

## AI-Driven Hake Catch Monitoring: Pioneering Size-Based Inventory Control in Longline Fishing

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**Abstract** – This study introduces a transformative approach in longline fisheries, employing YOLO v7 object detection algorithm for real-time, automated sizing of hake. We have developed an artificial intelligence (AI) model based on Yolo v7 that classifies captured specimen of hake into four commercial size categories, applicable to recorded or live-streaming video from on-board cameras in a new electronic monitoring (EM) system concept called iObserver Lite. This dual applicability demonstrates the model's adaptability to different operational scenarios. Obtained results reveal the YOLO v7-based model's outstanding accuracy in hake size detection, maintaining high precision in both controlled and real daily fishing activity environments. This performance is pivotal for real-time inventory management and offers the potential for advanced fishery analytics and real-time fish auction sales even before landing the catches. Moreover, by providing instantaneous catch size data, the technology aids in optimizing fishing efforts and supports sustainable fishing practices. The integration of YOLO v7 in longline fishing represents a significant technological leap, enhancing operational efficiency and contributing to achieving sustainable fishery management soon. This breakthrough showcases the vast potential of artificial vision and AI in revolutionizing the fishing industry, heralding a new era towards efficiency and sustainability of fishing activity regarding marine resource exploitation.

**Keywords** – Artificial Intelligence, Machine Learning, Longline Fisheries, Real-time fish inventory management, YOLO v7

### I. INTRODUCTION

The Great Sole fishing ground, well-known for its rich marine biodiversity and substantial economic value in terms of fishing stocks, faces the challenge of sustainable management and efficient utilization of its resources. To face it, longline fishing, a prevalent practice in this area, requires technological advancements to ensure both sustainability while maximizing environmental and socio-economic efficiency. Integrating artificial intelligence, particularly through deep learning object detection algorithms like YOLOv7 [1], presents a promising avenue for innovation in this sector. YOLOv7 stands out for its exceptional balance of speed and accuracy in real-time object detection, surpassing its predecessors. It excels in detecting small objects and performs robustly in varied complexity environments. Its versatility and scalability make it suitable for high-end and low-resource applications, backed by strong community support and continuous advancements in machine learning.

Longline fishing, characterized by its use of a long main line with baited hooks, is a method that can benefit significantly from above mentioned AI-based technological advancements. The critical aspect of this fishing method is the precise and efficient management of the catch (in terms of identifying and quantifying it), especially for commercially valuable species like hake. More in detail, nowadays applied traditional fish sorting and inventory management methods are time-consuming and often inaccurate, resulting in a not precise catch reporting data. Reliable fishing information obtained from fleets is the base of both economic sustainability of the fishing sector since it is in the foundation over which all fishing policies and measures to carry out a sustainable fisheries management are based. The advent of real-time fish inventory management systems, such as the one proposed in this project using YOLOv7, marks a significant step forward on providing real-time, automatic catch data. YOLOv7, a state-of-the-art object detection system, is tailored for rapid and accurate identification and classification of objects. By applying YOLOv7 in longline fishing, we aim to automate the sizing and counting of hake catches in real-time. This approach not only streamlines the inventory management process but also enhances the accuracy of catch reports, which is crucial for sustainable fishery practices. A notable parallel in this field is the iObserver [2], an artificial vision-based platform used in trawl fisheries for real-time fish catch and discards monitoring. The success of iObserver in trawl fisheries underscores the potential of similar AI-based systems in longline fishing. By adapting and refining these technologies for longline fishing practices, particularly in the Great Sole region, we can significantly improve the efficiency and sustainability of these fishing operations. The empirical relationship between the size and weight of individual hake [3], as outlined in various studies, is a critical factor in determining the commercial value and sustainability of the catch. Moreover, the size group ranges, or the so-called *caliber*, of hake for the commercial is tabulated by national regulatory normative [4]. In this project, the training set for the YOLOv7 model was meticulously crafted through hand-labeled observations, focusing on the caliber determined by human operators. This process, focused on the size of the hake, ensures that the AI model is accurately attuned to the practical needs of longline fisheries.

The future implications of a fully developed smart traceability platform are extensive. Such a system would enhance the immediate operational efficiency of longline fishing and lay the groundwork for a comprehensive traceability framework, allowing to track fish's journey from catch to consumer, ensuring transparency and accountability in the seafood supply chain. It would also contribute significantly to consumer awareness and sustainable consumption practices. In conclusion, applying YOLOv7 in longline fishing in the Great Sole region represents a ground-breaking approach to fishery management. By automating real-time fish sizing and inventory, this technology has the potential to improve substantially

the fishing industry activity, paving the way for a sustainable, efficient, and transparent future in marine resource utilization.

## II. METHODOLOGY AND RESULTS

The study was conducted aboard a bottom longliner from Celeiro (Spain) targeting hake as objective species. The so-called *iObserver Lite* was installed. It is based on two DOMO cameras that were strategically installed: one inside the fish gutting zone and another outside, near the longline pulling machine. These devices were active during longline fishing operations, capturing large volumes of fishing footage. In the gutting zone, overlapping happening among specimens made it challenging to train the artificial vision system effectively. Consequently, the training data were primarily sourced from the exterior camera, focusing on the area around the longline puller. This camera captured fish as they were pulled from the sea, providing a clear view of the specimens in various positions. Many snapshots were manually extracted from this footage, showcasing hakes and non-target species arriving at the puller. Each image was meticulously labelled using *LabelMe*, with a rectangle marking the hake specimen and its corresponding calibre, which was determined by visual inspection and empirical size-weight relationships. Also, non-target species were marked, in this case without reference to calibre. Approximately 2,000 such images were annotated and used to train a YOLO v7-based neural network.

This neural network was trained at Galician Supercomputing Center (CESGA), utilizing a Nvidia A-100 GPU. The neural network output of the video stream was refined to average the detections based on repetition in consecutive frames, thereby increasing true detections and reducing false positives. Additionally, time threshold optimization was implemented to prevent detection duplicities. The system was further integrated with a MySQL connection, allowing detected hakes and their sizes to be logged in a table within a local database. This database was synchronized with a remote management system, ensuring real-time data transmission.

Regarding performance, the YOLO v7-based neural network demonstrated a **high detection efficiency of approximately 90%** in daylight video analysis. Figure 1 shows a snapshot of video detection. However, limitations arose under nocturnal conditions due to the *iObserver Lite* hardware restricted capabilities, leading to a significant drop in detection accuracy. To overcome this drawback, further work on vision and lightning hardware will be carried out as future research.

The hardware detection system, equipped with a Nvidia RTX-3050 GPU, is operational on a computing control box located the fishing bridge of collaborating longliner as the processing and communication core of the *iObserver Lite* EM system. Ongoing trials aim to gather conclusive data on the system's effectiveness in natural fishing conditions, thus establishing a proof of concept for this innovative approach.



Figure 1. Snapshot that shows the detection of a specimen in a frame of a captured video, the trained network locates the specimen area with a detection rectangle. It associates a prediction about the calibre and a score. In this case, calibre 3 with a score of 0.69.

## III. CONCLUSIONS

This study represents a significant stride in integrating AI into bottom longline fishing, particularly in the automated sizing and counting of hake. The successful deployment of *iObserver Lite* based on a YOLO v7-based neural network aboard a commercial fishing vessel underscores the feasibility and potential of such technologies in real-world settings. While challenges persist, especially under nocturnal conditions, the current efficacy in daylight operations is promising. This initiative paves the way for future advancements in sustainable fishing practices and establishes a foundational step towards comprehensive fishery management and traceability systems.

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