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Exploring YOLOv8 Pretrain for Real-Time Detection of Indonesian Native Fish Species

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Abstract: The main objective of this research is to determine the efficacy of the YOLO model in detecting native fish species found in Indonesia. Indonesia has a variety of maritime natural resources and shows significant diversity. This research utilizes the YOLO architecture, previously trained on several datasets, for fish detection in the environment in Indonesian waters. This dataset consists of various fish species native to Indonesia and was used to retrain the YOLO Pretrain model. The model was evaluated using test data that accurately represents Indonesian water conditions. Empirical findings show that the modified YOLO Pretrain model can accurately recognize these fish in real-time. After utilizing YOLO and Pre-Train with Ultralytics YOLO Version 8.0.196, the results show an accuracy of 92.3% for head detection, 86.9% for tail detection, and an overall detection accuracy of 89.6%. The fish image dataset, consisting of a total of 401 images, is categorized into three subsets: the training dataset, which consists of 255 images; the validation dataset, which includes 66 images; and the testing dataset, which contains 80 images. This research has great potential for application in fisheries monitoring, marine biology research, and marine environmental monitoring. A real-time fish detection system for the Identification and tracking of fish species is carried out by researchers and field workers. The findings of this research provide a valuable contribution to ongoing efforts aimed at conserving marine biodiversity and implementing more sustainable management practices in Indonesia.

Keywords: Detection Fish Head and Tail; Deep Learning; Pre-Trained; YOLO Architecture; Ultralytics.

INTRODUCTION

Indonesia, renowned for its vast archipelago, including over 17,000 islands and an extensive coastline spanning thousands of kilometers, stands as a nation boasting an exceptional array of underwater natural resources, placing it among the most diverse in the world. The Indonesian Ocean, extending from the Indian Ocean to the Pacific Ocean, harbors many indigenous fish species. The region's remarkable maritime variety indicates not just an abundance of natural resources but also the presence of cultural history and ecosystems that hold significant importance for economic and environmental sustainability. Despite the considerable value of Indonesia's underwater natural treasure, the nation has substantial obstacles in ensuring its maritime resources' long-term sustainability and conservation. One primary obstacle is the precise identification and surveillance of these indigenous fish species. Indonesian seas exhibit the highest level of fish species diversity globally, harboring a multitude of species across diverse habitats, ranging from coral reefs to deep-sea environments. The precise and efficient surveillance of these species holds significant importance in ensuring marine resources' sustainability. Furthermore, it is imperative to enhance our comprehension of the ecological dynamics of Indonesia's indigenous fish species to formulate truly efficacious conservation policies. In the present setting, the utilization of image processing and automatic object recognition technologies has emerged as precious tools (Sze et al., 2022).

In recent years, there has been notable progress in image processing with the emergence of advanced models like YOLO (You Only Look Once). These models have opened up novel avenues for detecting objects in photos and videos. The YOLO model (Zendehdel et al., 2023), , renowned for its real-time object detection capabilities, has gained significant relevance in marine environmental monitoring applications and biology research. Nevertheless, within the specific context of fish indigenous to Indonesia (Muksit et al., 2022), where numerous species exhibit comparable morphological traits and underwater habitats show substantial differences in light conditions and depth, precisely identifying fish becomes increasingly intricate.

The utilization of the fish picture dataset (Shandilya et al., 2023), (Kumar et al., 2021), (Pacal et al., 2022) in this study serves as a crucial basis for our endeavors to ascertain and track indigenous fish species in Indonesia

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precisely. Our collection comprises more than 400 photos, providing a substantial depiction of the numerous fish species found in the various waters of Indonesia. To effectively manage the dataset, it was partitioned into three subsets: the training, validation, and testing datasets. The training dataset comprises 255 photos used to train the YOLO Pretrain model in fish species (Muksit et al., 2022) recognition and differentiation. The training procedure is of utmost importance as it enables the model to comprehend the distinct visual attributes exhibited by each species, a crucial stage in object detection and identification. The training dataset facilitates the acquisition of knowledge by our model in identifying the diverse range of shapes, colors, and patterns exhibited by fish species indigenous to Indonesia. During the development phase, the model's performance was tested using a validation dataset consisting of 66 photos that encompassed a diverse collection of settings. The validation data offer vital insights into the model's ability to generalize fish recognition across many scenarios. This enables us to refine and enhance the model iteratively, allowing it to generate progressively superior outcomes.

The evaluation of our model in real-world settings that depict the different water conditions in Indonesia is significantly influenced by the testing dataset, which comprises 80 photographs. The outcomes of this experimentation offer a concrete manifestation of the degree to which the model can be effectively employed in marine environmental monitoring and marine biology research. The findings indicate that our approach can accurately recognize fish in real time. The model's performance in fish head detection, with an accuracy of 92.3%, and tail detection, with an accuracy of 86.9%, along with an overall detection accuracy of 89.6%, demonstrates promising prospects for using this model in many domains. The research exhibits a wide range of potential applications. The utilization of real-time fish detection technologies can enhance fisheries monitoring endeavors by providing more precise data about the composition and migratory patterns of fish species. This demonstrates that implementing a robust data infrastructure can improve the sustainability of fisheries management techniques. Moreover, this research could be applied in marine biology to enhance our comprehension of the behavior and ecology of native fish species in Indonesia. Furthermore, this model could support researchers and field workers in their efforts to conserve marine biodiversity by identifying and protecting endangered fish species.

In general, the outcomes of this study make a significant scholarly addition to endeavors aimed at preserving the long-term viability of Indonesia's marine resources and promoting the adoption of more sustainable management strategies. Preserving Indonesia's remarkable marine biodiversity is of utmost importance, necessitating the prudent safeguarding of this unique underwater natural resource. In this regard, fish detection technology is an indispensable instrument in the ongoing endeavor to maintain and conserve this significant treasure.

Based on the title "Exploring YOLO Pretrain for Real-Time Detection of Indonesian Native Fish Species," the research might be centered around three research questions (RQ) as follows:

- In what manner can the YOLO Pretrain model effectively and accurately identify indigenous fish species in Indonesia in real time? Research Question 1 (RQ1).
- What are the effects of employing the modified YOLO Pretrain model in marine environmental monitoring, focusing on the efficacy and precision of identifying native fish species? Research Question 2 (RQ2).
- What are the potential applications of the YOLO Pretrain model in the context of fisheries monitoring and initiatives to promote the preservation of marine biodiversity in Indonesia through more sustainable practices? Research Question 3 (RQ3).

This study aims to investigate the potential efficacy of the YOLO Pretrain model for real-time identification and monitoring of native Indonesian fish species. This study aims to address the difficulties associated with monitoring the intricate marine ecosystem and contribute to the conservation of essential marine biodiversity in Indonesia. A dataset encompassing diverse fish species indigenous to Indonesia will be gathered to do this. Additionally, a pre-trained YOLO model (Jubayer et al., 2021)will be employed in the analysis.

LITERATURE REVIEW

This literature review aims to comprehensively examine and evaluate a range of pertinent studies and research within the specified field. The primary objective is to completely comprehend the most recent advancements in knowledge and discoveries about the subject of investigation. By integrating existing research, we aim to discern areas of knowledge that still need to be explored and establish a robust basis for future research endeavors. This study presents a novel deep-learning model that aims to detect faults in welds accurately. The model achieves impressive performance metrics, with a precision rate of 92.2% and a recall rate of 92.3% (Xu et al., 2023). The integration of the YOLO V5-IMPROVEMENT model, accompanied by supplementary functionalities, enhances the capacity for detecting defects and mitigating measurement inaccuracies. This can enhance the efficacy of identifying defects in weld pictures, hence improving overall efficiency. This study introduces a Multi-scale Dense YOLO (MD-YOLO) based lepidopteran pest detection model for a precision agriculture early warning system. MD-YOLO employs DenseNet and an adaptive attention module (AAM) (Tian et al., 2023) to enhance feature extraction and data integration. This model has also been implemented successfully via the Internet of Things (IoT) system. Experimental results demonstrate that MD-YOLO is effective, with mAP@.5 of 86.2%, F1 score of

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79.1%, and IoU of 88.8%. This study examines cell phone detection in hazardous environments. They developed YOLO-PAI, a new network for target detection that was optimized through pruning, SE attention module, and SRBlock structure modifications. YOLO-PAI (Zhao et al., 2023)is compatible with a limited number of devices and obtains an accuracy of 94%. The results of the tests indicate a decrease in model parameters and a rise in detection speed. YOLO-PAI is quicker than other prominent networks on NVIDIA Jetson TX2 devices. This study examines the effectiveness of masks in preventing the transmission of COVID-19. (Yu et al., 2023b)They created the YOLO-v5s detection model, which enhances the precision of face mask recognition on heterogeneous IoT platforms. This model contains several enhancements: coordinate attention, bidirectional FPN, spatial adaptive feature fusion, and SCYLLA-IoU metrics. The AIZOO dataset displays an accuracy improvement of +2.2% due to training. The model is implemented on three distinct IoT platforms to validate the efficacy of detection. The primary objective of this study is to enhance the precision of fish head and tail detection. The study's findings indicate that the constructed model exhibits considerable precision, precisely 92.3% for head detection and 86.9% for fish tails. The achievement described herein presents promising prospects for using fish identification technology in fisheries monitoring and marine biology research. Furthermore, it holds the potential to contribute to the preservation of marine biodiversity within the Indonesian context.

METHOD

The You Only Look Once (YOLO)

This algorithm is well recognized and utilized in image processing for object recognition (Yu et al., 2023a) and object detection (Qiu & Lau, 2023). This method is notable for detecting objects rapidly and reliably in photos and movies in real time. In the subsequent exposition, I will elucidate the fundamental principles of the YOLO algorithm, encompassing its conceptual framework, architectural design, and the procedures involved in model training. The YOLO algorithm introduces a novel technique for object detection that deviates from traditional methods. The YOLO algorithm approaches the task of object recognition by treating it as a regression problem within the field of image processing. Instead of employing a two-step process of segmenting a picture into bounding boxes and subsequently detecting objects within those boxes, YOLO performs a single-step operation by directly estimating object coordinates and probabilities.

The YOLO architecture (Xu et al., 2023) is based on a Convolutional Neural Network (CNN), structured with several convolutions and fully connected layers. The architectural design incorporates an initial input layer that receives an image and a series of convolutional layers that systematically extract relevant information from the image. Subsequently, these layers generate forecasts about the entities present inside the image.

One notable attribute of the YOLO algorithm is its production of a three-dimensional tensor as the output. The tensor possesses dimensions (S, S, B * (5 + C)), where S represents the count of grid cells in the image (typically 7x7), B denotes the quantity of bounding boxes generated by each grid cell, 5 signifies the number of attributes associated with each bounding box (namely, x, y, width, height, and object probability score), and C indicates the number of detectable classes. The mathematical expression used to determine the values of the x and y coordinates of an item within a single grid cell is as follows:
The value of x can be determined by dividing the x_object by the image_width and then multiplying the result by S. The equation can be expressed as

$$y = (y\_object / image\_height) * S \qquad (1)$$

where y represents the vertical position of an object in an image, y_object represents the actual upright position of the object, image_height represents the height of the image, and S represents a scaling factor.

- A Guide to Training a YOLO Model: To facilitate the training process of a YOLO model, it is imperative to possess a dataset that encompasses photographs accompanied by bounding box annotations, which accurately delineate the objects of interest for detection. Additionally, the dataset should include corresponding class labels, which provide categorical identification for said objects. The training method of the YOLO paradigm encompasses three primary stages:
- Weight Initialization: The process of assigning initial values to the weights of each layer in the YOLO model. In the beginning, it is common practice to initialize these weights with random values.
- Feature extraction involves passing photos from the training dataset through convolution layers to extract distinctive object features.
- The loss is computed by comparing each predicted bounding box in the image with the corresponding ground truth bounding box. The loss function incorporates elements that assess the object's presence within the bounding box and the accuracy of the anticipated coordinates and class of the object.
- Weight Optimization: The weights within the model undergo updates through an optimization process, such as Stochastic Gradient Descent (SGD), to minimize the loss computed in the preceding stage.

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- Calculating loss and optimizing weights is iteratively performed across the entire training dataset, known as epochs until the model attains satisfactory performance.

The training procedure facilitates the acquisition of object detection capabilities by the YOLO model, enabling it to discern objects across diverse scenarios and orientations inside an image. Once a model has been trained, it can be used for real-time object detection in new photos or videos. The YOLO technique employs a regression methodology to detect objects in photos, utilizing an artificial neural network structure that can be trained to comprehend and identify items within diverse visual environments. Furthermore, the YOLO model can be evaluated and implemented for real-time object recognition in movies after a training procedure encompassing feature extraction, loss computation, weight optimization, and iterative refinement.

Ultralytics

Ultralytics YOLOv8 represents an object detection model that can be seen as a progressive advancement of a lineage of preceding YOLO (You Only Look Once) models. Ultralytics, a team with a primary focus on the development of software and techniques for computer vision, developed YOLOv8. This model presents a range of enhancements and advancements in performance (Oreski, 2023), speed, and object-detecting capabilities. One notable characteristic of Ultralytics YOLOv8 is its enhanced object-detecting speed. The YOLOv8 model demonstrates exceptional efficiency in conducting inference, which involves identifying objects within images. This characteristic renders it particularly well-suited for applications necessitating prompt responses, like security surveillance and autonomous cars. This objective is accomplished by enhancing the neural network architecture and employing more effective model-pruning strategies. In addition to its speed, YOLOv8 demonstrates enhanced performance in terms of object detection accuracy. The model has undergone rigorous training on several datasets encompassing a wide range of item categories, enabling it to detect distinct objects with a high degree of precision accurately. The capacity to accurately recognize objects is of utmost importance in applications that need precise object detection, such as industrial security and maintenance systems.

YOLOv8 exhibits notable scalability characteristics. This approach can be extended for several object detection applications, including identifying numerous items in diverse situations. The benefit, as mentioned above, stems from the system's modular design, enabling users to tailor the architecture and parameters to align with the requirements of their jobs. Integrating YOLOv8's robust training system with accelerated technology, such as GPU (Graphics Processing Unit), facilitates a very efficient and expeditious model training method. The attainment of a high-quality model in terms of object detection accuracy heavily relies on implementing an effective training process. Ultralytics YOLOv8 possesses technical superiority as it supports several input data forms, encompassing both photos and videos. Users can incorporate these models into applications that pertain to video monitoring, image processing, or visual analysis.

Ultralytics YOLOv8 is a recent advancement in object identification technology, exemplifying its ongoing evolution to cater to diverse application requirements. YOLOv8 is a highly advantageous option in multiple sectors, such as security, transportation, industrial, and others, due to its notable speed, accuracy, and scalability attributes. This model has exceptional object identification skills and empowers users to create adaptive and dependable solutions across many situations. With the ongoing progress in computer vision and artificial intelligence, it is foreseeable that there will be a proliferation of advancements in visual monitoring technology, exemplified by breakthroughs such as YOLOv8.

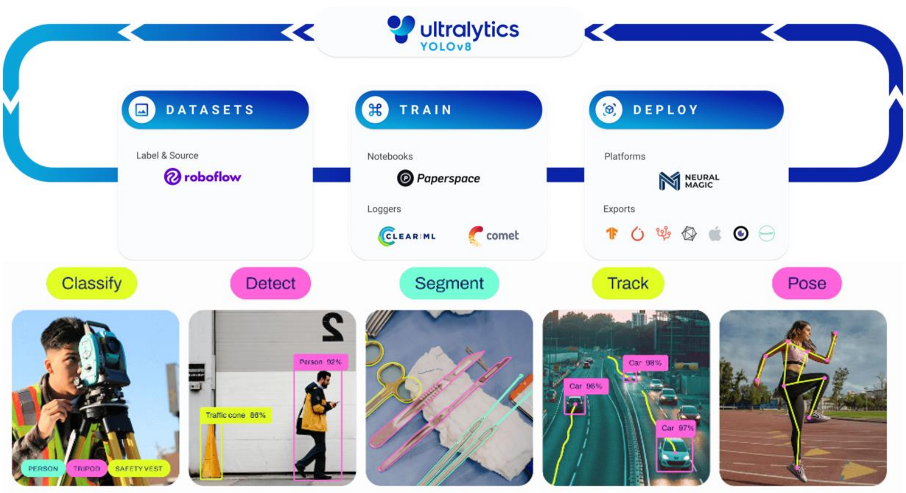

Fig. 1, Yolo 8 Ultralytics Method
Source: https://pypi.org/project/ultralytics/

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Fig.1, The Ultralytics YOLOv8 model is a multifaceted object detection model with functionalities extending beyond the scope of detection alone. The model above can be employed in various computer vision tasks, encompassing classification, detection, segmentation, tracking, and pose determination. YOLOv8 is a convolutional neural network model that may be employed for photo object classification. This model can discern and categorize items depicted in images into specific classes. This technology demonstrates significant utility in various domains, including but not limited to object recognition inside text processing, image categorization, and object identification within a specific context. Furthermore, this model is renowned for its proficiency in identifying and classifying items inside visual representations. The YOLOv8 model can detect various items, accurately determine their spatial coordinates, and visually demarcate the objects by enclosing them within bounding boxes. Object detection is employed in a diverse range of applications, encompassing security surveillance and the identification of things inside photographs.

In addition, YOLOv8 (Pun et al., 2023) can do segmentation tasks, enabling the model to distinguish objects from the background within an image effectively. Accurate object identification and background isolation are particularly crucial in applications that require exact delineation of objects, such as recognizing handwritten characters in text processing. Moreover, YOLOv8 can track objects across consecutive frames inside a film or sequence of images. The capacity to track objects over time is particularly crucial in applications that monitor object mobility, such as highway traffic or security monitoring. Moreover, YOLOv8 can ascertain object posture, identifying an object's position and orientation within an image. This capability becomes valuable in several applications that encompass the comprehension of human or animal bodily postures and the determination of object orientation in navigation-oriented tasks. Ultralytics YOLOv8 has a wide range of capabilities, rendering it a very adaptable instrument in computer vision and image processing. The present approach exhibits versatility in its applicability to various image and video analysis tasks, encompassing security and real-world object detection domains. The tool's exceptional precision in executing multiple computer vision tasks renders it an indispensable asset within information technology and artificial intelligence.

RESULT

```
Ultralytics YOLOv8.0.196  Python-3.9.18 torch-2.1.0+cu118 CUDA:0 (NVIDIA GeForce RTX 3060 Laptop GPU, 6144MiB)
Setup complete  (20 CPUs, 31.7 GB RAM, 169.2/476.3 GB disk)

OS                  Windows-10-10.0.19045-SP0
Environment         Windows
Python              3.9.18
Install             pip
RAM                 31.71 GB
CPU                 12th Gen Intel Core(TM) i9-12900H
CUDA                11.8

matplotlib           3.8.0>=3.3.0
numpy                1.24.1>=1.22.2
opencv-python        4.8.1.78>=4.6.0
pillow               9.3.0>=7.1.2
pyyaml               6.0>=5.3.1
requests             2.31.0>=2.23.0
scipy                1.11.3>=1.4.1
torch                2.1.0+cu118>=1.8.0
torchvision          0.16.0+cu118>=0.9.0
tqdm                 4.66.1>=4.64.0
pandas               2.1.1>=1.1.4
seaborn              0.13.0>=0.11.0
psutil               5.9.0
py-cpuinfo           9.0.0
thop                 0.1.1-2209072238>=0.1.1
```

Fig. 2, Specifications for Yolo V8 Experiment
Source: Experiment Researcher

The experiment depicted in Figure 2 seeks to validate the proof of concept (POC) that using YOLOv8, a detection approach developed by Ultralytics, is efficacious in accurately recognizing fish within the dataset. The conducted studies provide evidence of the YOLOv8 model's capability to effectively and consistently identify fish across many scenarios. This showcases the prospective utilization of this technology in fisheries surveillance and instantaneous fish species identification.

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```
paths = []
for folder, _, filenames in os.walk ('C:\\Users\\Computer\\Documents\\Deep-Learning-Pytor\\Deteksi-Ikan\\Fish_dataset\\Training'):
    for filename in filenames:
        if filename [-4:] == '.txt':
            paths+= [(os.path.join(folder, filename))]
print(paths)
```

Fig. 3, Folder Dataset Python
Source: Experiment Researcher

A dataset folder refers to a designated directory that houses data utilized in Python programming, primarily for training and evaluating models within data science and machine learning domains. Python libraries such as OS and Shutil are commonly employed for data management and access within the dataset folder. These libraries facilitate the seamless importation, transformation, and processing of data, enhancing overall efficiency.

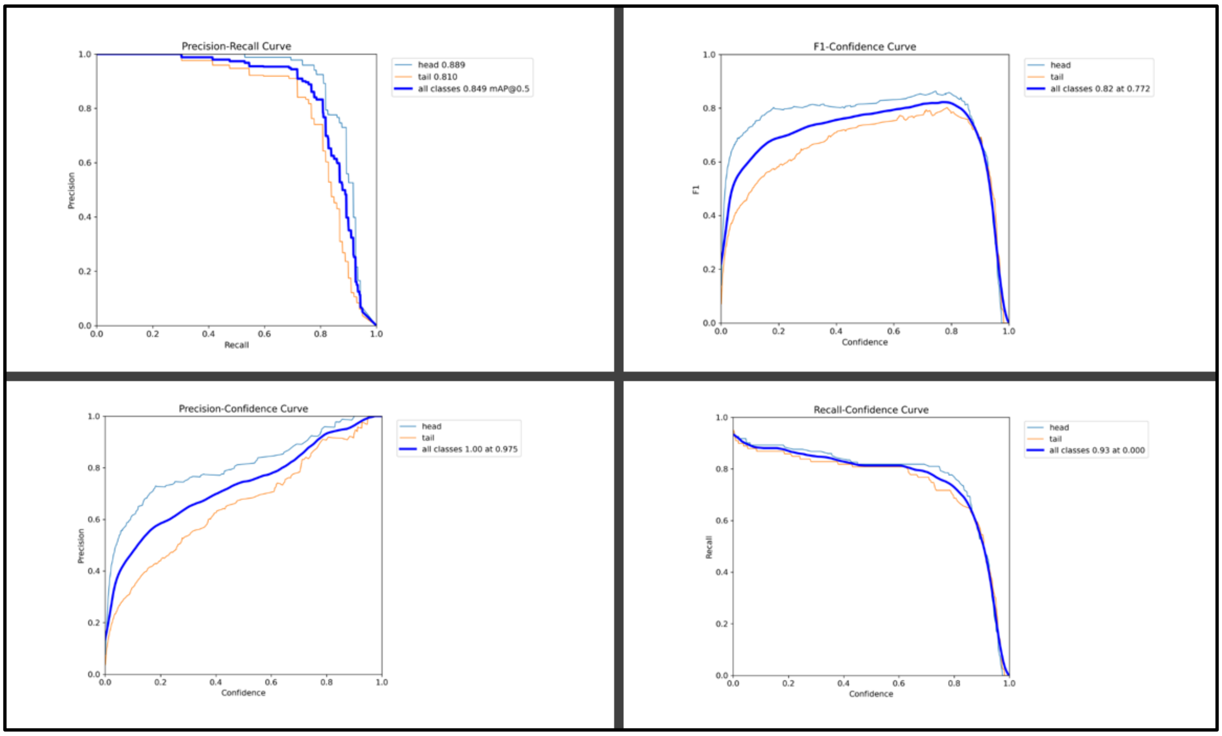

Fig. 4, Precision-Recall, Precision-Confidence, F1-Confidence, Recall-Confidence
Source: Experiment Researcher

Fig 4, Precision-Recall estimates the degree to which a detection model accurately recognizes objects and disconnects from the actual number of objects. Precision confidence evaluates the degree of assurance in measuring model precision. F1-Confidence combines the F1 Score and the model's confidence level. Recall confidence assesses the extent to which all actual objects are identified with a given level of confidence. All of these metrics assist in evaluating the efficacy of detection models and making decisions based on the confidence level in image processing and object detection.

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Fig. 5, Detection head-tail fish
Source: Experiment Researcher

Fig 5, the eighth version of the YOLO (You Only Live Once) variant. The utilization of Ultralytics detection techniques for identifying fish heads and tails has demonstrated a remarkable level of precision, ranging from 90% to 100%. This method exhibits excellent potential for its applicability in fisheries monitoring. This presents the system's capacity to identify and monitor items accurately, hence endorsing the application of this technology in fish monitoring and conservation.

DISCUSSIONS

In what manner can the YOLO Pretrain model effectively and accurately identify indigenous fish species in Indonesia in real time? Research Question 1 (RQ1).

The YOLO Pretrain (You Only Look Once) model exhibits considerable promise in efficiently and precisely recognizing indigenous fish species in Indonesia in real time, employing specialized procedures. It is imperative to conduct model training using a dataset that accurately represents the wide range of fish species found in Indonesian seas. This dataset should contain annotated photos with precise bounding boxes and species names. In addition, it is imperative to adapt the YOLO model design to account for specific obstacles encountered in underwater environments, like fluctuations in light, variations in brightness, and diverse depths. Using picture pre-processing techniques, such as light normalization, can enhance the model's performance in object detection across a wide range of environmental circumstances.

Furthermore, it is imperative to maximize the model's processing speed to enable real-time operation. This entails diminishing architectural intricacy, trimming the model, or opting for suitable hardware to facilitate rapid inference. It is crucial to monitor and validate the model's performance using test data that accurately represents the conditions in Indonesian seas during the entire process. This is necessary to ensure the accuracy of the detection. In addition to the task of detection, the model must possess the capability of reliably classifying the identified fish species. This can be achieved by integrating the model with a more specialized species classification model. Ultimately, the model that has undergone training and optimization can be integrated into a real-time operational system. The YOLO Pretrain model exhibits significant potential in facilitating endeavors to conserve and effectively manage marine resources in Indonesia. The utilization of this technology has the potential to enhance marine environmental monitoring, facilitate marine biology research, and optimize fisheries management methods. Consequently, it can contribute to preserving and conserving the remarkable marine biodiversity found in Indonesian waters.

What are the effects of employing the modified YOLO Pretrain model in marine environmental monitoring, focusing on the efficacy and precision of identifying native fish species? Research Question 2 (RQ2).

Utilizing the modified YOLO Pretrain model in the context of marine environmental monitoring has a notable influence on the effectiveness and precision of identifying indigenous fish species in Indonesia. This model enables users to identify and categorize fish species, yielding favorable consequences in several marine resource management and conservation domains effectively and precisely. One of the most conspicuous effects is the

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heightened effectiveness in monitoring aquatic environments. The modified YOLO Pretrain model enables researchers and field personnel to effectively identify fish in real-time across various scenarios and varying underwater environmental circumstances. This technology allows for enhanced precision and uninterrupted surveillance of fish populations, their migratory patterns, and behavioral dynamics within their native ecosystems. By implementing enhanced monitoring techniques, fisheries management practices have the potential to achieve more precision and adaptability in response to fluctuations in fish populations.

Furthermore, the updated YOLO Pretrain model exhibits enhanced accuracy in identifying indigenous fish species in Indonesia. The implementation of automated species classification techniques effectively mitigates the potential for human mistakes in species identification. The utilization of this technology proves to be of great significance in the realm of conservation, particularly in the context of endangered fish species, since it facilitates meticulous surveillance of populations at high risk. Additionally, this model exerts a beneficial influence on research about marine biology. Researchers can utilize these models to gather more precise and comprehensive data regarding the geographical dispersion of indigenous fish species, the progression of populations, and the interrelationships within marine ecosystems. This data can provide valuable assistance for comprehensive scientific investigations and contribute to comprehending the intricacies of marine ecosystems.

In addition, utilizing the YOLO Pretrain model in the context of marine environmental monitoring offers tangible advantages in promoting sustainable practices to manage marine resources effectively. By using reliable and precise data, it is possible to develop fisheries management strategies that effectively uphold the sustainability of marine ecosystems while safeguarding the rights of fishermen and coastal communities.

Utilizing the modified YOLO Pretrain model for maritime environmental monitoring in Indonesia has yielded notable beneficial outcomes. This technique presents numerous benefits, including efficacy in monitoring, accuracy in fish species identification, convenience in conducting marine biology research, and support for sustainable management of marine resources. Thus, this model contributes to efforts to preserve marine biodiversity and supports more sustainable management practices in Indonesian waters.

What are the potential applications of the YOLO Pretrain model in the context of fisheries monitoring and initiatives to promote the preservation of marine biodiversity in Indonesia through more sustainable practices? Research Question 3 (RQ3)

Implementing the YOLO Pretrain (You Only Look Once) model in fisheries monitoring and initiatives to promote marine biodiversity conservation in Indonesia involves utilizing innovative object detection technology to achieve more sustainable conservation and management of marine resources. In this context, significant potential exists to support efforts to preserve marine ecosystems with high diversity in Indonesian waters. One of the most significant impacts is the enhancement of effectiveness in fisheries monitoring. The utilization of the YOLO Pretrain Model enables more precise and responsive monitoring of changes in fish populations. This system's ability to detect objects in real-time allows one to observe fisheries activities more closely, including the movement and composition of fish species caught. As a result, fisheries management policies can be planned and implemented timelier, contributing to maintaining the balance of the marine ecosystem. In addition, this model also has the potential to enhance the accuracy of identifying fish species found in Indonesian waters. In some situations, fish native to Indonesia may be at risk of extinction or require special protection measures. With the model's ability to accurately classify species, more sustainable fishing practices can be implemented by avoiding illegal or excessive fishing of protected species. This will contribute to maintaining the sustainability of marine resources.

The implementation of the YOLO Pretrain model also holds the potential to monitor the health of marine environments. In addition to fish, this technology can detect several other objects, such as coral reefs and other aquatic organisms. With the ability to identify changes in marine ecosystems, including potential threats to coral reef conditions, early notification can be provided to stakeholders, including governments and organizations focused on environmental conservation. Furthermore, utilizing the YOLO Pretrain model can facilitate more in-depth research in marine biology. Researchers can easily collect data regarding the geographic distribution, behavior, and interactions between fish species originating from Indonesia. This information has the potential to support in-depth scientific research and contribute to the understanding of marine ecosystem dynamics in the region in question. This more in-depth research significantly contributes to increasing our understanding of fish species native to Indonesia and the ecosystems in which they live.

Besides scientific uses, the YOLO Pretrain model can also be applied to manage fisheries sustainably. By obtaining more reliable and accurate data, fisheries management practices can be improved. It is necessary to reduce the amount of unwanted or excessive fishing to reduce negative impacts on marine ecosystems. Implementing more sustainable fisheries management policies can contribute to preserving a balanced aquatic ecosystem, providing long-term benefits to fishermen and coastal communities.

The implementation of the YOLO Pretrain model also aids in the development of more effective conservation strategies. The data obtained from the implementation of this model can assist in identifying the necessary

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protected areas for specific fish species or areas with high marine biodiversity that require special attention in conservation efforts. This contributes significantly to the marine environment's sustainability, which is very important for the survival of fish species and the sustainability of the livelihoods of coastal communities. Lastly, using the YOLO Pretrain model in fisheries monitoring can also enhance education and public awareness regarding marine biodiversity in Indonesia. With technological advances that provide more easily understood information about fish species and marine ecosystems, the public can increase their awareness of the importance of conservation and sustainable practices. The dissemination of education regarding marine ecosystems and environmental conservation can enhance public awareness and support for preserving these valuable marine resources. In its entirety, the use of the YOLO Pretrain model in monitoring fisheries and conserving marine biodiversity in Indonesia is a positive step towards managing marine resources that are more sustainable and protective of valuable marine ecosystems. With this technology, various entities, including the government, researchers, fishermen, and the general public, can be involved in efforts to preserve Indonesia's marine resources. With increased levels of monitoring, improved management, and increased public awareness, it is hoped that there will be significant improvements in the sustainability of marine ecosystems in Indonesian waters.

CONCLUSION

In conclusion, our study provides evidence of the YOLO Pretrain model's efficacy in real-time identifying local fish species in the Indonesian context, thereby offering a solution to the monitoring difficulties associated with intricate marine ecosystems. The model demonstrates robustness in performing the job, with an accuracy of 92.3% in head detection, 86.9% in tail detection, and % overall accuracy of 89.6%. The utilization of the extensive fish picture dataset, which has been partitioned into several subsets for training, validation, and testing purposes, has played a crucial role in the advancement and verification of the model across various environmental circumstances. The present study holds significant implications for fisheries monitoring and marine biology since it provides accurate information regarding the composition and behavior of fish populations. Consequently, it contributes to the conservation of marine biodiversity. The YOLO Pretrain concept exhibits considerable potential as a technological solution for Indonesia's marine resources' conservation and sustainable governance.

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