**Survey On Disease Diagnosis in Shrimps Using Machine Learning Models**

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**Abstract**

Shrimp is one of the most popular foods that contain rich nutrients such as proteins, vitamins, and minerals. India has become the leading supplier of fresh and frozen shrimp products around the world. Unfortunately, the outbreak of various diseases has been rising in farming the shrimps in India. Aqua Farmers suffer enormous losses as a result of many diseases, but the white e-spot illness of the shrimp is particularly devastating. More species, including Penaeus monodon and Penaeus Vennammei, are affected by this illness. There are several traditional and machine-learning techniques available to diagnose shrimp white spot illness and other shrimp diseases. This research paper will showcase the machine-learning techniques available for shrimp disease diagnosis with their possible outcomes and performances.

**Keywords:** shrimps diseases diagnosis, machine learning,

**Introduction**

Shrimp production is a type of aquaculture that takes place in either a marine or freshwater environment and involves the cultivation of shrimp or prawns primarily for human consumption. Shrimp farming has become a dominant method of shrimp production globally, accounting for more than 50% of the world's shrimp supply. The major shrimp farming countries are China, India, Thailand, Indonesia, Vietnam, Brazil, Ecuador, and Bangladesh. These developing nations have seen significant economic gains from this industry. Shrimp farming has expanded the accessibility of shrimp to consumers in the US, Europe, Japan, and various other countries, satisfying the demand for seafood. India is the world's second-largest producer of white leg shrimp, producing 2.2 million metric tons of production, which translates to about 1 of every 6 of these well-known shrimps produced globally. Additionally, India is the top exporter to the United States, contributing 36% of the $2.4 billion worth of warmwater shrimp imported in 2020.

There are many factors which effects shrimp production in which majority of the problem arises due to diseases. And also, many other problems like overstocking, water quality, waste disposal, pollution, high cost of inputs, pandemic, market demand effects the production of shrimp culture. Above listed problems cause many problems to the shrimp farmers. Most common diseases in shrimps are caused by bacteria, virus, fungi, microsporidian parasite. Figure 1 shows the details of various shrimp diseases. The major symptoms of these diseases are anorexia, loss of appetite, lethargy, low growth rate, dark coloration etc. Infected shrimps may suffer with problems like fouling of the gills and appendages by ciliates. Severity in these problems may lead to epithelial cells of hepatopancreas. All these factors may lead to shrimp death or low growth rate which leads to loss to the farmers.

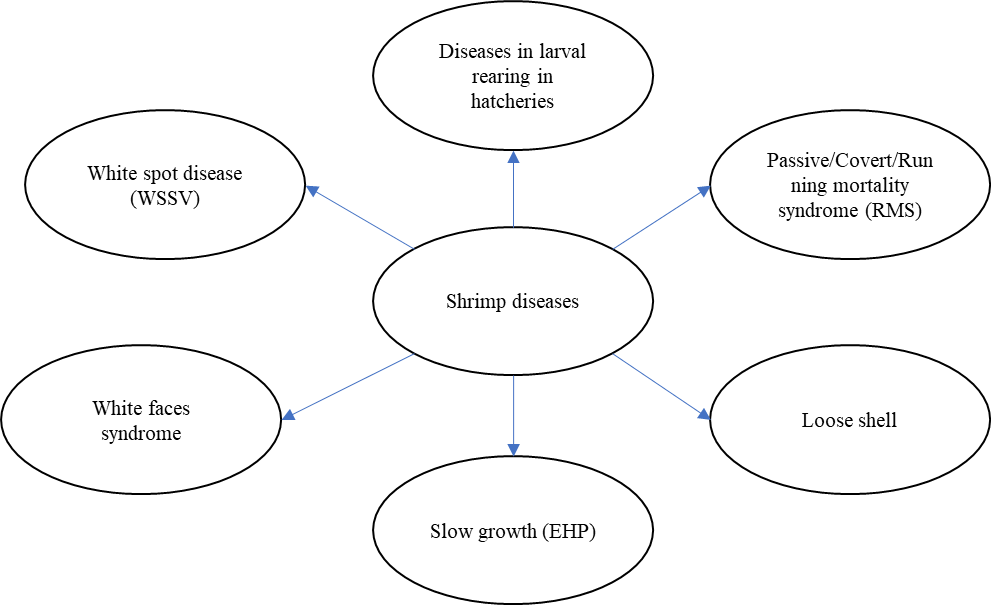


Fig 1: Taxonomy of shrimp diseases

The diagnosis of shrimp diseases is crucial to the aquaculture sector because it ensures the productivity and welfare of shrimp populations. The importance of disease detection can be attributed to several factors. Early detection of diseases in shrimps plays a vital role in shrimp culture. Shrimp diseases can be prevented from spreading to other populations of shrimp to reduce the quantity of infected shrimp in the pond further to reduce the financial toll on shrimp farmers. Choosing the best treatment requires accurate identification of the illness. Accurate diagnosis ensures that the proper course of treatment is taken as various illnesses call for different approaches to care. Shrimp illnesses can be avoided and managed using a variety of techniques, including vaccination, biosecurity precautions, efficient feeding system and water quality management. The identification of a disease and the choice of the best preventative and control methods are both aided by disease diagnosis. Many people depend heavily on shrimp as a food supply, so shrimp disease detection serves to guarantee that shrimp products are suitable for human consumption.

Overall, a fundamental component of managing shrimp farming is the diagnosis of shrimp diseases. Shrimp producers can keep shrimp populations healthy and guarantee food safety by identifying, classifying, preventing, and controlling diseases. Now, in this survey paper we mainly focus on diseases affecting shrimp production and their solution using various techniques.

**2. Literature Review**

**2.1 Traditional Methods for diagnosis of shrimp diseases**

It has been more than 30 years since shrimp pathology emerged as a career that supports shrimp farming. Viruses and bacteria are the common causes of the most serious diseases in farmed shrimp, but parasites and fungi also play a role in a few serious illnesses. The use of antibody techniques, morphological pathology, direct light microscopy, histology, electron microscopy, bioassay methods, and conventional microbiology are some of the conventional diagnostic techniques for these organisms. Table 1 shows the research conducted using traditional methods for shrimp disease diagnosis.

Table 1: Traditional methods for diagnosis of shrimp diseases

|  |  |  |
| --- | --- | --- |
| **Reference** | **Method** | **Description** |
| Mohan, C. V., Shankar, K. [12] | Histopathology | The histopathology method is a useful diagnostic tool for detecting and identifying the cause of shrimp diseases. It can provide valuable information on the nature and severity of the disease, which can aid in the development of effective treatment and management strategies. |
| Yukinori Takahashi, Toshiaki Itami, Masakazu Kondo [13] | Electron microscopy | The electron microscopy method is a powerful diagnostic tool for detecting and identifying the cause of shrimp diseases. It can provide high-resolution images of pathogens and other structures within the sample, which can aid in the development of effective treatment and management strategies. |
| Prior, S., Browdy, C. L. [14] | Bioassay | Bioassay methods can provide a direct measure of the pathogenicity of a sample and are useful for detecting pathogens that are difficult to diagnose using other methods. However, they require live animals, which can be expensive and raise ethical concerns. |
| Lightner, D. V., Walker, P. R.,& Subasinghe [15] | DNA Probes | DNA probes is a rapid method that can give results within a few hours, making it a valuable tool for disease diagnosis in shrimp aquaculture. However, it requires specific probes for each pathogen, which can be time-consuming and costly to develop. |
| Natividad, K. D. T., Migo, M. V. P [16] | PCR | PCR is a precise and sensitive diagnostic technique that has the ability to identify extremely low levels of pathogens in shrimp samples. This method is also very quick, with results being available within a matter of hours, making it an important tool for diagnosing diseases in shrimp aquaculture. |

Although all the above techniques are medically proven and give accurate results for shrimp disease diagnosis, there are a few drawbacks like being time-consuming, expensive, etc. By using machine learning techniques, we can get more accurate results within less time with analysis based on previously stored results and conclusions.

**2.2 Machine Learning methods for diagnosis of shrimp diseases**

A promising area of study is using machine learning to diagnose shrimp diseases, which has the potential to increase the speed and accuracy of disease detection. Machine learning techniques make predictions or decisions by using algorithms that are learned from previous data. Machine learning algorithms can be trained on large datasets of shrimps and related disease labels to diagnose shrimp diseases. Then, new shrimp data can be automatically classified based on the presence or absence of disease using these algorithms. There are several advantages using machine learning for shrimp disease diagnosis:

* Increased accuracy: Machine learning algorithms can be trained on large datasets, which can improve their accuracy in identifying shrimp diseases.
* Rapid diagnosis: Machine learning can provide rapid and automated diagnosis of shrimp diseases, reducing the time and labor required for manual diagnosis.
* Cost-effective: Machine learning can potentially reduce the cost of shrimp disease diagnosis by automating the process, reducing the need for skilled labor.
* Objective diagnosis: Machine learning algorithms can provide objective diagnoses, reducing the potential for subjective interpretation of shrimp images.

The paper looks into recent advances in machine learning methods that have significantly influenced the identification and understanding of a number of conditions. Machine learning algorithms like CHAID, KNN, and Decision tree are used to diagnose conditions like white spot, white faces syndrome and other prominent conditions. Table 2 shows the machine learning techniques used by various researchers for shrimp disease diagnosis.

Table 2: Shrimp diagnosis techniques using machine learning.

|  |  |  |
| --- | --- | --- |
| **Reference** | **Shrimp disease** | **ML Technique** |
| NguyenMinh Khiem, Yuki Takahashi[1] | Acute hepatopancreatic necrosis disease (AHPND) | logistic regression |
| NguyenMinh Khiem, Yuki Takahashi[1] | Acute hepatopancreatic necrosis disease (AHPND) | Artificial Neural Network |
| NguyenMinh Khiem, Yuki Takahashi[1] | Acute hepatopancreatic necrosis disease (AHPND) | Decision Tree |
| NguyenMinh Khiem, Yuki Takahashi[1] | Acute hepatopancreatic necrosis disease (AHPND) | K-Nearest Neighbor |
| Michael Onyema Edeh, Surjeet Dalal[2] | White spot Disease | Boot Strapping Random Forest |
| Michael Onyema Edeh, Surjeet Dalal[2] | White spot Disease | CHAID |
| G Lakshmi,  A Haritha, D Ratnam[3] | White spot Disease | Image Processing  Technique |
| Nghia duong-trung, Luly-da quach[4] | Black gill, Black spot, WSSV, IMNV, NHB,YHV | Transferred Convolutional Neural Networks |
| M Muni Sankar, CH Nageshwar Rao, G Shilaja[5] | White spot Disease | Image Segmentation Technique |
| PingSun Leung, Liem T. Tran [6] | Shrimp diseases | Artificial Neural Networks and Logistic Regression |
| [Milton Mendieta](https://www.semanticscholar.org/author/Milton-Mendieta/31509469), [Dennis Romero](https://www.semanticscholar.org/author/Dennis-Romero/2064243252)[7] | Organ disease of shrimps | Zero-Shot Learning |
| [R.P.Surya Sankar](https://ieeexplore.ieee.org/author/37086285921),  [V. Jenitta](https://ieeexplore.ieee.org/author/37086285827), [B.Kannapiran](https://ieeexplore.ieee.org/author/37085449556),  [K. Valarmathi](https://ieeexplore.ieee.org/author/37823750900) [8] | Shrimp infections | K-Nearest Neighbor |
| [Gadhiraju Tej Varma](https://ieeexplore.ieee.org/author/37089563031), [Adusumilli Sri Krishna](https://ieeexplore.ieee.org/author/37089563797)[9] | Shrimp diseases | Deep learning Convolution Neural Network |
| [AbdelAziz Ashraf](https://ieeexplore.ieee.org/author/37089275154), [Ayman Atia](https://ieeexplore.ieee.org/author/37085875974)[10] | white spot disease and black gill | Transfer Learning Models |
| Aleta C. Fabregas, Debrelie Cruz, Mark Daniel Marmeto[11] | White Spot Disease | Hybrid Neural Networks with Fuzzy Logic Algorithm |

Based on information gathered from shrimp farms, the authors[1] used machine learning to forecast the development of AHPND. They originally proposed that the dependent variable, AHPND, was influenced by 31 independent variables; however, they ultimately chose to train the models with just 15 important variables. The findings of each model were compared, with logistic regression predicted to be the most stable among artificial neural networks, K-nearest neighbor, and decision trees analyses. Hold-out tests for logistic regression produced accuracy values of 90.33% and 85.50%, respectively, using 572 training samples and 191 test samples. The data were split into three folds, each with 254 samples, and evaluated three times for the cross-validation test. (Training subset: 509 samples; testing subset: 254 samples). The precision was 83.44%. The accuracy scores for the training and validation subsets of the hold-out test for the K-nearest neighbour algorithm were 91.82% and 87.26%, respectively. The cross-validation test produced the worst results of all methods, with a sevenfold accuracy rate of 57.80%. Similar to the decision tree, there were significant differences in the KNN algorithm's accuracy between the hold-out and cross-validation experiments. The hold-out test predictive accuracy rates for decision tree models were 97.57% for the validation subgroup and 99.10% for the training subset, respectively. The cross-validation accuracy was considerably lower than the hold-out test accuracy, at 73.42%. The hold-out test's predictive accuracy for artificial neural networks was 86.43% for the test subgroup and 89.35% for the training subset. Using nine folds, the cross-validation test's best predictive accuracy of 73.05% was attained. (i.e., six more than for the logistic regression). The precision was significantly different, and the ANN was unable to detect any data trends.

The authors [8] utilized expert computer programming tools to effectively separate the features of the shrimp infection. Image processing tools are used to locate and recognize diseases in various zones, which is very helpful in identifying the various infections on shrimp. In that study, the shrimp state was classified as normal, medium, or abnormal using a KNN classifier. The job primarily consists of characterizing the infection in light of certain characteristics, which aids the farmers in thinking about the infected shrimps as soon as possible and figuring out how to combat and increase shrimp production.

For the research, the authors[2] used CHAID and Random Forest classification; Python was used for algorithm implementation and result visualisation. The model's suitability for precise disease prediction is demonstrated by the results, which revealed a high prediction accuracy (98.28%). The proposed method offers a reliable system for identifying white spots disease with a precision rate of 98.28%, which employs machine learning techniques (Random Forest & CHAID). This performance is impressive when compared to the previous methods. Therefore, the suggested technique is strongly advised for WSSV early prediction in aquaculture. The suggested approach demonstrates an effective way to identify shrimp farmers with white spots and forecasts the probability using a smoothed dataset and data pre-processing methods.

The authors[4] set up a data-collection hub for their ethnographic fieldwork in the Mekong delta. The transfer learning method is used to teach a number of deep convolutional neural networks. They looked into six frequently mentioned shrimp diseases. The classification accuracy is 90.02%, which is very helpful for pictures that are incredibly out of the ordinary. They call on shrimp specialists, computer scientists, treatment facilities, and lawmakers throughout the work to create preventive measures against shrimp diseases.

The K-Means clustering image processing method is used by the authors[3] to explain the diagnosis of the white spot syndrome disease in shrimp. The highly sensitive capacitive biosensor, which uses shrimp pond water contaminated with wssv and mixes glutathione-S-transferase tag for white spot binding protein (GST-WBP), was immobilised on a gold electrode through a self-assembled monolayer, is one of the many techniques used to detect wssv in aquaculture. By measuring capacitance, binding between WSSV and the immobilised GST-WBP was immediately identified. The capacitive bio sensor detects the type of shrimp under ideal circumstances. This procedure takes a long period. In comparison to other methods, using image segmentation techniques produced accurate results at a lower cost. The proposed method consists of capturing image sensing technique followed by image acquisition, histogram and K-Means clustering methods.

To identify white-spot disease on a shrimp image, the author[5] divided the proposed methodology into four steps:

* Capturing the Image
* Filtering the Image
* Apply the dilation operator on the Image
* Apply h-Dome transformation.

The suggested approach demonstrates how to locate the white spots on a shrimp picture and calculate how long the shrimp was alive. For this, applying filtering methods to a shrimp image resulted in the noise being eliminated and the shrimp image being smoothed. By filling in the gaps, broken areas, and connecting areas in white spots on a shrimp image, the dilation operator is then applied to identify the white spots, and the h-Dome transformation is then applied to bring together white spots that were separately detected from two wavelength channels. Finally, based on the detection of a white spot on a shrimp, this methodology is used to determine the infected shrimp.

A cross-modal transfer method between text descriptions of shrimp organs, diseases and images were assessed by the authors[7]. They looked through the scientific literature and chose the finest semantic word representation. Then, they selected histological images with the most crucial characteristics. They created a cross-modal learning model to map between word and picture representations to artificially create a new image. The technique offered a different approach to the issue of incomplete and unbalanced data. The effort, however, was merely a case study and did not demonstrate any particular performance.

To predict shrimp disease outbreaks in Vietnam, the authors[6] built a probabilistic neural network PNN using farm-level data from 480 Vietnamese shrimp farms, comprising 86 semi-intensive and 394 extensive farms. They also compared the PNN's prediction abilities to those of the more traditional logistic regression technique using the same set of data. Disease incidence, a 0 to 1 variable, is thought to be influenced by a group of almost 70 factors, including site features, agricultural methods, and farm practices. According to the results, the PNN model is more predictive than the logistic regression model.

The authors[9] have utilised deep learning architectures with the shrimp disease network (SDNet) t o locate the disease or virus, K-means clustering (KMC) is initially applied to the test photos. The best characteristics are then extracted from segmented pictures using the iterative random forest method (IRFA), which is based on machine learning. By training the best features, the deep learning convolution neural network (DLCNN) performs the multiclass categorization of shrimp illnesses. The proposed SDNet technique surpassed state-of-the-art methods in terms of both subjective and objective classification measures, including sensitivity, specificity, accuracy, precision, recall, and F1-score

The authors[11] created a method to identify the shrimp white spot disease. The system made use of image processing methods as well as AI algorithms like Fuzzy Logic and Artificial Neural Networks (ANN). In contrast to Fuzzy Logic, which is renowned for handling uncertainties, ANN has the capacity to learn from experience and categorise inputs based on those learning’s. The key objective of their research is to evaluate the tool's accuracy and reliability in identifying WSSV using a hybrid algorithm of ANN and fuzzy logic while taking into account the colour of the spot, the location of the white spots, and the discoloration in the shrimp's body. 50 samples of shrimps were used to evaluate the system. The algorithm evaluated each sample by examining the shrimps' images. The system's diagnosis and the expert's diagnosis were compared and examined when assessing a collection of shrimp samples. The accuracy rate was calculated using the confusion matrix and the accuracy rate formula, and the reliability rate was calculated using the test-retest reliability equation. The outcome of the tool produced a system performance with 90% accuracy rate and a reliability rate of 0.8.

There are also some challenges to use machine learning techniques for shrimp disease diagnosis, including the need for large, high-quality datasets, and the potential for over fitting or under fitting of the models. The part of machine learning in the healthcare assiduity is ineluctable due to its power to use in complaint discovery and operation. Disease opinion using machine learning ways can enhance the swiftness of decision making, and it can reduce the rate of false cons.

**Conclusion**

Machine learning techniques have shown great potential for improving shrimp disease diagnosis, and current research has made significant progress in this area. However, further research is needed to address the challenges outlined above and to. Overall, shrimp disease diagnosis using machine learning is a promising area of research that has the potential to improve the accuracy, speed, and cost-effectiveness of shrimp disease diagnosis, ultimately improving the health and productivity of shrimp populations in the aquaculture industry.

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