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# ARTIFICIAL INTELLIGENCE IN MARINE TECHNOLOGY: IMPROVING FISHERY MANAGEMENT & BIODIVERSITY MONITORING

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**ABSTRACT**

*Image identification has been transformed by artificial intelligence (AI) and machine learning (ML), which are essential to marine technology. Using Convolutional Neural Networks (CNNs) for feature extraction, preprocessing, and data collecting, image recognition allows machines to recognize and categorize fish species. Fish species identification, size and weight estimate, and ecosystem monitoring are important applications that support the preservation of marine biodiversity and sustainable fisheries. High accuracy, scalability, and real-time analysis is provided by the technology, which lowers human error and enhances decision-making. However, issues including fish overcrowding, biofouling, and water turbidity may disrupt system function. Despite these drawbacks, developments in AI-powered picture identification keep improving environmental sustainability, fishery management, and marine research. This study shows how image recognition is becoming more and more capable of improving marine technology and encouraging responsible resource management.*

***Keywords: Artificial Intelligence, Machine Learning, Image recognition, Convolutional Neural Networks (CNNs), Marine technology***

## Introduction

### *Definition of AI and Machine Learning*

Artificial Intelligence (Al) is defined as an ability of a system to correctly analyse external data, learn from it, and apply this knowledge to reach objectives and tasks (Kaplan & Haenlein, 2019). This technology enables computers or machines in responding to human language, problem solving and enhancing decision making. Currently, AI has become increasingly important due to its advancement in technology including in cybersecurity and education.

A subfield of artificial intelligence (AI) called machine learning (ML) aims to give computers and other machines the ability to mimic human learning, carry out activities on their own, and get better at them over time and with more data. There are a few examples of machine learning such as speech recognition, customer service, computer vision, and fraud detection. There are three main types of

machine learning models which are supervised machine learning, unsupervised machine learning, and semi-supervised learning (IBM, 2021).

***Definition of Image recognition***

Image recognition is a process of identifying and classifying specific objects within its images (Bagheri et al., 2023). AI in Image Recognition is a technology that uses AI and machine learning to analyze the image contained in them. In other words, it is an ability of computer software to interpret visual data the way a human might. It works through a process of training and recognition. Once trained, an image recognition system can accurately identify objects or scenes.

This technology is widely used in various fields. For example, in healthcare, image recognition is commonly used to aid diagnostic processes such as detecting potential tumours using MRI (Susanto et al., 2022). This new development in AI has raised hopes among patients for better healthcare outcomes. Similarly, in marine technology, image recognition plays a huge role in monitoring the health of ecosystems. For example, it can analyze underwater imagery to identify diseased fish using Autonomous Underwater Vehicles (AUVs).

Figure 1: Shows the image of MRI machine

Figure 2: Show the image of Autonomous Underwater Vehicles (Oceanographic Systems Lab, n.d.)

***How Image Recognition Works in Marine Technology***

***Data Collection and Preprocessing***

Image recognition allows machines to identify different people, objects and other things in the images (Liu et al., 2020). It includes methods of gathering, processing and examining data from the real world. To achieve image recognition, a larger data set of images is collected. These images can include various species of fish and aquatic plants to train the AI. The image will be labelled to be detected by the computer vision system. In other words, labelling processes ensure the AI system can correctly match the characteristics in the image with the right categories during recognition tasks. After labelling, the images will undergo preprocessing to increase its quality. Preprocessing techniques include resizing image, scaling and rotation.

***Feature extraction***

Feature extraction is a step where the system identifies and selects the most meaningful feature of an image. These features help the model to classify data more effectively between classes. Convolutional Neural Networks (CNNs) are a type of deep learning that was often used in image recognition (Divya et al., 2024). They have the ability in processing and analyzing patterns within an image. CNNs are built on convolutional layers that apply filters on a set of input images to examine their pixels and analyze the colours and shapes, extracting patterns from an image such as edges (Glover, 2023). The CNNs then employ a pooling layer to minimize the size of the feature map by keeping only the most essential information. Then, the extracted feature is sent into an output layer that predicts classes to which the input image belongs (Glover, 2023).

***Fish Classification***

Fish classification involves predicting the species or category of a fish based on the extracted features and assigning it to the most likely class using the trained model. The model outputs probabilities for each class will indicate the likelihood of the image belonging to each species. These probabilities can be threshold to improve decision-making and ensure only high confidence are considered. Validation and testing ensure the model generalizes well to unseen data by real word testing that can address challenges like lighting variability, motion blur, and ensuring robustness. For example, a standard CNN can achieve up to 94% accuracy in correctly identifying fish species from a dataset of images captured during a typical fisheries survey using a commercially available camera system (Allken et al., 2019).

Table 1: Example of fish classification

| Group | Characteristics | Examples |
|---|---|---|
| Jawless fishes | -Lack of jaws, fins and stomachs<br>-Have cylindrical and long bodies |  <br>Hagfish (Travis, 2024) |
| Cartilaginous fishes | -Skeletons made of cartilage instead of bone<br>-Have paired fins and nostrils |  <br>Shark (Travis, 2024) |
| Bony fishes | -A skeletons of bone<br>- Hinged jaws<br>-Pairs fins and nostrils |  <br>Salmon (Travis, 2024) |

## Applications in Marine Technology

### *Fish Species Identification*

Fish species identification using image recognition technology allows for precise and efficient monitoring of marine biodiversity. Thus, aiding in sustainable practices and research. For example, smart fishing nets such as Game of Trawls are equipped with a network of sensors and cameras that can detect and identify fish entering the nets in real-time. These devices enable fishers to target the specific species of fish they want before dragging the net back on board the boat. Unwanted fish are released back into the water through a built-in trap in the net.

Other than that, smart fishing equipment, mobile apps like Fish Disease advisory provide valuable tools for fishers. These apps allow users to search for information about diseases, causative agents and remedial measures (Kiranmayi, 2020). Apps with AI-powered image recognition enables

users to upload photos of those fish to find the species. These tools are particularly beneficial for those people who want accurate information about the fish they encounter.

Moreover, FishVerify is also a mobile application that was developed to assist the local Florida community in identifying fish. Users are given the ability to identify fish species through live scans or photos, along with access to fishing rules and regulations specific to Florida. In addition, Fish collectors are the primary target user of the FishID+ application, which serves the same function as FishVerify. It only focuses on little fish, verifies freshwater fish and aquarium fish using the DL. More than 240 different fish species are included in the database, including tetras, tangs, clownfish, cichlids, and many more typical aquarium fish (Mohd Rum, 2021).

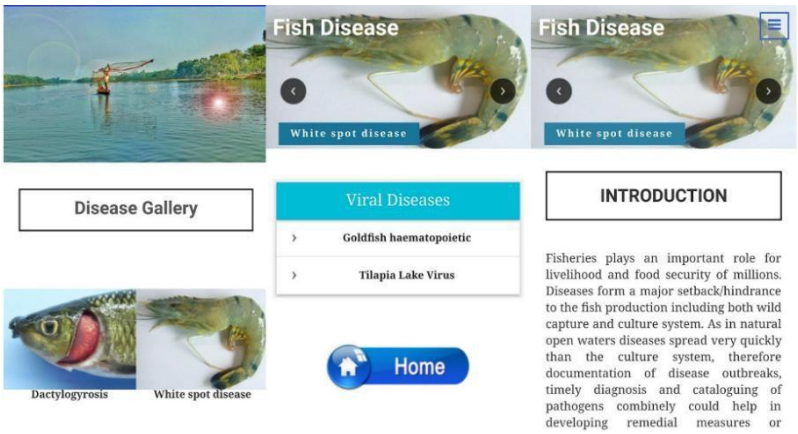


Figure 3: Shows the contents for Fish Disease advisory

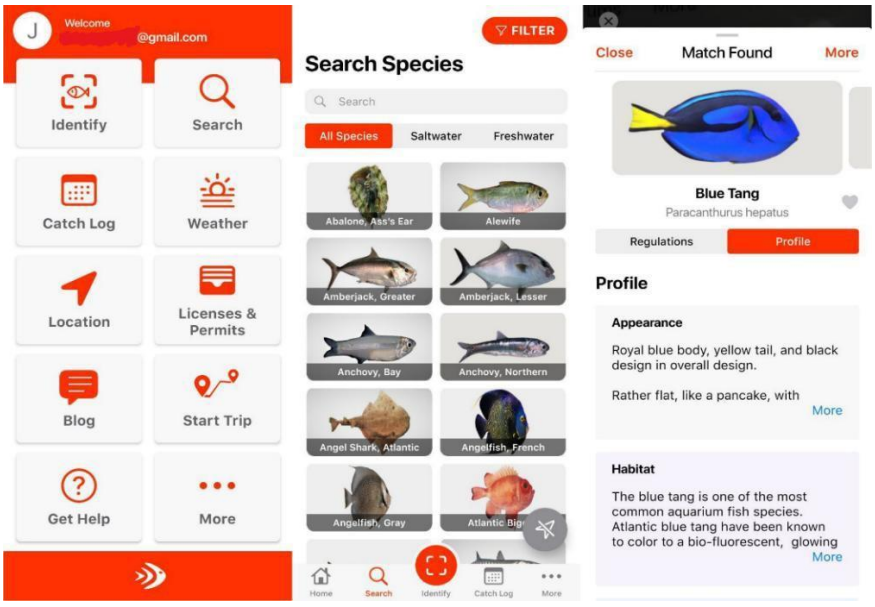


Figure 4: Shows the contents for FishVerify

***Size and Weight Estimation***

Image recognition technology plays a vital role in estimating the size and weight of fish and other marine organisms. The technology can detect key features and apply algorithms that have been calibrated using datasets with known dimensions and weight data by analyzing visual data. This allows for precise measurements in real time without the need of manual handling.

In fisheries management, this technology is invaluable by ensuring sustainable practices and monitoring fish growth rates in aquaculture. Providing accurate data on the size and weight of the fish can help prevent the harvest of undersized fish, thus contributing to marine biodiversity preservation. This reduction in overfishing minimizes environmental impact and allows younger fish to reach maturity, which is important for maintaining healthy fish populations.

The efficiency and scalability of image recognition make it a valuable tool for industrial fishing operations. For example, large-scale fishing vessels equipped with automated image recognition systems can efficiently classify the fish according to its size and weight, enhancing operations.

**Benefits of Image Recognition in Marine Technology**

Image recognition provides a lot of benefits including in marine technology. One of the key advantages of AI in image recognition is its ability to identify images with high precision. Al algorithms can analyze thousands of images per second that humans might miss, hence minimizing human error especially when identifying the species.

Other than that, AI in image recognition is scalable, making them suitable for large-scale applications. Unlike traditional methods, which require extensive manual labelling and rule based programming, AI systems can adapt to different types of visual content types such as monitoring extensive marine areas. For instance, AI systems can analyze photos from underwater drones to detect the fish species even in murky water. This scalability allows industries to monitor ecosystems more efficiently.

Furthermore, AI systems enable real-time analysis and decision making that are important for underwater research. For example, fisheries can instantly identify fish as they are caught. This immediate feedback is crucial for protecting the marine environment especially endangered species or undersized fish from overfishing.

**Challenges and Limitations**

Image recognition in Marine Technology also faces several challenges and limitations, including biofouling, water turbidity and presence of crowded fish at the same places.

The presence of many fish together at the same places and at the same time may disturb the camera recognition to function because the fish were overlapping with each other. It makes the camera

fail to recognize the specific species because there are too many numbers of fish gathered in front of the camera.

In addition, water turbidity also can limit the function of the camera. Changes in water clarity can significantly reduce the visibility in the water and make it difficult to distinguish fish from background clutter especially, those who were far away from the camera. The water will become a bit blurry, and it will disturb the camera focus when its need to capture the images. This can lead to missed detections.

Other than that, biofouling is also one of the challenges of using image recognition. Biofouling refers to things like algae and other organisms that live underwater that grow on the camera. These organisms can block the view and make it impossible for the camera to capture the image of the fish. It significantly impacts the accuracy of the counts.

**Conclusion**

The application of Artificial Intelligence (AI) and Machine Learning (ML) in marine technology has significantly improved the efficiency and accuracy of ocean exploration, environmental monitoring and marine biodiversity conservation. AI-driven image recognition, particularly through deep learning models like Convolutional Neural Networks (CNN), has enhanced the ability to classify fish species, detect anomalies in marine ecosystems and support automated underwater surveillance. These advancements have contributed to more precise data collection and analysis, aiding in sustainable fisheries management and conservation efforts.

Despite these benefits, challenges such as data quality, model accuracy and real-world implementation complexities remain. Future researchers should focus on improving AI algorithms for enhanced robustness, addressing environmental variability and integrating AI with other marine technologies such as Autonomous Underwater Vehicles (AUVs) and remote sensing, by leveraging AI innovations, the maritime industry can achieve smarter and more sustainable solutions for ocean resource management, ensuring the protection and longevity of marine ecosystems.

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