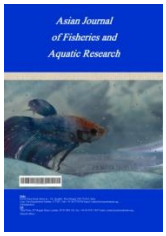

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Digitization in Detecting Fish Freshness Quality: Literature Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Fish contain a lot of nutrients that are very good for the body, but fish are often traded in a postmortem state with poor quality. One of the reasons is the difficulty of detecting the quality of fish freshness. Many studies currently make applications and special tools to see the fish quality in the digitalization of tools to facilitate human work. The method used is by identifying digital images, acoustic techniques, and electronic noses. In digital image identification, the fish's eye image is applied by taking pictures of the condition of the fish on a smartphone device and then processing it using the small square method or curve fitting. After that, the identification of the acoustic form utilizes sound waves emitted to the observed target. In addition, the electric nose method is carried out by using the nose's working principle, which receives a response to odors that arise from rotting fish.

Keywords: Digitization; fish freshness; fish quality; fish quality; fishery.

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1. INTRODUCTION

Fish is a source of animal protein that has advantages such as having complete essential amino acid content, much-needed unsaturated fatty acids, sufficient vitamin and mineral content, and high digestibility [1]. The quality of fishery products is synonymous with freshness. Fish quality must be maintained if handled with care, clean, and stored in a cool room and quickly. The process of physical, chemical, and organoleptic changes takes place quickly after the fish dies [2]. The sequence of changes in fish postmortem includes pre rigor mortis, rigor mortis, and post rigor mortis. According to Metusalach [3], one of the factors that influence the decline in the quality of marketed fish is time in bad environmental conditions. The longer the time, the faster the fish will experience a quality decline.

Several observations have shown that the quality of fish traded in the market varies [4]. In general, traded fish are dead and often still alive. A decrease in fish quality can be seen from changes in fish skin color, eyes, gills, and fish meat texture. These changes are caused by enzymes, chemicals, and bacteria in it, causing the fish to be unfit for trade, let alone for human consumption.

As production increases for the consumption of fresh fish, irresponsible people take advantage of the situation by selling fish that are not fit for consumption. One of the reasons is the result of poor handling methods. According to Afrianto and Liviawaty [5], the handling method affects the activity of enzymes and microbes. Whole fish that is freshly harvested can inhibit the decaying process as its natural defences are still active thereby slowing down the activities of microorganisms. Wounds that occur in fish are a way for spoilage bacteria.

There are various ways to detect fish freshness, one of which is by microbiological analysis and chemical analysis [6]. This analysis is needed to determine whether the fish is fresh or not. Fresh fish (pre rigor) is fish that has not undergone any physical or chemical changes. Meanwhile, fish that is not fresh (post rigor) are fish that have undergone physical changes such as reddish eye color, brown/ bluegills, scales easily come off [7]. One example is the examination of formaldehyde content which affects the freshness of fish and needs to be chemically analyzed [8]. These methods are less effective because they require a large amount of human labor, are quite expensive, require a longer time. Humans are also susceptible to physical fatigue, thus affecting fish production.

Currently, in Indonesia, there have been many digitalization tools developed to help the cultivation process to get excellent and efficient results. One of the digitization developments is the assembly of self-feeding systems [9,10]. Using a feed dispenser (Food timer, Seiko Clock) and modified to be driven by the control unit according to the signal from the switch actuation. The results obtained showed that the amount of feed used was more efficient. This principle can also be applied to detect the quality of fish by utilizing an existing tool or application and then modifying it to see fish freshness efficiently. Several studies on fish freshness detection tools have been carried out and proven to be more accurate and efficient. Therefore, this literature review work was made to find out how digitization in detecting the freshness quality of fish has been carried out.

2. METHODs

The source search in this review was carried out by taking several references from scientific journals related to the application of fishery digitization in detecting the quality of fish freshness. The criteria used are scientific journals intended to be published manuscripts with the last ten years (2011-2021), contain designs in making applications to measure fish freshness, and are national and international scientific journals. The number of studies used in this journal review is 13 journals.

3. RESULTS AND DISCUSSION

Given the importance of detecting the quality of fish freshness, currently, in Indonesia, there have been many studies on digitization in detecting the quality of fish freshness. The detection tools make it easier for people to get good quality fish easily and accurately. Several studies conducted identification based on digital images, acoustic methods, and electric nose methods.

3.1 Fish Freshness Identification Based on Digital Image

Digital images are two-dimensional images displayed on a computer screen as discrete sets of digital values called pixels/picture elements. In a mathematical view, the image is a continuous function of light intensity on a two-dimensional

plane [11]. The image of fish that has decreased in quality, which can be observed based on the shape, body pattern of the fish, along with changes in their characteristics.

Observation of the eye is one way that is easy to follow as the concept of iridology is used for various species of freshwater and marine fish and can detect fish freshness using a practical android device [12]. The eye is the most sensitive sense, so it plays an essential role in human perception, especially an image. So that many observations based on fish-eye images are carried out. This fish-eye image is used as input data to calculate the average Grayscale value which provides information in the form of values with a histogram display. The output results of the Grayscale value are processed by the least-squares method to calculate the level of freshness of the fish, which is then matched with the inference data previously stored in the training data, and the final output is an image containing information about the level of freshness [13].

In this study, it is proposed to detect the freshness of milkfish based on digital images using the image features of the fish head, especially the eye area. One of them is the observation on the milkfish eye image extracted in the RGB color space, which can be seen in Fig. 1 by taking the red color using the difference between the R color and the G and B colors in the input image. In the RGB color space, the red color in the fish's eye has a higher R-value than the G and B channels, with an accuracy value of 98.2% [14].

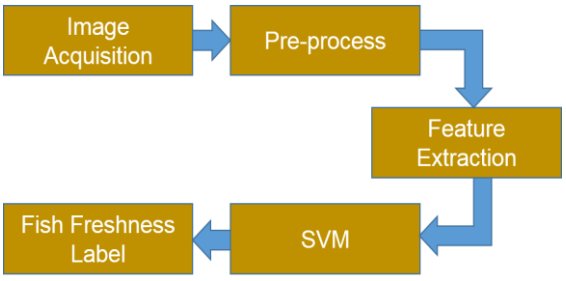

Fig. 1. Stages in the milkfish freshness detection system [14]

Observations have also been made using the small square method on tilapia. The least-squares method is a method that is often used in regression analysis techniques that aim to minimize the square of error so that the regression value is close to the actual deal. Measurement of the distance of the line = (x) is in the data using root-mean-square error, (f)= (1/N $(f(xi)-yi$)2Ni=1) 0.5 Coefficient of least-squares line =$ax+b$ which is the solution of a linear system known as standard equations:

$$(\Sigma xi_2 Ni = 1)a + (\Sigma xiNi = 1)b = \Sigma xi = 1$$

$$(\Sigma xiNi = 1)a + Nb = \Sigma yi$$

The system testing phase will be carried out by processing the image by equalizing the pixel size and cutting the eye of the fish. After processing the image, the image with the JPG extension is converted to grayscale form, then the RGB and grayscale histograms are displayed and then calculated and analyzed using the quadratic smallest method. In the last part, the input image is matched with the notion that has been saved as training data. The calculation and analysis of the least-squares method can detect changes in image color by comparing the data range of the average fish-eye texture value, which is the reference in determining the freshness level of a Tilapia fish [7,15].

Khan et al. [16] explain for futher details that the image recognition techniques are deep learning food safety after that translate high-dimensional text content. After we got the data, the next step is transactional data and trade data. And then, image processing that enhances or collects crucial data for actions on an image. In this step the processor input an image, and the output is an image or the properties/features of the picture.

In addition to the small square method, many studies have also been carried out using the curve fitting method based on fish-eye digital images [17]. The characteristic of this method is that it performs matching with curves that are close to the data. There are two methods of curve matching, namely interpolation, and regression. Suppose that there are y data on various x (n pairs), then we can find an equation y = f(x) which gives the relationship between y and x, which is close to the data (Fig. 2). This approach in numerical methods is called Curve Fitting [17,18].

This method is also used and applied to digital gill images by Latumakulita [19]. The steps are carried out by taking fish gill images, and then the first process. The application will calculate the red color in each fish gill image. Then the formula is determined using the fitting curve

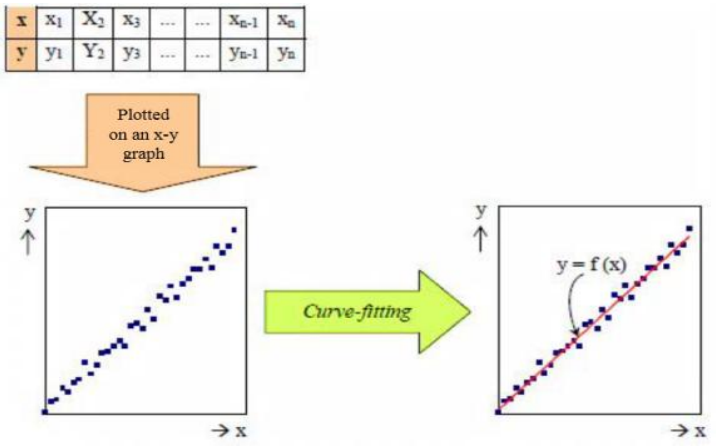

Fig. 2. Curve-fitting process [17]

method and then calculates the error value using the linear method, the quadratic method, and the cubic method so that the final stage will show whether the fish is still fresh or not.

3.2 Fish Freshness Identification based on Acoustic Method

This method utilizes sound wave pulses emitted and received by the transducer to determine the condition or characteristics of the sound reflection against the observed target. The process in this acoustic method is by inserting the fish into the fish place and then pressing the switch button on the conveyor. The conveyor will run until the LDR sensor detects the presence of the fish place to stop the conveyor. Then the microcontroller sends data to the Raspberry Pi so that the Raspberry Pi can instruct the camera to take pictures of fish. After that Raspberry Pi will processed the image. The results of the Raspberry Pi decision are sent again to the microcontroller to turn on the indicator light as a sign of fresh (blue) or rotten (red) milkfish [20].

The stages of measurement using this method are as follows [20]: (1) Calibration of the instrument. The Fish Freshness Instrument (FFI) is first calibrated by turning on, setting, and determining each shot released by the transducer to the target fish. (2) Prepare fish samples to be tested, in this case, whole fish and fish fillets. (3) Testing the freshness level of fish by shooting sound pulses on the target fish. The pulse sent through the transducer is in the form of sound waves with repetitions every 0.1 seconds. The reflection received is then processed by the instrument and displayed by the display, recorded as measurement data. Variations in the level of pulse reception in the form of peak amplitude to changes in fish conditions will be used as the basis for determining the level of freshness of fish. (4) Data collection is every 1 hour with several repetitions. Observations are carried out for 24 hours. (5) Analysis of fish freshness data is carried out by making graphs and seeing the changes obtained.

3.3 Fish Freshness Identification based on Electronic Nose Method

In addition to using digital image techniques, there is also an electronic nose design to detect the level of decomposition of freshwater fish [21]. The freshness level of fish meat can be distinguished by the smell it produces. Draft Electric nose is an instrument of smell electronics that can detect the scent of fresh fish water. The working principle of the electronic nose is to imitate the actions of the human nose by recognizing the response pattern to scents. Scents are made up of molecules that each have a specific size and shape. The receptor captures a molecule then sends signals to the brain and brain to identify the scent associated with the molecule.

E-nose consists of three components: a functional primary which operates as a serial in the sample scents that sample chamber), the arrangement of the sensors (sensor arrays), and the system acquisition data. The sample to be tested is placed in the sample room. After that aroma samples are supplied to the spatial arrangement of the sensors that are on a space sensor using a system of flow of air. Gas sensors

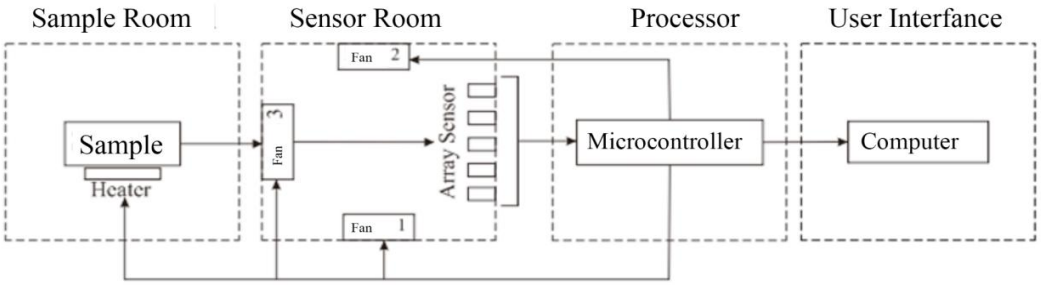

Fig. 3. Electronic nose system block diagram [21]

are arranged into a sensor array to respond to certain chemical compounds in the sample. The response is in the form of an analog signal which is then captured by the ADC (Analog to Digital Converter) to be read by a computer [21]. This process can be seen at Fig. 3.

3.4 Fish Freshness Identification Using Artificial Intellegence

Artificial intelligence (AI) for distribution of fresh foods by searching more viable route to keep intact the food attributes. This use of AI usually combines several methods in one device to get efficient results. One of the example is VIBHISHAN. This is an automated robot that can detect intruders and identify the condition of food (old or rotten food), ensuring the safety of the warehouse and the food stored there. A camera is installed in front of the robot to take pictures of the area around the warehouse. They are sent to the owner via the mobile app using the wifi on the robot's body. Attaching these wheels to the robot will help the robot move and properly monitor food depots and groceries. This process helps reduce food waste and prevents food from aging in large warehouses that people are unaware of [22].

Another example is Swarm intelligence (SI). This is a subfield of artificial intelligence and consists of many algorithms. SI is a branch of natural inspired algorithms by global search capabilities and adaptive properties that provide optimized solutions for real-time problems. This AI use artificial bee colony (ABC) optimization and cuckoo hunting (CS) algorithms also fall into the SI algorithm category. Researchers have implemented the ABC and CS algorithms to optimize the distribution channels for fresh food delivery within the time frame, taking into account other factors [23].

Application by using the technology of artificial intelligence robotics, the agriculture sector would need to increase its productivity by about 70%. The advantage of these computational frameworks is that they provide consistent data over a period ranging from hours to months and work with advanced models of cycles that may be manifested in a particular period accordingly. In addition, these frameworks is relatively easy to move derived intelligent models into the business environment for long-term improvement [24].

4. CONCLUSION

Digitalization in detecting the quality of fish freshness has been widely carried out in Indonesia. The method used is by identifying digital images, acoustic methods, and electronic noses. In this digital image identification, the fish-eye image is applied by taking pictures of the condition of the fish on a smartphone device and then processing it using the small square method or curve fitting. In contrast, the identification of the acoustic method utilizes sound waves emitted to the observed target. In addition, the electric nose method is carried out by utilizing the working principle of the nose, which receives a response to odors that arise from rotting fish.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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