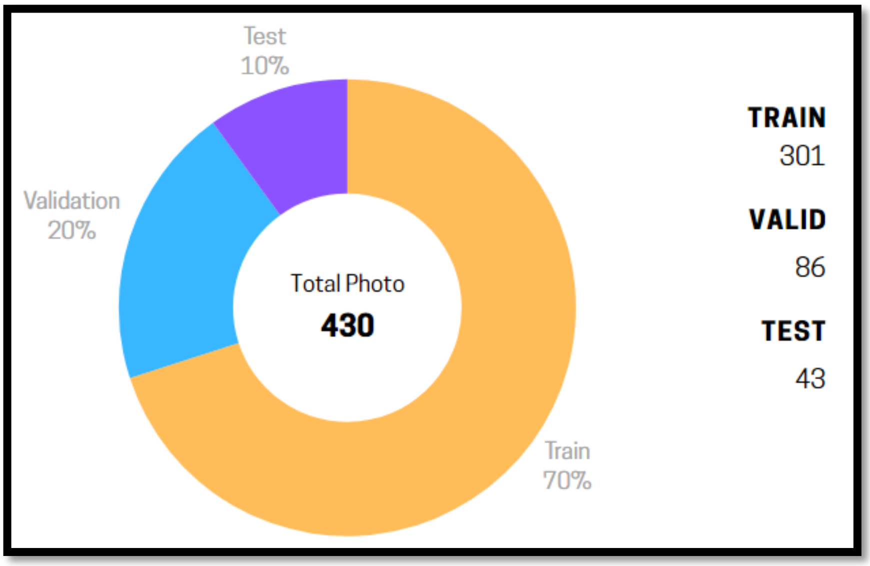

Figure 3: Dataset distribution

For training a model using YOLOv8, the Google Colab service is used to get the computational power necessary for training a deep learning model. The training process spanned 20 epochs, allowing the model to iteratively learn and refine its understanding of the diverse local fish species present in the dataset. After 20 epochs, its mean average precision for 0.50 to 0.95 (mAP50-95), box_loss, cls_loss and dfl_loss are calculated as 0.91, 0.29, 1.14 and 0.88, respectively (see *Figure 4*).

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      20/20       2.3G     0.2857      1.149     0.8841         12        640: 100%|██████████| 19/19 [00:06<00:00,  2.82it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 3/3 [00:01<00:00,  1.95it/s]
                   all         86         84      0.962       0.98      0.975      0.913
```

Figure 4: Epoch outputs of the model training process

Results

After training the model using YOLOv8, test dataset is used to assess the performance and accuracy of the model (see *Figure 5*). Additionally, several seafood images were gathered through online searches, and the model also predicted their species (see *Figure 6*).

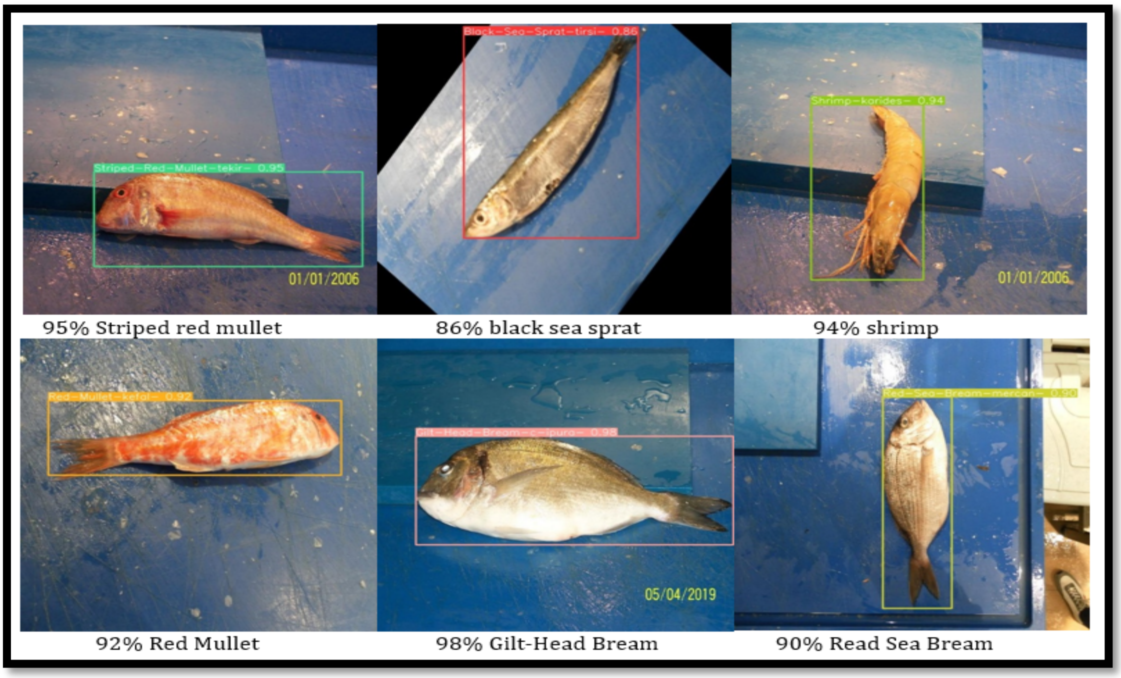

Figure 5: several results of the test dataset

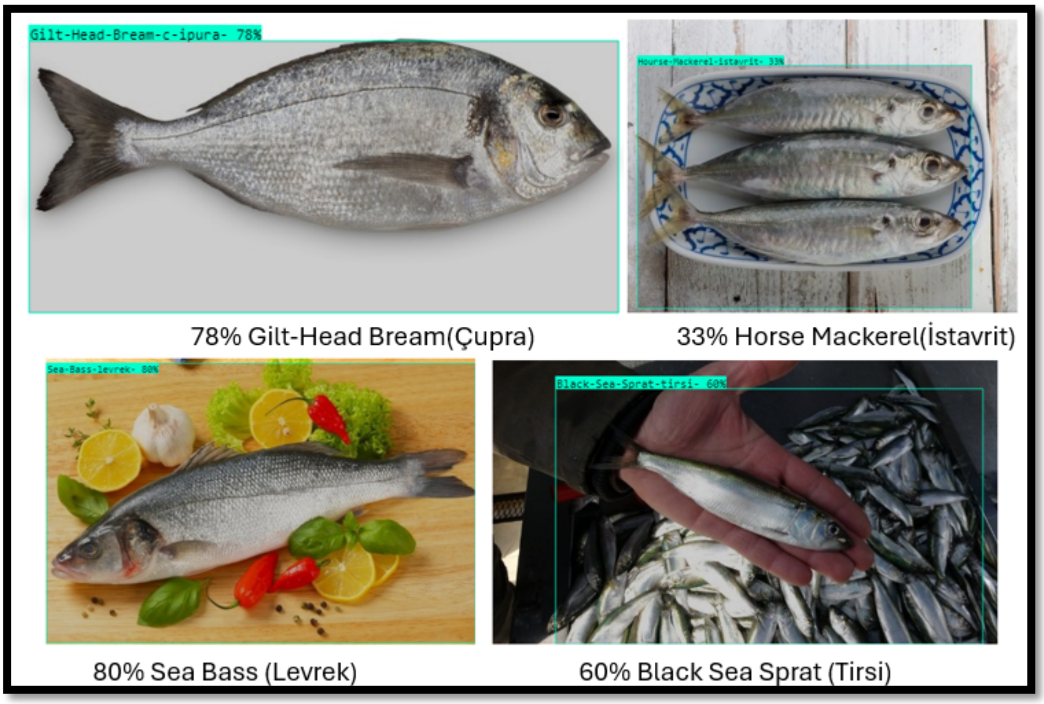

Figure 6: several seafood photos from online sources and model's predictions

In conclusion, the trained model shows a high prediction performance of up to 97% in identifying the species when predicting the test dataset, which is 10% of the complete dataset. On the other hand, the model showcases its adaptability by predicting fish species in photos gathered from online resources.

Discussion

The idea behind developing this model was to predict fish species in photos for hunters. In results, especially in photos with multiple fish, it is clear that the model cannot determine multiple fish in one photo. More research and data collection are needed to achieve multiple fish detection in one photo. Nevertheless, Model is still good at determining single fish in a photo. It is enough for hunters to determine the fish species they hunted.

References

[1] O. Ulucan, D. Karakaya and M. Turkan, "A Large-Scale Dataset for Fish Segmentation and Classification," *2020 Innovations in Intelligent Systems and Applications Conference (ASYU)*, Istanbul, Turkey, 2020, pp. 1-5, doi: 10.1109/ASYU50717.2020.9259867.

[2] G. Chen, P. Sun and Y. Shang, "Automatic Fish Classification System Using Deep Learning," *2017 IEEE 29th International Conference on Tools with Artificial Intelligence (ICTAI)*, Boston, MA, USA, 2017, pp. 24-29, doi: 10.1109/ICTAI.2017.00016.

Github Repo: https://github.com/mkorucu/Deep-Learning-Based-Seafood-Classification