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INNOVATIVE STUDY ON BILSTM-CNN APPROACH FOR FISH FRESHNESS STUDY

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Abstract. One of the most crucial aspects to consider when it comes to fish processing, marketing, sales, consumption, and preservation is freshness detection through innovative study. This metric is used to assess how fish have changed as a result of microbiological, chemical, physical, and biochemical factors. Traditional methods for evaluating fish quality are time-consuming and labor-intensive, lacking in-field or real-time applications .The major objective of the paper is to evaluate fish quality and freshness, which is done through image processing. This research recommends a hybrid deep learning model with an automated method based on image processing to assess the freshness of fish. By building a machine learning model using a Bi-directional Long Short Term Memory (Bi

LSTM) and VGG-19 neural network architecture, the approach retrieves features. The fisheye dataset from Kaggle is used as a sample in this study. The suggested work demonstrates an incremental improvement in fish freshness detection with a 95 percent of accuracy.

Keywords**—**Fish · CNN-BiLSTM · Deep Learning · VGG-19 · Freshness Detection.

1. INTRODUCTION

Fish is a perishable food that is especially susceptible to oxidation and microbiological decay. Effective storage strategies must be implemented to increase the shelf life and maintain the quality and safety of the product from catch through consumption. The amount of ice, fish species, storage period, temperature, and stress experienced during catch are just a few of the variables that affect how long fish can be kept fresh [1-3].Consumers are very concerned about the cleanliness of fresh seafood. Enzymatic reactions and microbial contamination kill fish rapidly. Before ingesting or industrially processing fish, it is very important for the client to verify its freshness. Physical examination, in which experienced panelists examine a fish’s color, eyes, gills, skin, texture, and odor, is the most straightforward method for detecting whether or not it is fresh. Compiling data in accordance with certain degradation algorithms yields a quality index. This method is problematic, however, since it relies on the abilities and knowledge of the panelists [4, 5].

The significance of food freshness and quality has soared in routine life. Fish is an indispensable part of our everyday diet. The freshness of fish is highly valued by consumers due to its close relationship with both flavor and health. Therefore, a direct and cost-effective approach for determining the cleanliness of fish is highly demanded [6]. The Support Vector Machine (SVM) algorithm is the classification and training model. Since it employs a machine learning (ML) algorithm to translate the input and then looks for the optimal boundary between expected outputs, this method saves classification time but demonstrates less accuracy [7]. Artificial Neural Networks (ANN) were developed to categorize fish photos based on their freshness and to identify various types of fish. Backpropagation will be used to train the ANN to generate the required outcomes [8]. However, it does not produce reliable categorised output, making prediction challenging. Convolutional Neural Network (CNN) has a number of significant benefits over other approaches, including the ability to do in-situ estimation and the non-discriminatory nature of the algorithm [9]. However, it only supports a limited amount of data and does not provide extensive accuracy. In addition, CNN is trained using VGG-16 to get precise features for enhanced prediction accuracy, but it does not solve overfitting difficulties [10].

To address the aforementioned flaws, the proposed work employs CNN classification that has been trained using VGG-19. Our proposed technique, termed as CNN-BiLSTM, employs a hybrid deep convolution-recurrent network for reliable identification of fish freshness. The convolution layer retrieves mid-level picture characteristics, while the BiLSTM layer removes spatial correlation from the middle level image. Finally the classifier classifies the output.

2. PROPOSED SYSTEM

Two classes- fresh and unfresh have been utilized in the proposed approach. The fresh fish is distinguished by its vivid, black eyes, white skin, and undamaged fins when the fish’s skin is examined. On the other hand, grey discoloration in eyes, red skin, and a bloated abdomen are signs of non-fresh fish. In essence, two distinct data categories have been developed in response to this alteration in eyes. Figure 1 displays the proposed method block diagram.maximum tardiness and number of tardy job.

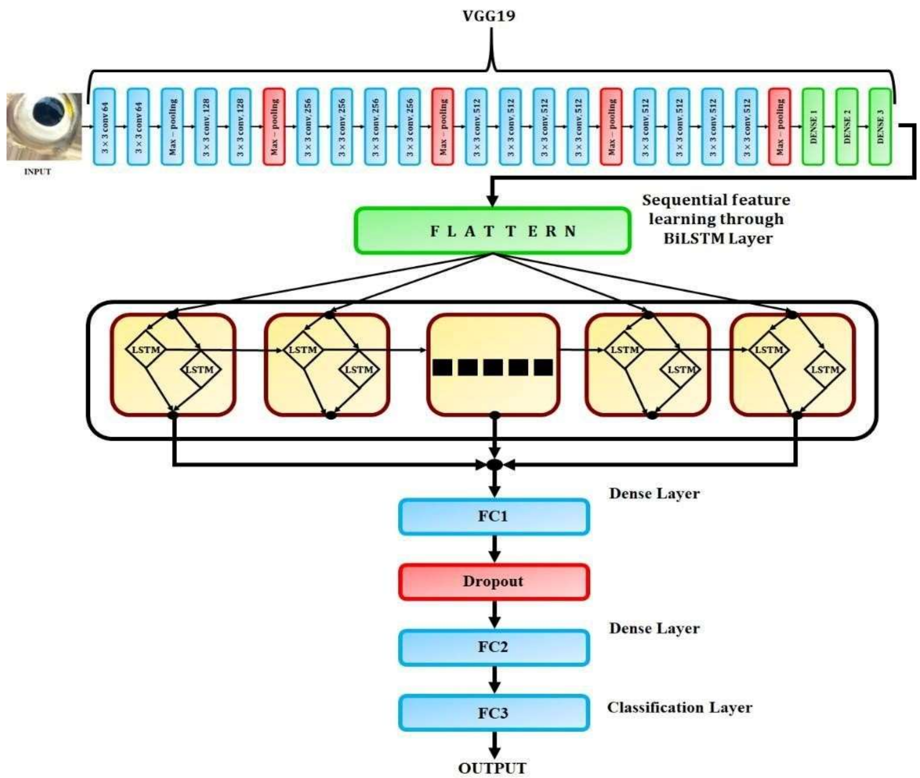

Fig.1. Architecture of Proposed Work

A set of RGB photos is often utilized as the method’s input since it employs a deep convolutional network with BiLSTM. It considers many variables. A lot of data is required for the network to train effectively. The network would not be trained adequately, and the risk of overfitting might arise otherwise. A total of 40 images with a resolution of 6000 x 3375 pixels were used. All of these RGB images in the JPEG format are then downsized to 224 x 224 pixels. To assess the freshness of fish, the CNN-BiLSTM hybrid model has been proposed. The VGG19 architecture is used as a deep convolutional network to extract the intermediate contextual

features. BiLSTM layers extract spatial dependencies among mid-level image models. Subsequently, dropout and Three Fully Connected (FC) layers are used. In order to retrieve output from the BiLSTM layer, the first two completely linked layers function as a dense layer. These two layers determine how to represent an image globally. Utilizing the Softmax function, the third FC layer performs the classification function. Dropout is utilized to minimize the model’s overfitting issue.

2.1 Data preparation

The Kaggle dataset provides the photos that are used to detect fish freshness. There are forty photos in all in the collection, twenty of them feature fresh fish and the other twenty do not. SNI 01-2729.1-2006 states that immaculate corneas and large pupils characterise fresh fish with black eyes. In contrast, the pupil in non-fresh fish seems to be very foggy. Preprocessing involves resizing the image to 500 by 500 pixels and focusing on the fish eye's pupil after data collection. According to the information above, one can determine the freshness of the fish by looking at its pupil.

2.2 VGG-19 Architecture

A deep CNN termed VGG19, which is an improved version of VGG16, consists of numerous convolutional and max pooling layers known as feature extractors. Following these layers, there is at least one fully connected layer called the classifier. The sizes and counts of convolutional and fully linked layers are regarded as design decisions made by CNN's architect.

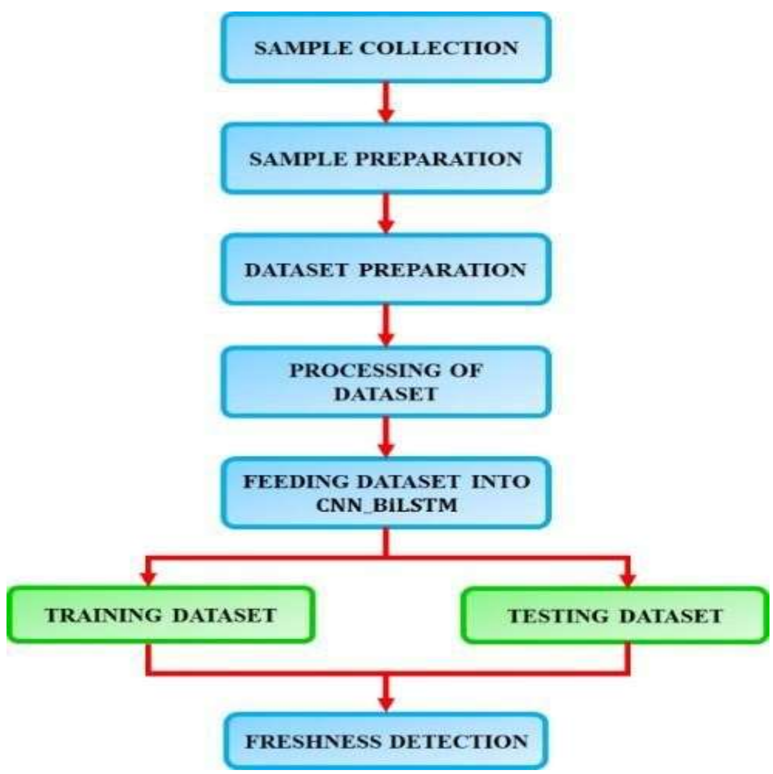

Fig.2. Flow Chart of Proposed Methodology

The output layer is replaced with a Softmax function which represents one of the types, with input layer size set to 64 by 64. It is simple to find the traits that distinguish fresh and unfresh fish without expending time manually, due to the autonomous feature extraction ability of VGG19. The classification of fish freshness is done using the VGG19 model. The block diagram shown in Figure 2 illustrates the phases that the suggested technique follows for determining fish freshness.

2.3 Bi-directional Long Short Term Memory

It is relatively simple to obtain a mid-level image utilizing convolutional networks. However, it cannot identify spatial dependencies among images. Therefore, to extract additional information from the same sequence, a bidirectional RNN is investigated. A BiLSTM is deployed in the feature extraction phase of the suggested framework, assuming that a full gait cycle is given as input. The BiLSTM network processes the sequence of flattened spatial characteristics that were produced by CNN. The input sequence is sent through LSTM cells in each of the two LSTM networks, and each of these cells acquires one spatial feature vector. The LSTM architecture maintains a long-term memory while sharing a cell state to simplify information flow along the entire chain.

2.4 Classifier

All input networks were trained to output neurons in dense layers, similar to conventional neural networks. These layers derive spatial learning features from image labels. In order to diminish the model’s overfitting issue, a dropout layer is implemented. In the initial two dense layers, the ReLU function is implemented. In the final dense layer, the Softmax activation function is utilised to categorise the data as fresh or not.

3 PERFORMANCEEVALUATION

For each class in the model, a confusion matrix employing 40 test datasets is established. In accordance with the confusion matrix, 13 test datasets for the new class were classified appropriately whereas for the non-fresh data set, it is observed that all 6 test datasets were accurately classified except for 1 test dataset. Figure 3 demonstrates the confusion matrix.

Fig.3. Confusion Matrix with 40 Iteration

Based on the confusion matrix, the model displayed a satisfactory performance. However, in order to determine whether our model can be improved, it is required to examine different assessment criteria. Typically, classification accuracy is administered to assess a model's performance. But in this case, it is combined with other criteria. These include classification error, F1 score,recall,precision and specificity.

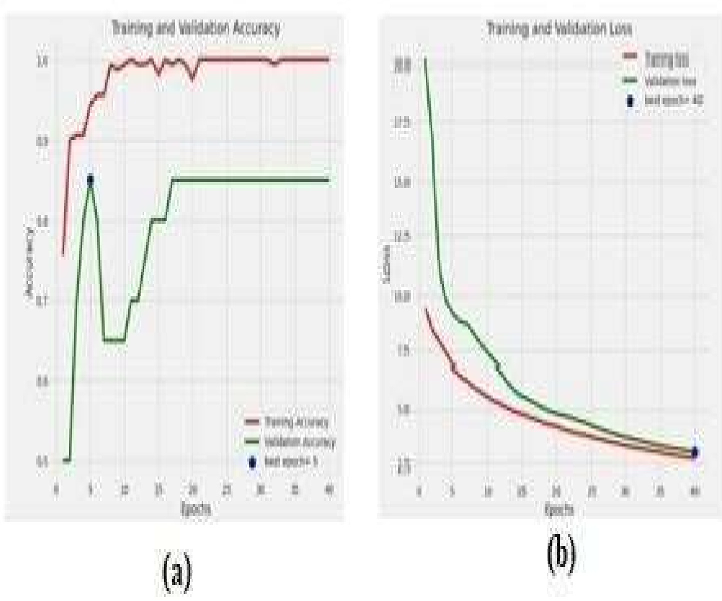

Fig.4. (a) Accuracy of the Model (b) Loss of the Model

The model is trained for 40 epochs from a batch of 100, in which the proposed model achieves 99% training accuracy with 95% success in testing as shown in Figure 4(a). The validation loss shown in Figure 4(b), specifies that the proposed model fits well for classification in generating valid and reliable results. The classification report shown in Figure 5, illustrates that the proposed system effectively classifies with an improved accuracy.

Classification Report:

	precision	recall	f1-score	support
fresh	0.88	1.00	0.93	7
non-fresh	1.00	0.92	0.96	13
accuracy			0.95	20
macro avg	0.94	0.96	0.95	20
weighted avg	0.96	0.95	0.95	20

Fig.5. Classification Report

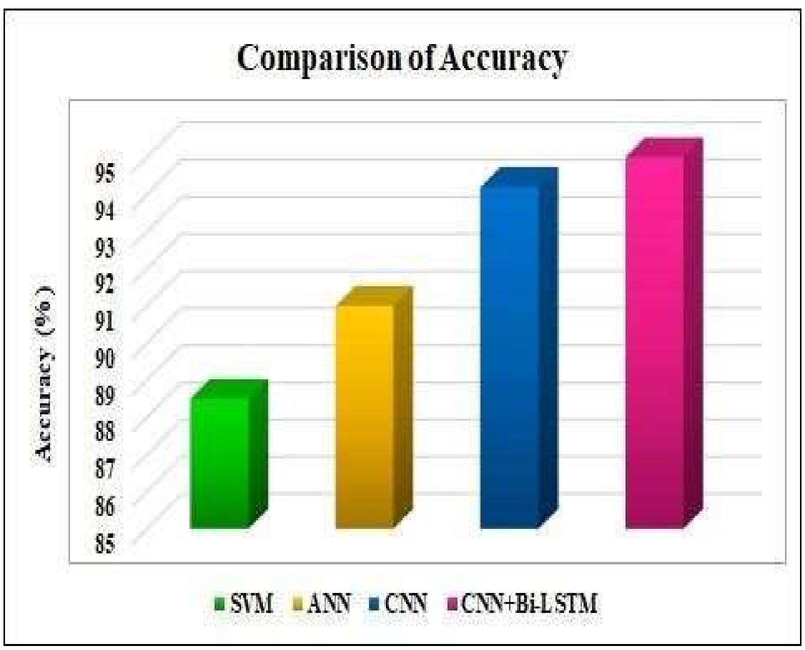

Fig.6. Accuracy Comparison

From the accuracy comparison depicted in Figure 6, it is demonstrated that the proposed CNN based Bi-LSTM shows improved accuracy of 95% in comparison to other classifiers.

4 CONCLUSION

A CNN-BiLSTM model for fish freshness classification has been put out in the study. The model was created using the data that was gathered, and it was then trained, verified, and tested using VGG-19 at various stages. MATLAB Simulink was used to test the suggested system findings and provide improved categorization outcomes. Compared to other traditional models, the suggested CNN-BiLSTM model has a high classification accuracy of 95%. The suggested approach aids in minimising quality loss and offers feedback to enterprises to help them alleviate waste and health risks.

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