A MULTI LAYERED IOT BASED BODER ALERT HEALTH MONITORING SYSTEM FOR COMMERCIAL FISHERMEN

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ABSTRACT

The proposed system presents an intelligent and automated boat-based monitoring solution designed for the detection and identification of microplastics in water bodies. This system integrates advanced image processing techniques, embedded control systems, wireless communication, and IoT-based monitoring to ensure accurate detection and real-time data transmission for environmental protection. In this system, MATLAB is utilized to process boat-captured images from a predefined dataset. The image processing stage plays a crucial role in analyzing water surface images to detect the presence of microplastics. A Convolutional Neural Network (CNN) algorithm is implemented for efficient feature extraction and classification. The CNN model automatically learns important visual patterns such as shape, texture, and colour variations, which are essential for distinguishing microplastics from other floating particles. Additionally, colour-based segmentation techniques are incorporated to improve detection accuracy by isolating plastic materials based on their spectral characteristics. This combination of deep learning and colour analysis enhances the reliability and precision of microplastic identification.

The overall system operation is controlled by an ESP32 microcontroller, which serves as the central processing unit of the boat system. The ESP32 manages all connected sensors and coordinates real-time data acquisition and processing. Its high processing speed, built-in Wi-Fi capability, and low power consumption make it suitable for embedded marine applications. The

controller continuously collects sensor data, processes operational commands, and ensures smooth integration between hardware and software components. For wireless communication within short distances, an RF transmitter and receiver pair is implemented. This radio frequency communication system enables the reliable transmission and reception of essential boat information, such as detection status, system health, and navigation updates. The RF module ensures stable and low-latency communication between the boat and the nearby monitoring station, even in remote water environments where conventional communication networks may be limited. Overall, the proposed smart boat monitoring system combines image processing, artificial intelligence, embedded systems, wireless communication, and IoT technology to create an efficient and automated solution for microplastic detection. The integration of MATLAB-based CNN analysis with ESP32-controlled real-time operations ensures accurate identification, reliable communication, and effective environmental monitoring, contributing significantly to sustainable water resource management.

INTRODUCTION

The proposed intelligent boat monitoring system integrates advanced image processing, embedded control, wireless communication, and IoT technology to ensure efficient environmental analysis and real-time operational management. The system is designed to enhance autonomous decision-making capabilities while maintaining reliable communication between the boat and monitoring authorities. In this system, MATLAB is utilized to process boat images obtained from a predefined dataset. Image processing plays a crucial role in analyzing visual information captured from the water surface. A Convolutional Neural Network (CNN) algorithm is implemented to perform color conversion and feature extraction. During preprocessing, color conversion techniques are applied to transform images into suitable color spaces that improve detection accuracy and reduce noise. The CNN model then extracts significant features such as texture patterns, color intensity variations, and object boundaries. These extracted features enable the system to classify and interpret visual data intelligently. By combining deep learning with advanced image preprocessing

methods, the system supports accurate detection and data-driven decision-making.

The hardware operations of the boat are managed by an ESP32 microcontroller, which serves as the central processing unit of the embedded system. The ESP32 efficiently collects and processes sensor data in real time, ensuring smooth coordination between sensing modules, motor control mechanisms, and communication units. Its high processing speed, integrated Wi-Fi capabilities, and low power consumption make it highly suitable for autonomous marine applications. The microcontroller continuously monitors inputs, executes control commands, and maintains synchronization among all connected components. For short-range wireless communication, RF transmitters and receivers are employed to establish reliable frequency-based data exchange between the boat and the base station. This RF communication system enables continuous transmission and reception of operational data such as system status, navigation updates, and sensor readings. The use of frequency-based communication ensures stable connectivity even in remote water environments where conventional communication networks may be unavailable or unreliable. The movement and navigation of the boat are controlled using a motor driver interfaced with gear motors. The motor driver regulates voltage and current supplied to the motors, enabling precise control of speed and directional movement such as forward, reverse, left, and right turns. This ensures systematic navigation and accurate positioning during monitoring operations. Additionally, a buzzer is integrated into the system to provide audible alerts in case of abnormal conditions, obstacles, or system malfunctions, thereby enhancing operational safety. Furthermore, IoT technology is incorporated to enable long-range wireless notifications to concerned authorities. Through internet connectivity, real-time alerts and operational updates are transmitted to monitoring personnel, allowing timely response and decision-making. This remote monitoring capability enhances the effectiveness and reliability of the entire system.

PROPOSED SYSTEM

The proposed system focuses on intelligent water surface monitoring and microplastic detection by integrating image processing, embedded control, wireless communication, and IoT technology within an autonomous boat platform. The system combines advanced computational

techniques with real-time hardware coordination to ensure accurate detection, smooth navigation, and continuous environmental monitoring.MATLAB is utilized to process boat images collected from a predefined dataset. A Convolutional Neural Network (CNN) algorithm performs color-based feature extraction to identify relevant visual patterns associated with microplastics or floating objects. The CNN analyzes color variations, texture, and shape characteristics to accurately distinguish target objects from surrounding water surfaces. This intelligent image analysis enhances detection accuracy and supports automated decision-making within the monitoring system. An ESP32 microcontroller serves as the central control unit, managing sensor data acquisition and overall system operations. It coordinates communication between sensing modules, motor drivers, RF communication units, and alert mechanisms. By processing real-time data efficiently, the ESP32 ensures synchronized system performance and reliable operation of the autonomous boat. An RF transmitter mounted on the boat sends real-time operational data such as detection status and system conditions through radio frequency signals. An RF receiver at the monitoring station collects the transmitted data for continuous supervision. In addition to RF communication, IoT connectivity is integrated to send wireless notifications and status alerts to authorized personnel, enabling remote monitoring and timely response. A motor driver regulates the boat's speed, while a gear motor enables precise directional movement for systematic navigation across the water surface. A buzzer is incorporated to provide audible warning alerts during detection events or critical system conditions, ensuring safety awareness for nearby individuals.

- **Image Processing and Microplastic DetectionSystem**

  The system utilizes MATLAB to process boat-captured images from the dataset. A CNN algorithm performs color-based feature extraction to identify microplastics or other relevant floating objects. By analyzing color intensity, texture, and shape patterns, the system achieves intelligent visual recognition and supports accurate environmental monitoring.

- **Sensor Data Acquisition and Embedded Control System**

  An ESP32 microcontroller acts as the central processing unit, collecting and

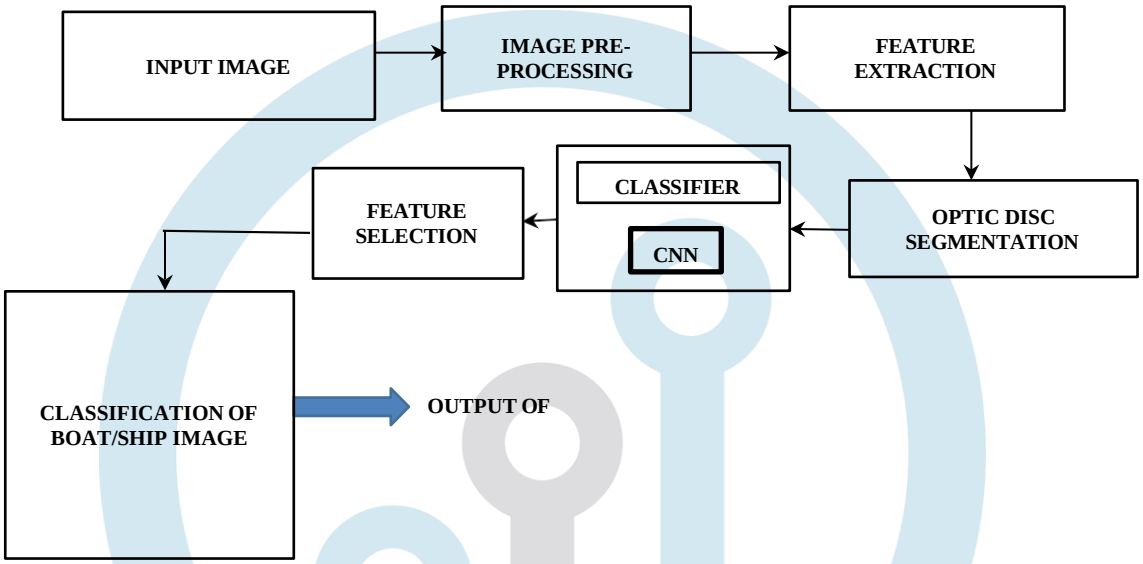
managing sensor data while coordinating system components. It ensures efficient communication between sensors, motor drivers, RF modules, and alert mechanisms, enabling real-time processing and reliable autonomous boat operation.

- **RF Communication and IoT-Based Monitoring System**

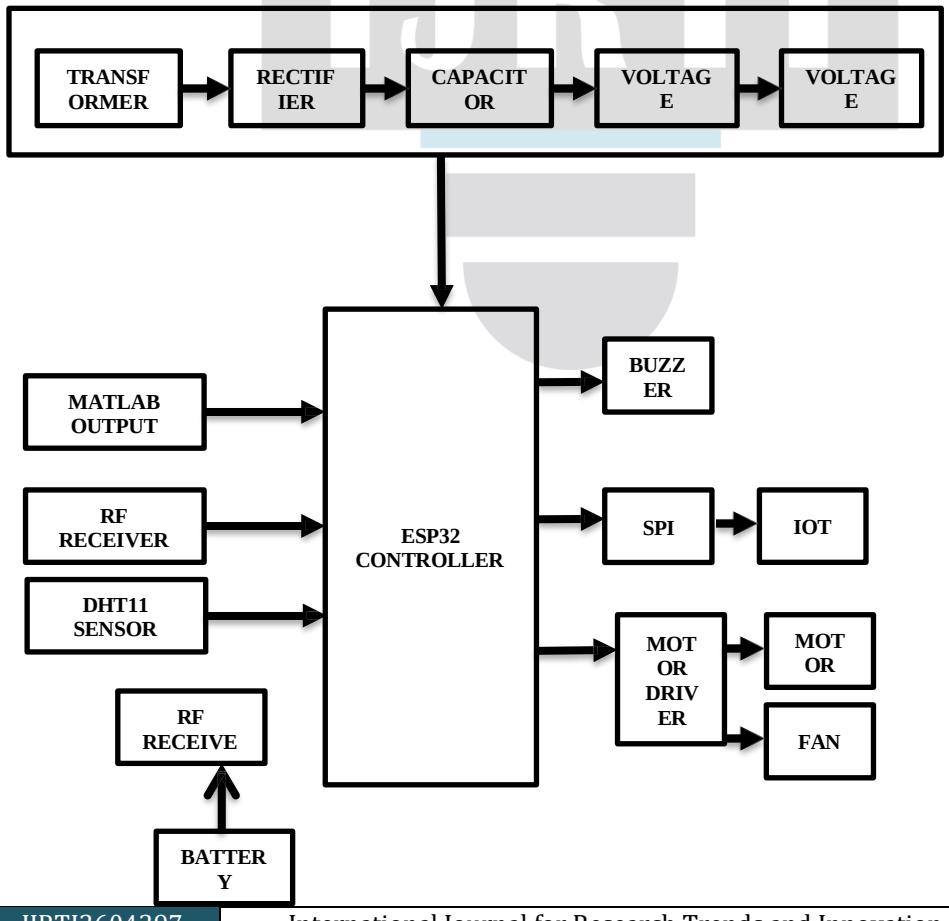
An RF transmitter on the boat sends operational data through radio frequency, while an RF receiver collects the transmitted information at the base station. Additionally, IoT connectivity enables wireless transmission of status updates and alerts to authorized personnel, ensuring continuous remote monitoring and timely decision- making.

Motor Control and Alert Mechanism System A motor driver controls the boat's speed, and a gear motor enables directional navigation such as forward, reverse, and turning movements. A buzzer provides audible warning alerts during detection events or abnormal conditions, enhancing operational safety and awareness in the surrounding environment.

BLOCK DIAGRAM



HARDWARE BLOCK DIAGRAM



CONCLUSION

In conclusion, the proposed intelligent boat monitoring system successfully integrates advanced image processing, embedded control, wireless communication, and IoT technology to ensure efficient water environment monitoring. MATLAB-based image analysis combined with a CNN algorithm enables accurate color-based feature extraction and identification of relevant objects or conditions in the water. The ESP32 controller effectively manages sensor inputs, processes real-time data, and controls the motor driver and gear motor for precise speed regulation and directional navigation. The RF transmitter and receiver establish reliable wireless communication between the boat and the monitoring station, ensuring continuous data exchange. Additionally, the buzzer provides immediate audible alerts for nearby individuals, while the IoT platform delivers instant notifications to authorized authorities for timely action. Overall, the system offers a smart, automated, and reliable solution for real-time monitoring, enhancing environmental safety and operational efficiency.

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