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A Review of the Literature on IOT and Artificial Intelligence on Rural Fishing Techniques and Chinese Fishing Nets

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Abstract

Internet of Things (IOT) and artificial intelligence provide promising opportunities to modernize fishing techniques and instruments. However, there is very less research conducted on exploring IOT specifically in the fishing industry to benefit the poor fishermen in rural areas. Hence, this research proposal explores the opportunities of modernizing the fishing techniques and instruments and improve the efficiency and in-turn profitability of fishermen.

Introduction

Internet of Things (IOT) and artificial intelligence provide promising opportunities to modernize fishing techniques and instruments. However, there is very less research conducted on exploring IOT specifically in the fishing industry to benefit the poor fishermen in rural areas. Hence, this research proposal explores the opportunities of modernizing the fishing techniques and instruments and improve the efficiency and in-turn profitability of fishermen.

Precision fishing is an emerging concept, introducing the possibility of integration of Echo sound scanners, IOT censors, raspberry PI sand fishing mechanical winches and gears driven by Artificial Intelligence. These are capable of opening up wider opportunities in traditional fishing instruments and techniques.

Background

Although Cochin in Kerala projects a luxurious tourism vibe in the backdrop of beautiful backwaters, the unseen parts of the city are inhabited by fishermen who struggle for their day-to-day living. While we visit some of these areas, we won't go unnoticed on 500-year-old Chinese fishnets were still being used by fishermen. This practice is believed to have been introduced in Cochin by the Chinese explorer Zheng between 1350 and 1450 AD.

These nets, made of teak wood and bamboo poles, work on the principle of balance. Each structure, about 10 meters high, is fixed on the shores. It features a cantilever structure supporting a net extended across an approximately 20-meter area. These huge, shore-operated lift-nets, work on simple physics, much like the sides of a weighing balance which go up and down according to the weights placed on them. A huge fishing net is operated by a group of 2 to 3 fishermen, and they pull a heavy rope tied on the movable structure to pll the net out of the water. It takes approximately 30 seconds to pull the net completely out. The catch on these nets depends on the mere luck of the fishermen and the probability of fish passing through that particular spot.

On average, these fishermen lift the fishnets every 20 minutes, approximately 42 times a day. This involves huge manual effort which surprisingly is prevalent in a world where we have IoT and Artificial Intelligence plays a major role in industrial automation and reducing manual efforts and improving predictability.

Most of the fishermen still live with these age-old techniques and instruments. For example, they often throw nets in backwaters, hoping that they will have a good catch. Often we can see the nets are pulled off empty and luck generally won't play into the factor.

The techniques used for Backwater and river fishing area bit different from sea fishing.
Large fishing boats go to sea these days and have stand alone echo sound scanners, though the range of scanners is

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limited, still help to understand the availability of fish in that particular area. Moreover, they use totally different techniques to lay the nets and most of them are pulled off with the help of huge winches. Whereas on backwaters and rivers, they use Chinese fishnet structures, small throw able nets and largely fishing depends on their experience and past knowledge. Fishermen use their heuristic ideas, knowledge learned and acquired from their forerunners, the density of salt content of backwater, the flow of water, weather, monsoon season sand moon calendars, etc. Some of these data are very useful for building AI and developing predictive models and applying them to fishing instruments.

Literature Survey

This section goes through the previous research on IOT and AI integration on fishing instruments, monitoring, fish farm, echo sounder technologies and overview of the past research in these areas. To begin a research project, its essential to understand fishermen's requirements on the system, as essential this will supply the with much-needed additional data on the methodologies and technologies available and used by other research complement around the world. This chapter provides a compressed summary of literature reviews on key topics which related to improving fishing techniques using IoT and AI.

Integrating echo-sounder and underwater video data for demersal fish assessment

In November 2016, Montserrat Landero, Iain Parnum, Benjamin Saunders and Miles Parsons from Curtin University worked on a project called Marine Fauna monitoring.
(Landero et al., 2016)

The primary conclusions drawn from the research indicate a notable correlation between the relative biomass captured by the stereo-BRUVs and the acoustic energy documented by the echo sounder. This suggests the possibility of combining these two methods for a more thorough evaluation of demersal fish. Furthermore, a significant correlation was observed between the acoustic backscatter data and the relative biomass recorded by the stereo-BRUVs, especially in water column backscatter. This implies that non-extractive and fishery-independent approaches can offer complementary insights into the distribution and abundance of demersal fish.

Their research paper delves into the effective management of demersal fish species, emphasizing precise, spatially explicit assessments of their abundance and distribution. Non-extractive methods, such as echo-sounders and visual censuses, are pivotal in no-take marine reserves, especially when direct sampling is constrained. The study explored the application of echo-sounders and Baited Remote Underwater Stereo-Videos (stereo-BRUVs) in assessing demersal fish. Echo-sounders offer the advantage of covering nearly the entire water column and vast areas in a relatively short time. However, obtaining "ground-truth" data for species-specific identification usually requires challenging sampling close to the seafloor, particularly in areas with complex topography. This research provides insights into using echo sounders for monitoring purposes.

Study limitations include the possibility of underestimating acoustic backscatter, the need for in situ echo sounder calibration for accurate fish distribution estimation, considering the current acoustic data and stereo-BRUVs' relative biomass relationship as indicative, and the requirement to expand echo-sounder coverage and stereo-BRUVs sampling points for more robust testing.
The study didn't directly compare interventions or provide specific intervention effects. Instead, it focused on understanding how active acoustic methods and stereo-BRUVs correlate in assessing demersal fish abundance.

Effects of transducer motion on quantifying single fish echoes

The main findings of the paper(Furusawa and Sawada, 1991)are: - The motion of the transducer of quantitative echo sounders with ship motion causes errors in individual fish observation, particularly in measuring the target strength of fish or the volume backscattering strength of aggregation of fish. - The magnitude of the motion error, especially in cases where the beam width is smaller than 10° and the target depth is deeper than 100m, must be carefully calculated and considered in surveys and analysis. - Monitoring and minimizing transducer motion is crucial for accurate acoustic surveys, especially with the future widespread use of the split-beam method and tracking of single fish echoes.

The study primarily examines the error in quantifying the target strength (TS) of fish or the volume backscattering strength in fish aggregations. This assessment specifically addresses the influence of transducer motion on quantitative echo sounders.

Several limitations are recognized in the study, including a scarcity of previous research in the field, insufficient investigation into errors stemming from transducer motion in individual fish observation, and the potential obsolescence of current techniques due to anticipated advancements in surveying methods.

AN IMPROVING FISHERMAN PRODUCT QUALITY AND FISHING PERFORMANCE BASED ON IOT

The paper's(Sandy Andhana Surbakti, Solly Aryza, and Adi Sastra P Tarigan, 2022). key discoveries encompass the creation of a system for detecting fish objects in water through technology, the successful design of a tool for initializing fish objects, and the technology's potential to assist fishermen in boosting their catch.

The fish object initialization tool's performance involves utilizing an echo sounder to detect fish movement around the sensor, determining fish positions, and identifying safe swimming zones at each point. The study also involves collecting longitude, latitude, and depth measurements from five tracks.

Limitations of the research include the high cost of acoustic technology packages, restricted accessibility for small-scale fishermen, and drawbacks of sonar applications linked to environmental factors.

In summary, the integration of IoT and AI in the fishing industry demonstrates considerable potential for enhancing efficiency and productivity. Agossou (2021) and Dhenuvakonda (2020) highlight IoT's role in real-time water quality monitoring and disease detection, with Dhenuvakonda also emphasizing the significance of mobile apps. Chrispin (2020) underscores AI's transformative impact on fisheries, from reducing labor intensity to improving sustainability and cost management. However, potential vulnerabilities to cyber-attacks are acknowledged, and Chukkapalli (2021) proposes an ontology-driven AI and access control system to address these concerns.

IoT & AI Based System for Fish Farming: Case study of Benin

The system has the potential to minimize human labor, strengthen capacity development, and expand fish production and market prospects for fish farmers.(Agossou and Toshiro, 2021)

The primary discoveries of the research encompass the creation of an automated system, utilizing IoT and AI, for fish farming that incorporates real-time monitoring of water quality and web applications for disease detection and community collaboration. This system holds promise in reducing human efforts, reinforcing capacity development, and enhancing fish production and market opportunities for fish farmers.

Key features of the system include real-time measurement of chemical parameters in water quality, visualizations of sensor data with real-time alerts, fish disease detection with corresponding care recommendations, and a reduction in human efforts. Additionally, the system aims to reinforce capacity building, boost fish production, and create market opportunities for fish farmers.

As outlined in the paper, the study's limitations include the absence of an evaluation of the proposed system's performance in real-world fish farming environments, the lack of validation for the accuracy and reliability of disease detection and suggestions in practical scenarios, the omission of a discussion on the scalability and cost-effectiveness of the proposed system, and the failure to address potential challenges and barriers to the adoption of the IoT and AI-based system.

A method to automatically detect fish aggregations using horizontally scanning sonar

A method has been developed to automatically identify fish aggregations within extensive sonar data. Key findings include the algorithm's comparable performance to manual interpretation, with discrepancies attributed to overlooked aggregations in manual work. The algorithm operates with minimal user intervention, improving efficiency over traditional semi-automated processing. The outcome involves a robust method for automatic identification, validated through comparison with manually interpreted datasets.

Limitations include sensitivity dominance by the threshold level, requiring parameter setting, and the algorithm's reliance on patterns of stationary aggregations during straight-line vessel movement. Additionally, biases such as fish avoidance and the blind zone are measurable, but further research is needed to quantify variations between years, times of the year, and locations.

Research Gap

There is no research on the significance of artificial intelligence’s role in improving the fish prediction and detection logic from echo sounder, and sensory data from backwater or similar water sources. Most of the echo sounder and fish detection research carried out for fishing in open sea.

Substantial research carried out echo sounder and improving fish detection, intended to use in fishing vessel and boats. Absolutely there is no data available on echo sounder usage in niche fishing techniques like Chinese fishnet and rural fishing.

Very little research is done to improve the efficiency of rural fishermen and reduce manual efforts. There is also very few details on modernizing the fishing equipment. There is a concept called “precision fishing”, with insights to optimize where and when they fish, along with sensors that detect the fish and catch size and onboard cameras that assist with sorting the catch. There isn’t enough research on logic to determine the catch size and automate the operation of fishing nets. The catch size is a very important metric in fishing as it will help to improve the overall echo systems and sustainability. The idea behind this size restriction for the catch is that only the older, mature fish get taken, leaving juveniles behind to continue breeding and propagating their species and maintaining sustainable.

Objectives of Study

This research is to study reducing the manual efforts and improve the efficiency of rural fishing in backwaters with help of the latest IoT and AI technologies.

The research aim to study the significance of artificial intelligence's role in improving the fish prediction and detection logic from echo sounder, and sensory data from backwater or similar water sources. Study on precision fishing and how the integration of echo sound scanners with IoT controllers and Sensors will provide data for precision fishing. Analyzing data in the cloud with Artificial intelligence can play a role in futuristic predictive fishing. The research to go in-depth on precision fish detection, catch size logic, alert mechanism, IOT controller integration with fishing equipment and electrical winches etc.

Exploratory research and study on automating the fishnet pulling techniques and proposal on developing custom electrical machinery with raspberry PI controller integration. The study will expand on how AI can determine to pull the fishnets automatically based on echo sounder data and heuristics. This research will also focus on describing what factors fishermen to take into account in making such decisions as whether to adopt new technologies and factors to make it more profitable and sustainable..

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