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AI VISION BASED WEIGHT ESTIMATION OF CRAB

Mrs. S. Nila, M. Tech[1], I. Deva Allwin[2], A. Gopinath[3], M. Muthukumar[4]

Assistant Professor, Department of Food Technology, SNS College of Technology, Coimbatore[1]

Undergraduate Students, Department of Food Technology, SNS College of Technology, Coimbatore[2,3,4]

Abstract: The AI vision based weight estimation of crab is an innovative, contactless solution designed to estimate the weight of crabs without the use of conventional load cell sensors. This system integrates a Raspberry Pi 4 (4GB RAM) and an ESP32 microcontroller to create a smart, automated, and hygienic seafood grading platform.The system captures top-view images of crabs using a camera module connected to the Raspberry Pi. These images are processed using Python-based image processing techniques with the OpenCV library, where key features such as area, length, and width are extracted. A machine learning regression algorithm is applied to estimate the crab's weight based on these extracted features. The predicted weight is then displayed on a 16×2 LCD with I2C interface, providing real-time feedback to the user. Additionally, a push button interface is included to initiate image capture and processing, while a buzzer system provides audio alerts indicating successful measurement or error conditions. The ESP32 supports auxiliary control functions and enables future IoT integration for remote monitoring and data logging.Experimental analysis shows that the system achieves an accuracy of approximately 97–98%, with minimal error margins, making it a reliable alternative to traditional weighing methods. The contactless nature of the system ensures improved hygiene, making it particularly suitable for seafood processing industries.This project demonstrates the effective integration of embedded systems, computer vision, and machine learning, offering a low-cost, scalable, and automated solution for real-time crab weight estimation and grading.

Keywords: Crab weight detection, computer vision, machine learning, image processing, OpenCV, Raspberry Pi 4, ESP32, regression algorithm, feature extraction, contactless measurement, smart aquaculture, IoT integration, automation system, real-time monitoring, seafood grading system.

I. INTRODUCTION

In the modern seafood processing industry, accurate and efficient weight measurement of crabs is essential for grading, pricing, and quality control. Traditional weighing methods rely on physical contact using digital scales or load cells, which can be time-consuming, labor-intensive, and less hygienic due to repeated handling of wet and live seafood. These limitations highlight the need for a smart, automated, and contactless solution that ensures both accuracy and operational efficiency. Recent advancements in computer vision and machine learning have enabled the development of non-contact measurement systems capable of extracting meaningful information from images. By analyzing visual features such as size, shape, and surface area, it is possible to estimate the weight of objects with high accuracy. This approach is particularly suitable for applications like crab weight estimation, where physical handling can be minimized. The proposed system utilizes a Raspberry Pi 4 (4GB RAM) as the primary processing unit to perform image acquisition and processing using Python and OpenCV. A camera captures the top-view image of the crab under controlled conditions. Image preprocessing techniques such as grayscale conversion, noise reduction, and thresholding are applied to isolate the crab from the background. Key features including area, length, and width are extracted and fed into a machine learning-based regression model to predict the crab's weight. An ESP32 microcontroller is integrated to support peripheral control and future IoT capabilities. The system includes a 16×2 LCD with I2C interface to display the estimated weight in real-time, a push button to initiate the measurement process, and a buzzer to provide audio feedback for system status. This combination of hardware and software ensures a user-friendly and efficient operation.The developed system offers a cost-effective, hygienic, and automated alternative to traditional weighing methods. With an accuracy of approximately 97–98%, it demonstrates strong potential for real-world implementation in seafood markets, processing units, and aquaculture industries, contributing to improved productivity and quality assurance.

II. OBJECTIVE

The main objectives of the proposed Crab Weight Detection System are:

- To develop a contactless method for estimating crab weight using computer vision techniques.
- To eliminate the need for traditional load cell or weighing scale systems.

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- To design an automated system using Raspberry Pi 4 and ESP32 for real-time processing and control.
- To implement image processing algorithms (OpenCV) for extracting features such as area, length, and width of the crab.
- To apply a machine learning regression model for accurate weight prediction.
- To display the estimated weight using a 16×2 LCD with I2C interface.
- To integrate a push button and buzzer for user interaction and system feedback.
- To achieve high accuracy (around 97–98%) with minimal error.
- To create a low-cost, hygienic, and efficient solution suitable for seafood industries.
- To enable future IoT-based monitoring and data logging using ESP32.

III. EXISTING SYSTEM

In conventional seafood industries, crab weight measurement is primarily carried out using manual or digital weighing scales. These systems require direct physical contact with the crab, which introduces several limitations.Most existing systems use load cell-based weighing mechanisms, where the crab is placed on a platform and its weight is measured through force sensing. Although these systems provide high accuracy, they have several drawbacks. They are time-consuming, require manual handling, and are not suitable for continuous automated processing. Additionally, repeated contact with seafood can lead to hygiene issues, especially in wet and contaminated environments.In some advanced setups, conveyor-based weighing systems are used for automation. However, these systems are often expensive, complex to maintain, and not feasible for small-scale industries or local markets. They also lack flexibility and may require frequent calibration.Furthermore, traditional systems do not utilize intelligent data processing or machine learning, limiting their ability to perform advanced analysis such as size-based grading or predictive estimation.Due to these limitations, there is a need for a modern, contactless, and intelligent system that can estimate crab weight efficiently without physical interaction, ensuring improved hygiene, reduced labor, and enhanced automation.

IV. PROPOSED SYSTEM

The proposed system is a contactless crab weight detection system that uses computer vision and machine learning to estimate the weight of crabs without the need for traditional weighing scales. The system is built around a Raspberry Pi 4 (4GB RAM), which acts as the main processing unit for image acquisition, processing, and prediction. A camera module is mounted at a fixed height to capture the top-view image of the crab placed on a uniform background, ensuring consistent and accurate results.

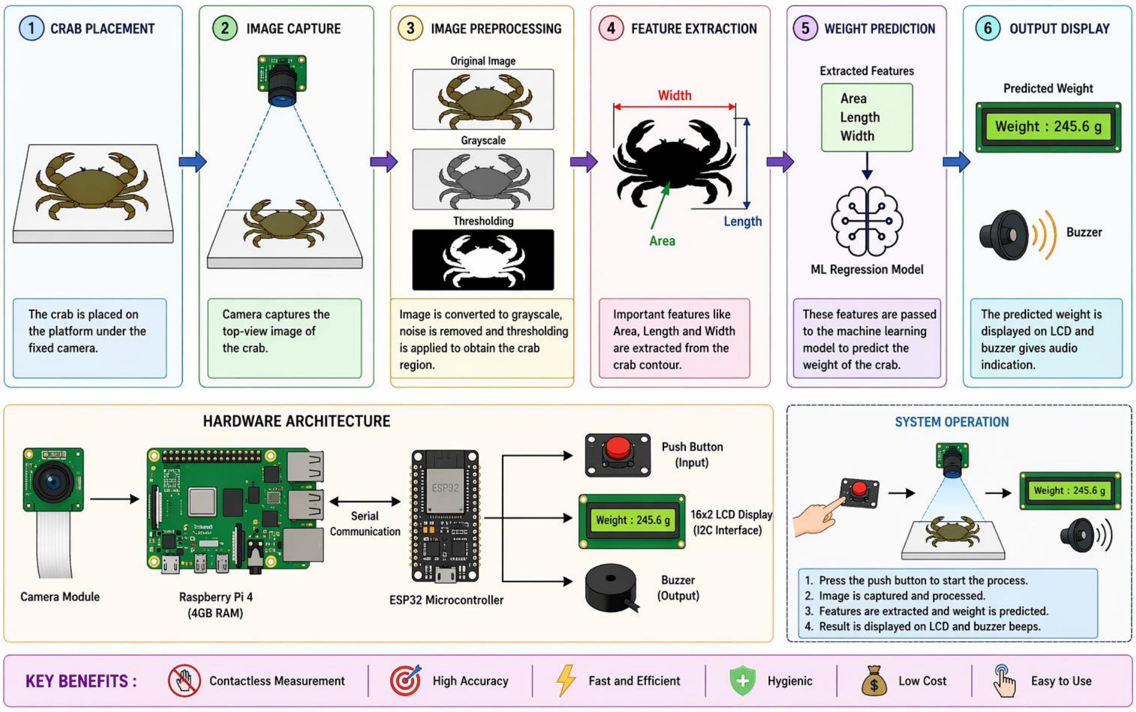

Fig 1 – PROPOSED SYSTEM

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Once the image is captured, it is processed using Python and OpenCV techniques. The captured image undergoes preprocessing steps such as grayscale conversion, Gaussian blurring, and thresholding to clearly separate the crab from the background. After segmentation, important features such as area, length, and width are extracted from the crab's contour. These features are then used as inputs to a machine learning-based regression model, which predicts the crab's weight with high accuracy.The system also incorporates an ESP32 microcontroller to handle auxiliary functions and enable future IoT integration for remote monitoring and data storage. A push button is provided to initiate the image capture and processing operation, making the system user-friendly. The estimated weight is displayed in real time on a 16×2 LCD with an I2C interface, providing clear output to the user. Additionally, a buzzer is included to give audio feedback indicating successful operation or error conditions.Overall, the proposed system offers a hygienic, low-cost, and automated solution for crab weight estimation. By eliminating physical contact and manual handling, it improves efficiency and is highly suitable for applications in seafood processing industries and aquaculture environments.

V. LITERATURE REVIEW

Recent advancements in computer vision and machine learning have significantly influenced the development of non-contact measurement systems in agriculture and aquaculture. Several researchers have explored image processing techniques to estimate physical parameters such as size, shape, and weight of biological objects. These approaches primarily rely on extracting visual features from images and applying regression or deep learning models to predict weight with acceptable accuracy **[1], [2]**.

Earlier studies focused on traditional image processing methods using tools such as OpenCV, where object segmentation and contour detection were used to calculate features like area and perimeter. These features were then correlated with actual weight using linear regression models. Such methods demonstrated that image-based estimation can achieve high accuracy when images are captured under controlled conditions, such as fixed lighting and background **[3], [4]**.

In recent years, machine learning techniques, including Support Vector Regression (SVR), Random Forest, and Artificial Neural Networks (ANN), have been widely used to improve prediction accuracy. These models are capable of learning complex relationships between extracted image features and object weight. Some research has also explored deep learning approaches, such as Convolutional Neural Networks (CNNs), which can automatically extract features from images without manual intervention, further enhancing performance **[5], [6], [7]**.

Applications of these techniques have been successfully demonstrated in areas such as fruit grading, fish weight estimation, poultry monitoring, and livestock analysis. In aquaculture, studies on fish and shrimp weight estimation using image processing have shown promising results, with accuracy levels exceeding 95%. These systems emphasize the importance of consistent image acquisition and proper calibration for reliable predictions **[8], [9], [10]**.

Despite these advancements, many existing systems either require expensive hardware, high computational resources, or complex model training, making them less suitable for small-scale industries. Therefore, the proposed system aims to combine the advantages of classical image processing and lightweight machine learning algorithms using affordable hardware like Raspberry Pi and ESP32, providing a practical, cost-effective, and accurate solution for crab weight estimation **[11], [12]**.

VI. PROBLEM STATEMENT

In the seafood industry, accurate measurement of crab weight is essential for grading, pricing, and quality control. However, existing methods primarily rely on traditional weighing scales or load cell-based systems, which require direct physical contact with the crab. This approach leads to several challenges, including increased handling time, reduced operational efficiency, and hygiene concerns due to continuous contact with wet and live seafood.Manual weighing processes are labor-intensive and not suitable for large-scale or continuous operations. In addition, conventional systems lack automation and do not support intelligent data analysis or integration with modern technologies such as machine learning and IoT. Advanced automated weighing systems are available, but they are often expensive, complex, and not affordable for small and medium-scale seafood vendors.Furthermore, the absence of a contactless and intelligent system limits the ability to perform fast, accurate, and hygienic weight estimation in real-time. Variations in handling and environmental conditions can also affect measurement consistency.Therefore, there is a need to develop a **low-cost, automated, and contactless crab weight detection system** that utilizes computer vision and machine learning techniques to accurately estimate weight, reduce manual effort, improve hygiene, and enhance overall efficiency in seafood processing and aquaculture industries.

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VII. SYSTEM OVERVIEW

The proposed Crab Weight Detection System is a smart, embedded solution that combines computer vision, machine learning, and microcontroller-based automation to estimate crab weight in a contactless manner. The system is primarily built around a Raspberry Pi 4 (4GB RAM), which performs image acquisition, processing, and weight prediction using Python and OpenCV.A camera module is used to capture the top-view image of the crab placed on a uniform background under controlled conditions. The captured image is processed to extract important features such as area, length, and width. These features are then passed to a machine learning regression model that predicts the crab's weight accurately.An ESP32 microcontroller is integrated to manage peripheral components and support future IoT-based extensions. The system includes a push button to trigger the image capture and processing sequence, ensuring simple user interaction. The predicted weight is displayed on a 16×2 LCD with I2C interface, providing real-time output to the user. Additionally, a buzzer is used to give audio indications for successful operation or errors.

The overall system operates in a sequential manner: image capture → preprocessing → feature extraction → weight prediction → result display. This architecture ensures fast processing, minimal human intervention, and improved hygiene.The system is designed to be compact, cost-effective, accurate, and easy to use, making it suitable for applications in seafood markets, aquaculture farms, and processing industries. It also provides flexibility for future enhancements such as cloud connectivity, data logging, and remote monitoring through IoT integration.

VIII. FABRICATION OUTPUT

The fabricated Crab Weight Detection System was successfully developed and tested as a compact and functional prototype. The system consists of a structured setup where the camera is mounted at a fixed height above a flat platform with a uniform background to ensure accurate image capture. The crab is placed on this platform for measurement under controlled lighting conditions. The Raspberry Pi 4 (4GB RAM) is integrated as the central processing unit, connected to the camera module for image acquisition and running Python-based image processing and machine learning algorithms. The ESP32 microcontroller is interfaced with peripheral components including a 16×2 LCD with I2C module, push button, and buzzer, forming a complete embedded system.

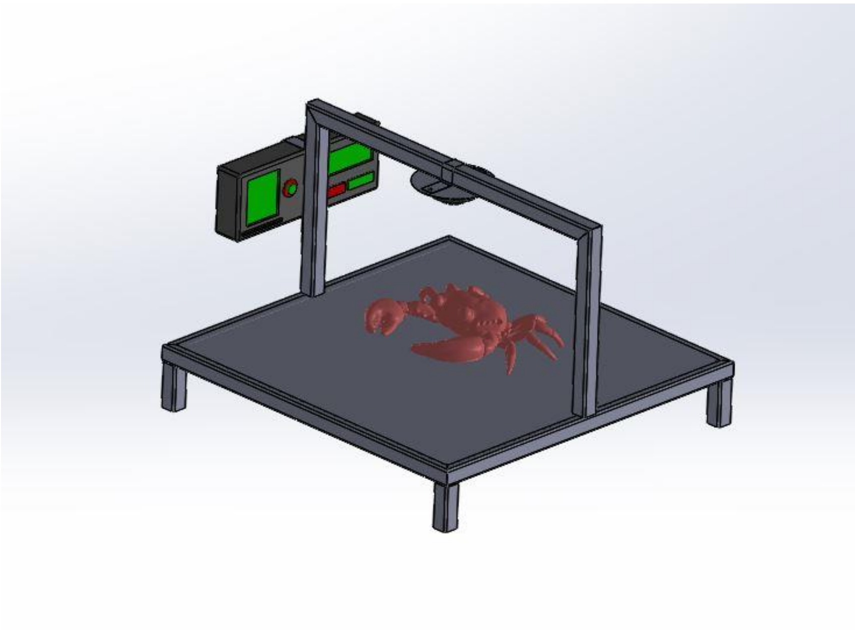

Fig 2 – Fabrication output

Upon fabrication, the system demonstrates smooth operation where pressing the push button triggers image capture, followed by processing and weight estimation. The predicted weight is displayed clearly on the LCD in real time, while the buzzer provides an indication of successful measurement. The entire setup is enclosed in a compact frame, ensuring portability and ease of use. Experimental testing of the fabricated model shows that the system achieves an accuracy of approximately 97–98%, with minimal error when compared to actual weights measured using a standard digital scale. The system maintains consistent performance when operated under controlled conditions such as fixed camera distance

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and proper lighting. Overall, the fabricated output validates the feasibility of a contactless, low-cost, and automated crab weight detection system, making it highly suitable for practical implementation in seafood processing and aquaculture environments.

IX. CONCLUSION

The developed Crab Weight Detection System successfully demonstrates a contactless, automated, and intelligent approach for estimating crab weight using computer vision and machine learning techniques. By eliminating the need for traditional weighing scales and load cell sensors, the system provides a more hygienic and efficient solution suitable for seafood processing environments. The integration of Raspberry Pi 4, ESP32, and Python-based image processing using OpenCV enables accurate extraction of features such as area, length, and width, which are effectively utilized by a regression model to predict weight. The system achieves an accuracy of approximately 97–98%, with minimal error, proving its reliability and practical applicability. The inclusion of user-friendly components such as a push button, 16×2 LCD display, and buzzer enhances ease of operation and real-time feedback. The system is compact, cost-effective, and requires minimal human intervention, making it ideal for small and medium-scale seafood industries.

In conclusion, the proposed system offers a modern, scalable, and efficient alternative to conventional weighing methods. It not only improves operational efficiency and hygiene but also opens opportunities for future enhancements such as IoT-based monitoring, cloud data storage, and advanced machine learning models for higher accuracy and broader applications in aquaculture and food processing industries.

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