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FISH DISEASE DETECTION USING IMAGE BASED MACHINE LEARNING TECHNIQUE IN AQUACULTURE

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ABSTRACT

Fish diseases in aquaculture constitute a significant hazard to nutriment security. Identification of infected fishes in aquaculture remains challenging to find out at the early stage due to the dearth of necessary infrastructure. The identification of infected fish timely is an obligatory step to thwart from spreading disease. In this work, we want to find out the salmon fish disease in aquaculture, as salmon aquaculture is the fastest-growing food production system globally, accounting for 70 percent (2.5 million tons) of the market. In the alliance of flawless image processing and machine learning mechanism, we identify the infected fishes caused by the various pathogen. This work divides into two portions. In the rudimentary portion, image pre-processing and segmentation have been applied to reduce noise and exaggerate the image, respectively. In the second portion, we extract the involved features to classify the diseases with the help of the Support Vector Machine (SVM) algorithm of machine learning with a kernel function. The processed images of the first portion have passed through this (SVM) model. Then we harmonize a comprehensive experiment with the proposed combination of techniques on the salmon fish image dataset used to examine the fish disease. We have conveyed this work on a novel dataset compromising with and without image augmentation. The results have bought a judgment of our applied SVM performs notably with 91.42 and 94.12 percent of accuracy, respectively, with and without augmentation

INTRODUCTION:

The word aquaculture is related to firming, including breeding, raising, and harvesting fishes, aquatic plants, crustaceans, mollusks, and aquatic organisms. It involves the cultivation of both freshwater and saltwater creatures under a controlled condition and is used to produce food and commercial products as shown in Fig. 1. There are mainly two types of aquaculture. The first one is Mariculture which is the farming of marine organisms for food and other products such as pharmaceuticals, food additives, jewelry (e.g., cultured pearls), nutraceuticals, and cosmetics. Marine organisms are farmed either in the natural marine environment or in the land- or sea-based enclosures, such as cages, ponds, or raceways. Seaweeds, mollusks, shrimps, marine fish, and a wide ange of other minor species such as sea cucumbers and sea horses are among the wide range of organisms presently farmed around the world's coastlines. It contributes to sustainable food production and the economic development of local communities. However, sometimes at a large scale of marine firming become a threat to marine and coastal environments like degradation of natural habitats, nutrients, and waste discharge, accidental release of alien organisms, the transmission of diseases to wild stocks, and displacement of local and indigenous communities (Phillips,

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2008). The second one is Fish farming which is the cultivation of fish for commercial purposes in human-made tanks and other enclosures. Usually, some common types of fish like catfish, tilapia, salmon, carp, cod, and trout are firmed in these enclosures. Nowadays, the fish-farming industry has grown to meet the demand for fish products (Winkler, 2020). This form of aquaculture is widespread for a long time as it is said to produce a cheap source of protein. Global aquaculture is one of the quickest growing food productions, accounting for almost 53% of all fish and invertebrate production and 97% of the total seaweed manufacture as of 2020. Estimated global production of farmed salmon stepped up by 7 percent in 2019, to just over 2.6 million tonnes of the market

Fig. 1. Aquaculture (Infected, 2020).

(grapple with Atlantic salmon price rollercoaster, 2020). Global aquaculture of salmon has a threat of various diseases that can devastate the conventional production of salmon. Diseases have a dangerous impact on fishes in both the natural environment and in aquaculture. Diseases are globally admitted as one of the most severe warnings to the economic success of aquaculture. Diseases of fishes are provoked by a spacious range of contagious organisms such as bacteria, viruses, protozoan, and metazoan parasites. Bacteria are accountable for the preponderance of the contagious diseases in confined fish (Miller and Mitchell, 2009). Infectious diseases create one in every foremost vital threat to victorious aquaculture. The massive numbers of fishes gathered in a tiny region gives an ecosystem favorable for development and quickly spreads contagious diseases. In this jam-packed situation, a comparatively fabricated environment, fishes are stressed and also respond to disease. Furthermore, the water ecosystem and insufficient water flow make it easier for the spread of pathogens in gathered populations (Nicholson, 2006). Detection of disease with the cooperation of some image processing can help to extract good features. Image segmentation becomes indispensable for various research fields like computer vision, artificial intelligence, etc. The k means segmentation is a popular image processing technique that mainly partitions different regions in an image without loss of information. In Kailasanathan et al. (2001), authors applied k means segmentation for authentication of images. Another application of k means segmentation shown at Gaur and Yadav (2015) where they use this technique to recognize handwritten Hindi characters. One of the most popular supervised machine learning techniques, support vector machine (SVM), has brought convenient solutions for many classification problems in various fields. It is a powerful classification tool that brings out quality predictions for unlabeled data. In Khan et al. (2016) Authors built an SVM model based on three kernel functions to differentiate dengue human infected blood sera and healthy sera. For image classification, another SVM architecture has been proposed in Agarap (2017) where they emulate the architecture by combining convolutional neural network (CNN) with SVM. SVM provides remarkable accuracy in many contexts. In this paper, we conduct our research on the salmon fish disease classification, either the fish has an infection or not, with a machine vision-based technique. A feature set is a trade-off for the classification of the disease. Image processing techniques are used to extort the features from the images, then a support vector machine (SVM) is employed for the successful classification of infectious disease. Hither, we summarize the entire concept of this work's contribution given below: Propose a groundbreaking framework for fish disease detection based on the machine learning model (SVM).

Appraising and analyzing the performance of our proposed model both with and without image augmentation.

Juxtaposing our proposed model with a good performing model by some evaluation metrics.

RELATED WORK Some works focused on only some basic image processing techniques for the identification of fish disease. Malik et al. (2017) proposed an image-based detection technique where firstly applies image segmentation as an edge detection with Canny, Prewitt, and Sobel. However, they did not specify the exact technique that engrossed for feature extraction. In feature extraction, they applied Histogram of Gradient (HOG) and Features from Accelerated Segment Test (FAST) for classification with a combination of both techniques. They tried to discover a better classification with a combination instead of applying a specific method with less exactness. Another technique Lyubchenko et al. (2016) proposed a structure called the clustering of objects in the image that obliged diverse image segmentation actions based on a scale of various clusters. Here, they chose markers for individual objects and objects encountered with a specific marker. Finally, they calculated the proportion of an object in the image and the proportion of infected area to the fish body to identify fish disease. However, individual marking of an object is time-consuming and not effective. There are some approaches focused on the consolidation of image processing and machine learning. Malik et al. (2017) proposed a specific fish disease called Epizootic Ulcerative Syndrome (EUS) detection approach. Aphanomyces invadans, a fungal pathogen, cause this disease. Here, they approached combination styles that combine the Principal Component Analysis (PCA) and Histogram of Oriented Gradients (HOG) with Features from Accelerated Segment Test (FAST) feature detector and then classify over machine learning algorithm (neural network). The sequence of FAST-PCA-NN gives 86 percent accuracy through the classifier, and HOG-PCA-NN gives 65.8 percent accuracy that is less than the previous combination. Verma et al. (2017) proposed a sensitive topic that is kidney stone detection. In this paper, the authors apply morphological operations and segmentation to determine ROI (region of interest) for the SVM classification technique. After applying this technique, they investigated the kidney stone images with some difficulties, such as the similarity of kidney stone and low image resolution. Zhou et al. (2017) introduced a device-free present detection and localization with SVM aid. Here, the detection algorithm can detect human presence through the SVM classifier using CSI (channel state information) fingerprint. Trojans in hardware detection (Inoue et al., 2017) depend on SVM based approach. Here, the authors evaluated a trojans detection method with their designed

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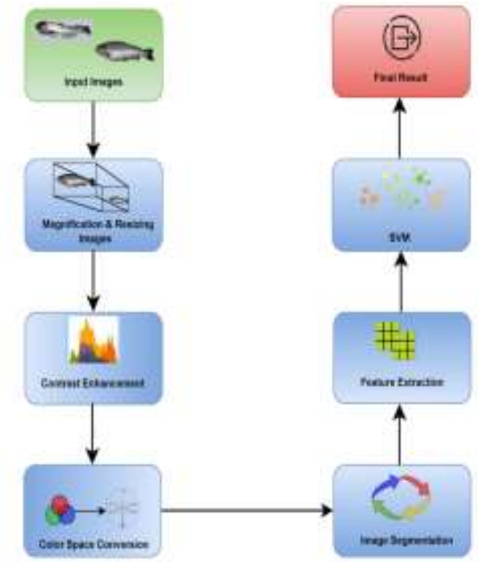
hardware. For SVM analysis, their netlists consist of three types of hardware trojan with normal and abnormal behavior. We can conclude that none has performed any depth research work on salmon fish disease classification regarding the research obligations described above. Furthermore, most of the research works involved typical fish disease classification but not in aquaculture. All those described techniques depend solely on image processing or a combination of image processing and machine learning technique but not up to the mark.

Preliminary and Proposed Framework This section has several stages presented in Fig. 2. Here we precisely present the appurtenant technologies and a solution framework of salmon fish disease classification.



FISH DISEASE DETECTION Infected fishes usually can be examined according to visible marks including lesions, erosion, cuts, redness, swellings, and lumps on either skin, gills, eyes or scales [2] of the fish. Some of the disease presents a complex visible pattern which cannot detect anomaly. Thus, it is important to grasp the domain of the issue by having a detailed analysis before developing any model for fish disease detection. For this matter, problems that arise in disease detection must first be recognized before potential strategies for dealing with them in a computer-based framework can be investigated further [21]. As a consequence, various models have employed different parameters to detect fish diseases, such as description input of visible external signs and symptoms, behaviour signs, water conditions, captured image of the infected fish, microscopic images and others [5]. Meanwhile, image-based monitoring and analysis is considered extremely valuable for early detection and addressing complex pattern identification duties in decision-making of fish disease detection. There are several image processing techniques that have been proposed in the field of fish disease based on statistical methods, Artificial Intelligence (AI) and hybrid methods. However, studies related to image processing techniques in current practice are still limited. Therefore, this study discusses the current state of art in the field of image processing for detection of fish disease based on previous studies.

Workflow of Image Processing Image processing is among the most promising technologies for enhancing raw images gathered from external sources such as cameras, satellite sensors,

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space probes, aircraft, and others [22]. Image processing techniques could greatly improve the quality of the original image and prepare for machine interpretation. The hand-crafted image processing in fish disease detection involves a fundamental procedure to extract and classify features from infected fish that is commonly implemented in several steps. Ammar and Neama [7]; and Hu et al. [14] summarized their work into four steps, which are image acquisition, image pre-processing, feature extraction and classification. Park et al. [9] added another step of object detection before feature extraction process in order to confirm the presence of the interested object which was pathogen. On the other hand, Jovanovic et al. [15], Shaveta et al. [16], Waleed et al. [18] and Hitesh et al. [23] incorporated image segmentation process before feature extraction in their methodology. In comparison, Hitesh et al. [23] included dimensionality reduction step using Principal Component Analysis (PCA) before segmentation process, while, Shaveta et al. [16] included this step after feature extraction. In most cases, at the end of the process, the proposed model was tested using images allocated for testing or images obtained from the users. The validation of each model is usually done after all the aforementioned processes based on common indexes such as accuracy, precision, sensitivity and specificity. To sum up, the general workflow of image processing in fish disease detection is as shown in Figure

Fig: General workflow of image processing for fish disease detection

Image Pre-processing and Segmentation In general, pre-processing is the first step in improving the quality of input colour captured from different environments in image-based applications. At this stage, noise and unwanted items are removed from the image using various techniques designed for image resizing, smoothing, and enhancement [24]. Park et al. [9] considered emphasizing pathogen areas in microscopic images using a variety of techniques for the purpose of noise reduction, edge detection, morphological operations, background extraction, and object detection. They used 3×3 mean and edge sharpening filters at the beginning of pre-processing to minimize the salt and pepper noise and to highlight the edge feature of the microscopic image. Besides, the unimportant spectrum of histogram analysis was removed during levelling process in red/green/blue individual plane and the rest of the spectrum were equalized. The edge region in RGB space was discovered through several steps of edge detection masks. Binarization using thresholding was done at the last stage of pre-processing. In the study by Hitesh et al. [13], K-means clustering was used to segment the colour features of infected areas present in the images. This clustering technique was used successfully in plant disease detection, skin colour detection, and leaf disease classification [8]. Apart from these, Hu et al. [14] determined to crop the live images acquired by GRPS into 32×32, 64×64, 128×128, 256×256, 512×512 window sizes using automated software before manually filtering the unqualified images that do not show full skin of the fish. After the selection, the images were filtered by 3×3 media filter similarly as in [9]. In the study by Jovanović et al. [15], the collected videos were pre-processed by dividing each frame into 64×64 pixels size of blocks, hence producing around 100 000 images dataset for training. However, the distribution was irregular because more than half of the features appeared to be in the normal class. Then, the codebook of the SIFT descriptors was retrieved from each image and applied K-means clustering algorithm to group these descriptors into a fixed size codebook. Meanwhile, the study by Divinely et al. [6] and Shaveta et al. [16] undertook the pre-processing step by applying filter to remove noise, normalize the intensity of the image and utilized morphological operations at the pre-processing stage. Additionally, Shaveta et al. [16] adapted histogram equalization to equalize and improve the image and Canny's edge detection technique was used on image to remove the irrelevant information while retain the useful information. On the other hand, Ammar and Neama [7] reduced the noise present in the microscope sample images via Gaussian filter and removed the unrelated background to obtain the Ichthyophthirius multifiliis parasite image by GrabCut algorithm. Moreover, Gujjala et al. [17] segregated the video collected into frames followed by noise removal using Unscented Kalman filter (UKF). In other study, Waleed et al. [18] applied different colour spaces (RGB, Ycbcr and XYZ) on input images during pre-processing phase. For segmentation, they utilized the Gaussian distribution to measure the probability of any infected area.

CONCLUSION It can be concluded that several efforts had been brought up in the direction of fish disease detection with the help of image processing although there are scarce studies been conducted. Overall, it can be implied that based on the previous studies of fish disease detection, image processing can be done with minimum time and efforts, and is also more reliable in providing better alternative to the manual technique conducted by fish experts. Besides, with the help of image-based model, early detection of diseases can be accomplished to prevent the diseases from spreading. This is very useful in monitoring application of fish disease. Furthermore, development of image processing technique is able to contribute to a more advanced technique with higher automation principles and accuracy behind the techniques. This paper attempts to provide a conclusive review of image processing application in fish disease detection

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