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CHAID for Predicting White Spot Disease (WSD) Among Shrimps in Aquaculture

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ABSTRACT: Shrimp farming is a critical sector of the global aquaculture industry, providing a significant source of seafood for human consumption. However, the industry faces substantial challenges in managing the health and sustainability of shrimp populations due to the prevalence of infectious diseases. This research aims to address these challenges by integrating deep learning techniques with comprehensive shrimp image analysis and water quality data to predict pathogen-based shrimp diseases. The ultimate goal is to develop an accurate and efficient system for early disease detection, which can significantly reduce economic losses and environmental impact in the shrimp farming industry. The study leverages state-of-the-art deep learning models, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), to analyze large datasets of shrimp images. By combining the visual characteristics of infected shrimp with water quality data, we create a holistic model capable of predicting disease outbreaks.

KEYWORDS: Shrimp, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs).

I. INTRODUCTION

A. Background Studies:

Aquaculture plays a vital role in our food system, but maintaining healthy fish and shrimp populations can be challenging. Thankfully, machine learning (ML) and artificial intelligence (AI) are emerging as powerful tools to revolutionize disease detection and improve selective breeding practices in shrimp farming.

Traditionally, identifying fish diseases relied on manual inspection, a slow and error-prone process. Researchers like Md. Shoaib Ahmed et al. are pioneering a new approach: combining image processing with machine learning for pathogen detection. Their method tackles this issue in two steps. First, image pre-processing and segmentation reduce noise and enhance the clarity of fish images, allowing for more accurate disease identification. Second, a Support Vector Machine (SVM) algorithm analyzes the pre-processed images to classify diseases based on extracted features. This offers a potentially faster, more objective approach to disease diagnosis compared to traditional methods.

Selective breeding has long been a cornerstone of improving shrimp health and production. However, limitations exist in identifying the most desirable genetic traits. Recent research is unlocking new possibilities in this area. Studies have revealed significant genetic variations in reproductive traits of Pacific white shrimp. This opens doors for selective breeding programs to target traits like increased egg production, ultimately enhancing overall shrimp health.

Another promising technique is Marker Assisted Selection (MAS). MAS allows scientists to identify specific genes associated with disease resistance, like White Spot Syndrome Virus (WSSV). By breeding shrimp with these resistant genes, researchers can develop hardier shrimp breeds. This approach has the potential to significantly reduce disease outbreaks and improve farm sustainability.

The application of machine learning and AI in disease detection and selective breeding practices represents a major leap forward for shrimp farming. These advancements hold immense potential to improve the efficiency, accuracy, and sustainability of aquaculture, ensuring a healthier future for this vital food source. As research continues, we can expect even greater breakthroughs in the years to come.

B. Problem Statement

To meet the growing demand for shrimp products, the global shrimp farming industry has expanded significantly in recent years. But along with this growth has come a greater vulnerability to many illnesses, which has resulted in significant financial losses and environmental issues. The development of a reliable and accurate method for detecting

and diagnosing illnesses in shrimp farming is important in order to solve this problem. This problem statement focuses on to develop an automated system for identifying diseases in shrimp farming by utilizing cutting-edge technology and data-driven methodologies. The objective is improving disease control procedures and supporting the long-term sustainability of the shrimp farming sector are the goals.

C. Objectives

There are various objectives for this project, including:

- To collect a dataset of shrimp images from various Indian aquaculture farm.
- To apply preprocessing techniques for the collected dataset using different preprocessing techniques.
- To develop a deep learning model for disease identification using Convolutional Neural Network (CNN).
- To predict the model by combining the outputs of deep learning model (shrimp disease identification).

D. Significance of study

Shrimp farming is a major source of food around the world, but keeping shrimp healthy can be difficult. The usual ways of finding diseases and breeding shrimp have some problems. This research is important because it looks at how machine learning and artificial intelligence can be used in shrimp farming.

There are two main reasons why this research is important. First, using image processing and machine learning to find disease-causing organisms allows for faster and more reliable diagnosis. This can mean farms can react to outbreaks quicker, which can lead to fewer shrimp dying and a healthier overall farm. Faster and more accurate disease detection also allows for treatments that target specific problems, which can stop the spread of disease and keep more shrimp alive.

Second, the advances in selective breeding offer a way to make shrimp farming more sustainable in the long term. By using information about genetic variations and a technique called Marker Assisted Selection, scientists can breed shrimp that are more resistant to disease and that reproduce better. This means there will be stronger shrimp breeds that lay more eggs, leading to a more efficient and productive farming system. These improvements not only help the shrimp farming industry, but also contribute to a more reliable and secure supply of food.

II. LITERATURE REVIEW

“Through the integration of impeccable machine learning techniques with seamless image processing”, Md. Shoaib Ahmed et al. were able to identify the pathogen infected fish.

There are two sections to this work. The core element of this study involves the application of image pre-processing and segmentation methods to reduce noise and enhance the image. Subsequently, in the second part, the researchers adopt the SVM algorithm, utilizing a kernel function to effectively extract relevant features for the purpose of disease classification. In order to decrease noise and amplify the image, image pre-processing and segmentation techniques have been employed in the core component. In the second section, they use the Support Vector Machine algorithm with a kernel function to extract the proper features and for disease classification. This (SVM) model has been applied to the first portion's processed photos. Next they combine a thorough experiment using the suggested set of procedures on the dataset of images of salmon fish used to study the fish diseases.

“A fresh technique for predicting the CO in the water in prawn ponds”, was provided by Ashfaque Rahman et al. They suggest a strategy to forecast future timestamps by creating predictors.

The sampling method determines the precise number of time stamps ahead of prediction, yet each predictor is capable of training on sampled data to only forecast one step ahead of prediction. The step ahead predictor makes minimal errors even at greater time stamps ahead predictions because it behaves as a short-term predictor. Experimental findings show that the suggested approach, when compared to other current approaches, achieves a much lesser as compared in long-term prediction .

“In East Java's intense aquaculture ponds for white leg shrimp”, Litopenaeus vannamei, Supriatna et al. develop a model of DO and its link with water quality.

The researchers closely monitored the shrimp ponds and assessed their current condition by observing the rigorous farming practices over a period of approximately hundred days. They employed a normal model and a descriptive method based on natural phenomena, enabling an retroactive analysis. Pond management follows a set of guidelines. From the start of shrimp farming until harvest, the key indicator of water quality was DO, which was monitored daily at intervals of every two hours to establish a replica of daily DO. Daily measurements of pH, temperature, salinity, and transparency were also made to support other water quality metrics.

“A unique Clustering-based Softplus ELM approach”, (CSELM) is presented by Shi P, Li G, et al. to effectively and accurately predict changes in the concentration of dissolved oxygen using time series data.

The CSELM uses a new Softplus ELM algorithm to identify a common trend in a cluster of time series components and then forecast the future trend. The dataset is first divided into clusters based on Dynamic Time Warping(DTW) distance. The Softplus ELM enhances ELM by introducing a novel activation function, Softplus, to address the continuous and nonlinear issues of time series data streams.

“In the ponds of tilapia in northern Thailand”, Sriyasak et al. (2008) investigated the impact of water destratification on DO and ammonia concentrations.

In different seasons that is hot, rainy and dry fifteen ponds distributed across five provinces of northern Thailand were tested out at different times. Thinning the water content near the surface decreased the depth of dissolved oxygen just above the bottom layer while mixing with surface waters increased it below that line. The mean level of DO at 2-6 PM in about 68% cases was less than 1 mg/L for in older integrated and commercialized ponds. repetitive processes According to ANOVA results, there were significant effects of water depth and fish culture systems on total ammonia nitrogen levels.

“Despite current progress in the shrimp farming”, biz over the past few decades, there's still a lot of room for improvement.

We've got some big questions about how viruses and their shrimpy hosts interact, and we need to step up our biosecurity game. We've also gotta develop better diagnostic tests, especially ones that'll work on the farm, to help control the spread of viruses better. And then there's the whole immunostimulants and vaccines thing. We need to do more field trials and figure out how effective and affordable they really are. It'd be awesome if we could get this all figured out, so we can keep our shrimp healthy and our farms profitable. That way, we can keep everyone happy and avoid those pesky virus-related losses in production .

“Global shrimp (*Penaeus spp.*) aquaculture suffers significant financial losses due to the microsporidian *Enterocytozoon hepatopenaei* (EHP), an emerging disease”, It has been claimed that the gut microbiota of shrimp can be manipulated to avoid illnesses.

It is vital to have prior knowledge about the host-microbiome, though. Using high throughput sequencing of 16S rRNA and ITS amplicons, we evaluated how the microbiome (bacteria/fungi) and its expected roles changed along the course of the disease in shrimp that were experimentally challenged with EHP for 30 days. For the first time, quantitative digital histopathology was used to evaluate the infection grade.

III. METHODOLOGY

When a system is designed, it is determined what the system's needs are. This includes deciding the architecture, modules, interfaces, and design. It's safe to assume that system design encompasses everything from discussing system needs to creating goods. Procedures, practises, and techniques are altered to create or change a system throughout system development.

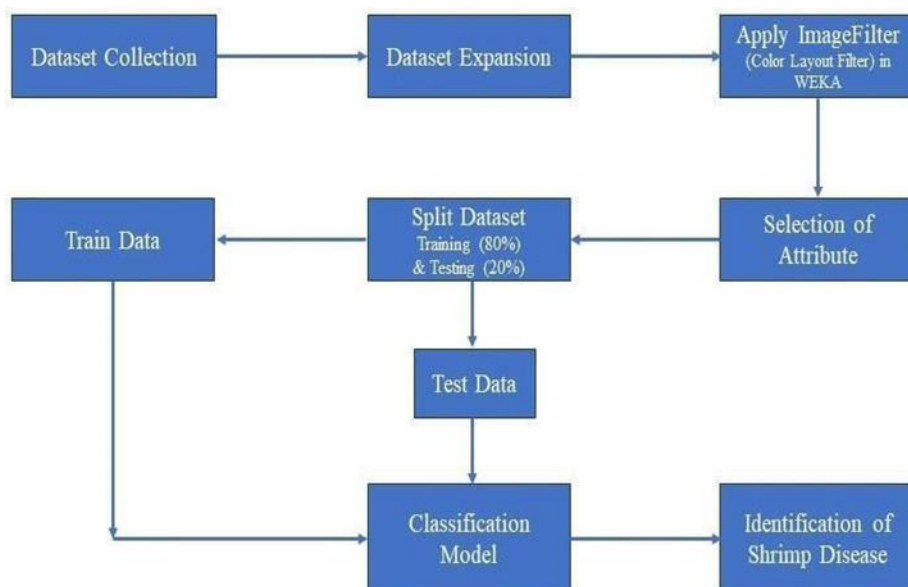


Fig 1. System Architecture

The figure represents the workflow of the entire work of the Shrimp disease. The dataset was created manually by separating infected shrimp into different categories of diseases. The format of each image is .jpg. The size of the dataset can be increased by image augmentation. After that, the ColorLayoutFilter image filtering can be used to convert the images into features which add various attributes in the dataset. Then correlation-based attributes selection technique was used to determine prominent attributes. The dataset can then split into two parts: training set, which comprises of the 90% data and test set, which comprises of the remaining 10%. Finally, different classification algorithms can be used that will generate different results.

IV. CONCLUSION

Shrimp farmers battling white spot disease can benefit greatly from CHAID analysis. This method acts like a branching decision tree, identifying key factors that trigger outbreaks. This allows farmers to take preventive measures instead of reactive ones. The study goes a step further by incorporating powerful computer programs like VGG16, EfficientNetB0, and ResNetV50. These programs excel at automatically detecting white spot disease in shrimp images. The true power lies in combining both approaches. CHAID provides clear explanations for disease outbreaks, while the computer programs offer exceptional detection accuracy. This integrated strategy empowers shrimp farmers to pinpoint the root causes and implement focused mitigation plans, ultimately paving the way for a more sustainable and secure shrimp farming industry.

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