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Image-Based Fish Disease Detection Methods: An Innovative Technique for The Diagnosis

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1. Introduction

Large-scale fish infections occur frequently in aquaculture, spreading quickly from one region to another. Therefore, to keep fish safe and healthy and to stop and control disease transmission in aquaculture, it is essential to develop contemporary, non-destructive, quick, real-time, and automatic fish disease prediction and diagnosis systems (Ahmed *et al.*, 2022). For disease monitoring and diagnosis, image processing technology is being used increasingly in various industries, including aquaculture. It provides a non-intrusive and effective method for analysing photographs of aquatic species, allowing for the early recognition and management of illnesses. Images of fish, shellfish, or other aquatic animals are taken using high-resolution cameras or underwater imaging equipment. After the acquisition of the image, it is processed through image-processing technology. Machine learning and computer vision algorithms are used further to process the data. IPT (Image Processing Technology) has several applications in different fields. In aquaculture, IPT is used for fish length-weight measurement, fish detection, and tracking, identification of fish disease, etc (Yang *et al*., 2021).

2. What is Image Processing Technology?

Image processing is a way of extracting information from or improving an image by performing operations on it. This involves de-noising of an image, segmentation of the region of interest of that image, feature extraction, target recognition, and detection. Feature characteristics may include colour patterns, textures, shapes, and size measures. These features can be located and extracted using particular methods, such as edge detection or texture analysis. IPT consists of some basic steps, which are summarized below:

2.1. Image Acquisition

In image processing, picture acquisition is always the initial step in the workflow sequence because processing is impossible without an image. Image acquisition in image processing is acquiring an image from some source, usually a hardware-based source, so it can be processed through whatever processes are required later. The obtained image is unprocessed and is the result of whatever the camera was used to generate it, which can be highly significant in particular fields to have a constant baseline from which to work. Both underwater cameras and outside cameras are used to capture images in aquaculture for disease diagnosis and to monitor the health of the fish. Real-time picture acquisition is a type of image acquisition used in image processing in aquaculture. This usually entails collecting photos from a source that captures photographs automatically and continuously. The quality of the image directly determines the accuracy of fish disease detection based on the image.

To diagnose fish diseases, image acquisition can be classified into two types-

a) **Image captured from the natural aquatic environment:** In this case, fishes are under surveillance of the cameras in their natural habitat. Any abnormality (abnormal swimming, lethargy, gasping, swirling, no or less feed consumption) of the fishes are easily observed and recorded. The fish surface condition is also examined using spectral and ultrasonic images.

b) **Image captured by external human intervention:** In this case, fish might be damaged to capture the images. External human intervention is needed. This type of image acquisition includes microscopic images, fluorescence images, etc.

2.2. Image processing

Image processing is necessary to remove noise or superfluous information from an image and improve image quality after capture. Several methods of image processing techniques like image de-noising, image sharpening, image smoothing, and enhancement of the image have been adopted in aquaculture. Image de-noising is performed by using wavelets and filters. Image sharpening is necessary to improve the edges and contours of fish images in detection. Sharpening (high-pass filtering) is used to compensate for image contours, making the image's edges more visible (Awalludin *et al*., 2020). All of these processes are performed to increase the quality of the image.

2.4. Feature Extraction

An image consists of several pieces of information in the form of pixels, and the use of a computer algorithm to extract picture information from this image, where the features are the same type of measurement data in the image, is referred to as feature extraction. Colour feature extraction, texture feature extraction, shape feature extraction, and spatial feature extraction are the four common feature extraction methods. Feature extraction helps reduce the complexity of processing a huge data set without losing any important information about that image.

2.5. Target Detection

Many fish diseases alter fish behaviour, and target detection could identify and track fish movement. Target detection aims to locate and detect the object of study in an image or video. Numerous fish may be tracked at the same time. Machine vision has the potential to enhance tracking accuracy greatly.

2.6. Target Recognition and Classification

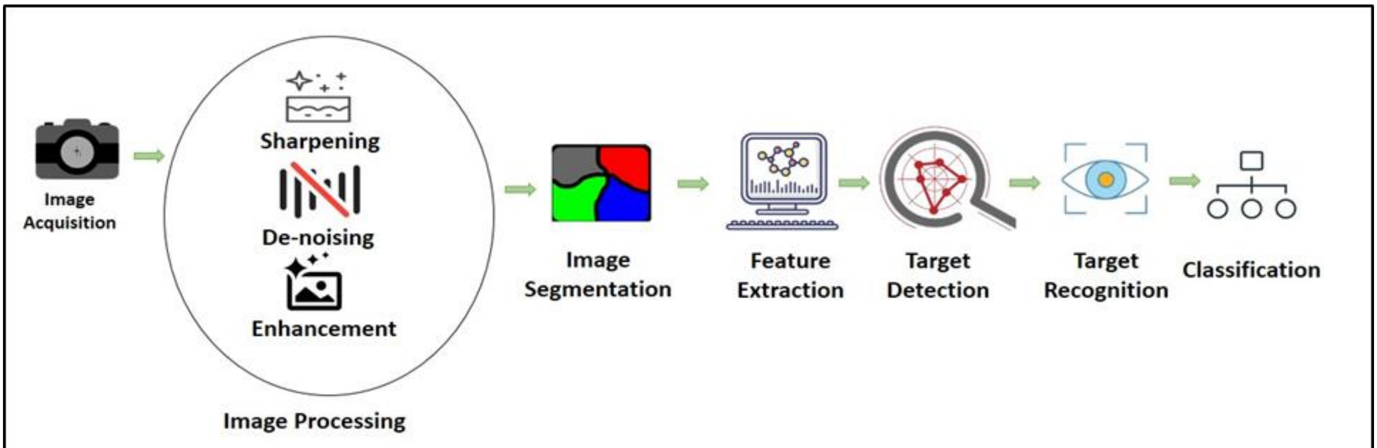

Fig 1- Overview of image processing technology

2.3. Image segmentation

In an image, only some portions are required for disease diagnosis. Accurate image segmentation is necessary to obtain a region of interest in the image. Image segmentation is also helpful for finding and recognising targets. Rather than processing the whole image, it is usual first to utilise an image segmentation technique to locate things of interest in the image, improving accuracy and reducing inference time. Algorithms like C-means clustering and K-means clustering are used to segment the image in successful disease diagnosis (Yao *et al*., 2013).

The goal of target recognition is to find the research object in an image or to classify a target of the same type in an image. Aquaculture uses target recognition primarily for fish categorization and identification and fish status analysis. Colour, shape, and texture are key features that can be used to identify fish. After recognition, the image information is classified by several classifiers to detect particular abnormalities and associated diseases. Different algorithms can be trained using a collection of tagged photos, each linked to a specific disease or medical condition. After being trained, the algorithms are capable of classifying new images into various disease categories.

3. Usefulness of Image Processing Technology in fish disease detection

Image processing technology is critical in detecting fish diseases and provides several benefits to the aquaculture business. Here are a few ways image processing can help with fish disease detection and management.

3.1. Monitoring and early detection

IPT helps to identify abnormalities at an early stage. By analysing surface images of the fishes, any changes in colouration shape can be easily detected even before these symptoms appear to the human eye. Fish behaviour (Slow moving, not feeding, floating or sinking) also plays an essential role as a critical variable for successful disease detection.

3.2. Automation

Automated image processing systems can handle enormous amounts of data rapidly and efficiently, and massive fish populations may be monitored. This technology decreases the labour of aquaculturists, allowing them to focus on preventive measures and therapy.

3.3. Non-invasive way to monitor health status

Though some methods are available to observe the internal health of the species in an invasive way by image processing technology, IPT allows for non-invasive fish health monitoring, too. Traditional methods frequently include handling and stressing the fish, which might increase illness symptoms. Continuous monitoring is achievable with picture processing without additional stress to the fish.

4. Different images used in disease detection

a) Spectral image: Pathogens in fish tissues can be detected promptly, noninvasively, and effectively using spectral imaging. Spectral images are also used to detect pathogens from processed fish tissue. Underwater hyperspectral photography could be a promising new tool for counting louse in sea cages (Pettersen *et al.*, 2019).

b) Ultrasonic image: Ultrasonic imaging is a powerful method for detecting fish diseases and is widely used in aquaculture. Contrast-enhanced ultrasound (CEUS) imaging helps to assess the intestinal health of the fish (Horn *et al.*, 2023). Ultrasonography has been well-established as a technique to identify parasites in fish (Frisch *et al.*, 2016).

c) Fluorescence image: Fluorescence imaging has been used as a non-destructive diagnostic tool to detect disease in farmed fish. It is also used to detect the localization and distribution of pathogens in fish bodies.

5. Challenges of IPT in fish disease diagnosis

IPT has not been operating on a broad scale till today. Several challenges of this technology keep it in a limitation. Various technical challenges, its accuracy and variability for several diseases, and minimal diagnostic capabilities are notably its negative side. Skilled manpower is required for operating and data management. The operational cost of an automated disease monitoring system is also high.

6. Conclusion

Image processing technology has emerged as a potent tool for detecting fish diseases, with various advantages and challenges. In this modern era, as technology advances, ongoing image processing research, and innovation will undoubtedly improve our ability to protect the well-being of aquatic species in aquaculture and natural ecosystems by this type of technology. Image processing techniques in fish health management have improved our ability to monitor, diagnose, and reduce diseases in aquaculture settings.

7. References

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