

Design and Development of Hybrid Boat with Fish Identification

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Abstract—The fishing industry relies heavily on conventional boats and They primarily dependent on fuel-based propulsion, creating a need for more flexible, economical, and technology-assisted fishing solutions. This paper presents the design and development of a low-cost hybrid smart fishing boat that integrates petrol-electric or diesel-electric propulsion within a single platform. The proposed boat is designed to provide flexible operation by enabling the use of different propulsion modes according to operating requirements. The developed controller includes functions for main-engine operation, solar charging, engine cooling, acceleration, steering, and propulsion-related control. In addition to hybrid propulsion, the system included with smart fishing assistance through a fish prediction mode and environmental sensing. Parameters including water temperature, pH can be monitored through the control interface to provide useful information during fishing operations. The system is further designed to support the identification of selected fish types and provide an indication to the user. By combining hybrid propulsion, solar-assisted charging, wireless control, environmental monitoring, and fish-oriented functionality in a single compact platform, the proposed system provides a low-cost technological approach for smart and sustainable fishing applications.

Keywords—Hybrid Fishing Boat, Smart Fishing, Petrol Propulsion, Diesel Propulsion, Electric Propulsion, ESP32, Solar Charging, Fish Detection, Water Quality Monitoring, Sustainable Marine Technology.

I. INTRODUCTION

Fishing is important marine activity that supports food production and the livelihood of coastal communities. The performance of a fishing boat depends strongly on its propulsion system, Fuel consumption, and efficiency of engine. Conventional boats generally depend on fuel-based propulsion, which makes more trip cost of boat changes depend on fuel price and reflect on their income so selection of an appropriate energy source an important consideration for operating efficiency and environmental impact.

Studies comparing electric and petrol-powered boats have shown that propulsion choice can influence the environmental performance of a vessel over its operating life, while the benefits of electric propulsion can also depend on factors such as energy source used for charging and operating conditions of the boat [1].

Hybrid propulsion provides another approach by combining conventional and electrical power sources. Research on hybrid boat propulsion has investigated the integration of an internal-combustion engine, electric drive, battery storage, and associated power-management mechanisms. these systems can provide different operating modes depending on required speed, power demand, and battery condition. Hybrid propulsion architectures and their energy-management strategies become an important area of research for improving the operational flexibility of marine vehicles [2], [3].

Renewable energy can further complement to hybrid marine systems by providing additional source of electrical energy. Previous marine-energy studies have investigated combinations of solar, wind, diesel, and battery-based systems for marine applications. Renewable-assisted configurations can reduce dependence on a single energy source and provide additional energy utilization [4]. Renewable-energy generation has been used specifically for fishing-boat applications, demonstrating potential for integrating alternative energy sources into fishing platforms [5].

Not only propulsion, monitoring the surrounding aquatic environment can provide useful information during fishing. Sensors Integrated System for monitoring important water parameters such as temperature, pH, dissolved oxygen, and turbidity. These measurements can also support the observation of aquatic conditions and provide additional information for fish-related monitorin and helps for fish Prediction [6].

Although these studies demonstrate significant progress in hybrid marine propulsion, renewable energy integration, environmental monitoring, and intelligent fish detection, these functions are often addressed as separate systems.

A compact platform that combines multiple propulsion options, renewable-assisted BMS, environmental sensing, and fish-oriented assistance can provide a more integrated approach for small-scale fishing applications. This motivates the development of a low-cost smart fishing boat that combines these functions within a single prototype.

The proposed work presents the design and development of a low-cost hybrid smart fishing boat capable of operating through petrol, diesel, and electric propulsion. The system integrates an ESP32-based control unit that control the solar charging, propulsion selection, and collection of data from Sensors. The boat sensing functions for monitoring water temperature and pH. By integrating propulsion, control, sensing, and fish-oriented functionality into one platform, the proposed system aims to provide a flexible and economical technological solution for smart fishing applications.

II. RELATED WORK

Research on smart and sustainable marine systems has progressed across several areas, including hybrid propulsion, renewable-energy assisted boat, environmental monitoring, and fish Prediction. Existing studies demonstrate the potential of these technologies to improve the efficiency, flexibility, and information availability of marine and fishing operations. However, these functionalities are generally investigated as separate systems rather than as a unified low-cost fishing platform.

Studies on hybrid marine propulsion examined the integration of conventional and electric power sources to improve vessel operation. A life-cycle assessment of electric and petrol-powered boats investigated environmental impacts associated with different propulsion options are highlighted the importance of considering both propulsion technology and the energy source used for charging [1]. Hybrid thermal-electric propulsion systems also been investigated using model-based energy management strategies that coordinate the operation of conventional engines, electric drives, and battery systems under different operating conditions [2]. Design considerations for hybrid-electric boat propulsion have further addressed the selection and sizing of propulsion and energy-storage components for marine applications [7]. These studies establish the importance of appropriate propulsion architecture and energy management. however, their primary focus is on propulsion systems and they mainly Focuses on the efficiency while the Cost of them also Increases very High.

Renewable energy has also been explored as a supplementary energy source for marine vessels. A hybrid Solar/wind/diesel power configuration was investigated for a patrol boat to support onboard energy requirements and reduce dependence on conventional diesel generation [4]. Renewable energy generation has additionally been examined in fishing boats through the use of a small wind-turbine generator connected to onboard electrical system [5]. These studies demonstrate the feasibility of incorporating renewable sources into marine platforms. However, renewable power availability is dependent on environmental conditions, and the investigated systems mainly focus on energy generation rather than combining renewable-assisted power.

IoT-based environmental monitoring also become an important area in modern fisheries and aquatic applications. Sensor-based monitoring systems have been studied for observing environmental parameters and supporting data-driven management of aquatic environments [6]. Such systems demonstrate the usefulness of continuous sensing for obtaining information about surrounding water conditions.

More techniques have further been applied for fish detection, classification, and selective fishing. An IoT-based eco-smart fish-trap system was developed for fish detection and classification, supporting selective fishing based on identified fish characteristics [8]. Another smart fishing device for sensing, imaging, acoustic, illumination, artificial intelligence, and IoT-based techniques to improve fish attraction and detection for selective fishing applications [9]. Image based techniques have also been developed for marine fish identification, Although these approaches provide advanced solutions for fish detection and identification, they generally require specialized sensing or high processing systems and are not integrated with a low-cost hybrid boat platform containing multiple propulsion options.

Overall, the reviewed studies demonstrate the significant progress in hybrid marine propulsion, renewable-energy-assisted boat systems, environmental monitoring, and intelligent fish detection. However, these functions are Mainly addressed as separate applications, with limited integration of multiple propulsion options, renewable-assisted charging, wireless boat control, environmental sensing, and fish-oriented assistance within a single low-cost fishing platform. This gap motivates the development of the proposed smart fishing boat, which integrates petrol, diesel, and electric propulsion with ESP32-based control, solar-assisted charging, environmental monitoring, and fish prediction functionality in a unified prototype.

III. PROPOSED SYSTEM AND METHODOLOGY

The proposed system is a low-cost smart fishing boat designed to integrate hybrid propulsion, microcontroller based control, environmental monitoring, and fish-oriented assistance within a single platform. The boat supports petrol, diesel, and electric propulsion modes, providing flexibility in operation according to the requirements of the user. An ESP32-based control unit that Communicates with the sensors, BMS and other control system of Boat.

The system architecture consists of the hybrid propulsion unit, ESP32 controller, solar-assisted charging unit, environmental sensing section, and BMS.

A. Hybrid Propulsion System

The boat incorporates any 2 propulsion options: petrol-electric or diesel-electric. The hybrid arrangement Makes the boat to get better performance with longer range of Trip with Reduceing cost per km they Travel and provide operational flexibility by allowing the boat to utilize different propulsion modes according to the required operating condition. In case of fuel outage in the middle of trip the solar charges the battery and with electric propulsion they return by consuming extra time. The integration of multiple propulsion options within the same platform forms the primary feature of the proposed hybrid boat. The propulsion-related functions are controlled through the central ESP32-based system.

B. ESP32-Based Control Unit

An ESP32 microcontroller is used as the central control unit of the proposed system. It coordinates the different control and monitoring functions of the boat and provides communication between the sensors, solar relay, and propulsion gear change. The controller based on commands operates the corresponding functions of the boat. The ESP32-based architecture also enables the integration of environmental sensing and fish prediction functionality with the boat-control system, providing a unified control platform instead of requiring separate interfaces for individual operations.

C. Solar-Assisted Charging

Solar energy is used to Charge batteries using Solar panels. The proposed system provide solar-assisted charging for the electrical section of the boat as shown in Fig 1. The solar charging function is integrated with the control interface so that the user can access the control. The use of solar-assisted charging provides an additional energy source for the electrical system and complements the hybrid propulsion architecture. The proposed design therefore combines conventional propulsion options with an electrically supported operating system.



Fig 1 Prototype of Solar charging

D. Environmental Monitoring and Fish Prediction

The proposed boat incorporates environmental monitoring functionality to provide information about the surrounding water conditions. The system considers water temperature and pH measurements. The measured information is made available through the control interface and can support the user in observing the operating environment during fishing activities. The system provides an indication through LED when monitored conditions correspond to required fish profile.

IV. IMPLEMENTATION DETAILS

The proposed smart fishing boat was implemented by integrating the hybrid propulsion system, ESP32-based control unit, environmental monitoring, solar-assisted charging, and fish prediction functionality into a single prototype. The implementation provides a unified platform through which the user can control the boat, monitor selected parameters, and access fish-oriented assistance during fishing operations.

The ESP32 microcontroller coordinates the hardware components, processing commands. The prototype includes motor drivers, steering servos, solar pannels water pump relays, solar charging modules, and sensor interfaces for pH and temperature. The mobile application interface centralizes all controls, allowing real-time interaction and telemetry display.

V. RESULTS AND DISCUSSION

The developed prototype was evaluated based on the integration and operation of its major functional modules, including hybrid propulsion, wireless control, environmental monitoring, solar-assisted charging, and fish prediction. The implementation demonstrated the feasibility of combining these functions within a single low-cost smart fishing boat platform.

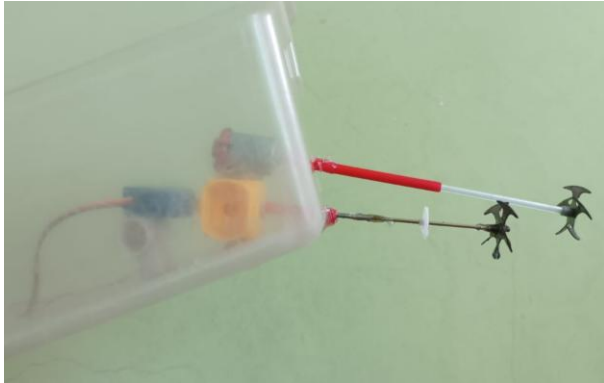


Fig 2 prototype with multiple propulsion integrated

The hybrid propulsion system successfully operated across petrol, diesel, and electric modes under user command as shown in Fig 2. The ESP32 controls the Propulsion gear, Environmental monitoring accurately captured water temperature and pH while the fish prediction module successfully triggered LED indicators based on predefined environmental thresholds. Therefore we can Decrease the fuel cost and increase the Fishing profit and below Fig 3 shows the working prototype testing.



Fig 3 Testing the prototype on water

VI. FUTURE SCOPE

The proposed smart fishing boat provides a foundation for further development sustainable marine applications.

Future scope includes Advanced fish detection using sonar, GPS-based navigation , Enhance probability of detection with additional marine sensors, Cloud and IOT connectivity for remote monitoring; and Real-world field testing under different marine conditions.

VII. CONCLUSION

This paper presented the design and development of a low-cost hybrid smart fishing boat that integrates petrol, diesel, and electric propulsion with microcontroller based control and fishing-assistance features. The developed prototype uses an ESP32-based control system. The integration of multiple propulsion options, renewable-energy assistance, environmental monitoring, and fish-oriented functionality demonstrates a robust and economical approach for sustainable fishing systems.

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