

## Development of an AI-Based Non-Destructive Fish Freshness Detection [Fish Snap] and Quality Classification System Using Deep Learning

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### Abstract

Fish freshness evaluation is critical for maintaining seafood quality, consumer safety, and reducing post-harvest losses in the aquaculture sector. Conventional freshness assessment methods rely on sensory evaluation, biochemical tests, and laboratory-based analysis, which are time-consuming and require skilled personnel. This monograph presents **FishSnap**, an artificial intelligence-based mobile application developed for real-time fish freshness detection using deep learning image classification. The system classifies fish samples into three categories: Fresh, Moderately Fresh, and Spoiled. The model was optimized using TensorFlow Lite for mobile deployment, ensuring fast and accurate predictions. The study demonstrates the potential of AI-driven non-destructive methods in fisheries quality control and digital aquaculture transformation.

### 1. Introduction & Background

In many parts of the world, including India, seafood is a major source of nutrition and livelihood. However, ensuring **fish quality and freshness** remains a challenge for consumers, vendors, and food safety authorities. Fish quality deteriorates rapidly after death due to biochemical processes like enzymatic decomposition and microbial growth. Standard methods for assessing fish freshness involve sensory evaluation (smell, texture, color), chemical tests, and laboratory analysis — but these require expertise, time, or expensive equipment. (Hamidy *et al.*)



The **Fish Freshness Detection App** is a **Streamlit-based web application** designed to bridge this gap by providing a **fast, accessible, and user-friendly AI-powered tool** for

assessing fish freshness through images (Tomas *et al*). By leveraging computer vision and machine learning techniques, the app allows users to upload a fish image and receive a **quality prediction output** — helping them make informed decisions about consumption, purchasing, or storage. This approach democratizes fish quality assessment and promotes food safety in both domestic and commercial contexts.

The app was developed using the open-source Python framework **Streamlit**, which enables rapid deployment of data science and machine learning models into interactive web applications without requiring front-end expertise (Widyatama & Wibowo)

## 2. Problem Statement & Motivation

### 2.1 The Challenge of Assessing Fish Freshness

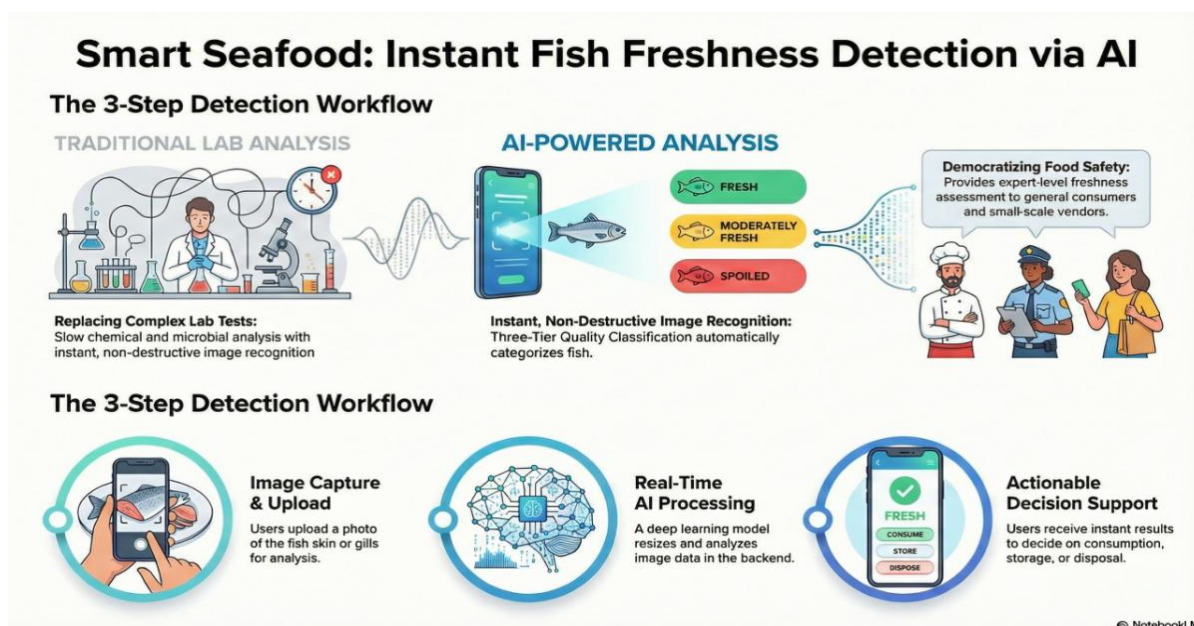
Freshness is the primary indicator of fish quality and safety. Traditional assessment methods include:

- **Sensory evaluation:** Trained experts detect texture, smell, and appearance.
- **Chemical testing:** Measures compounds like trimethylamine (TMA), total volatile basic nitrogen (TVB-N), and pH.
- **Microbial analysis:** Uses lab culture methods to detect spoilage organisms. (Helmud *et al*)

While effective, these methods are often:

- **Time-consuming**
- **Require equipment or expertise**
- **Inaccessible to general consumers**
- **Not scalable for small vendors** (Mahendra & Faurina)

### 2.2 Motivation for an AI-Based Solution



The motivation behind this app is to:

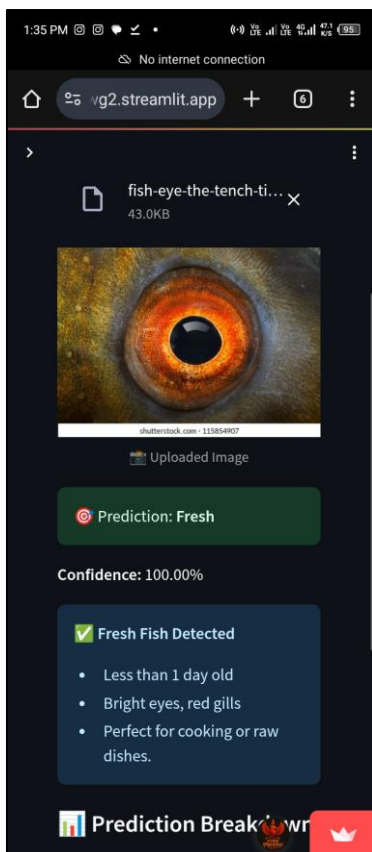
- **Provide instant feedback** on fish freshness.
- **Reduce food waste** by helping users avoid discarding good fish unnecessarily.
- **Improve food safety** by identifying potentially spoiled fish.
- **Utilize modern AI capabilities** in an accessible Python web app.
- **Enable scalability** without heavy infrastructure requirements. (Saputra *et al*)

In regions where seafood is abundant and widely consumed, such as coastal India, easy access to freshness evaluation can significantly impact public health and economic outcomes.

### 3. App Description & Features

#### 3.1 Core Purpose

The primary purpose of the app is to **allow users to upload an image of a fish** and receive a **real-time prediction** of its freshness level using a trained machine

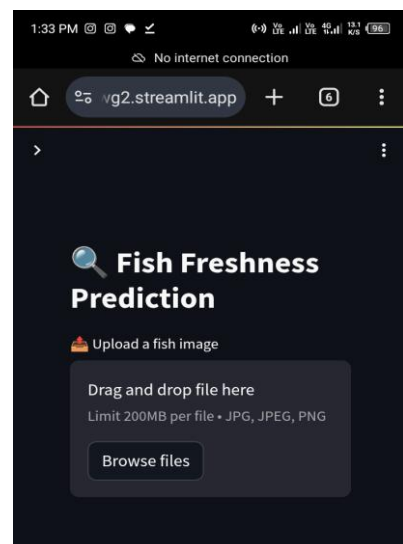
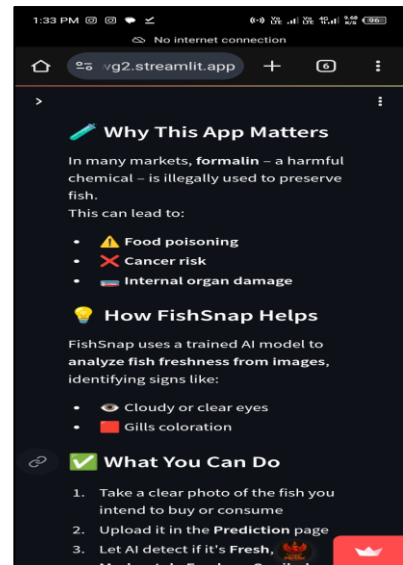


learning model.(Hoang *et al*) The app outputs a clear classification (e.g., “Fresh,” “Moderately Fresh,” “Spoiled”), which assists users in making consumption decisions.(Hoang *et al*)

#### 3.2 Features

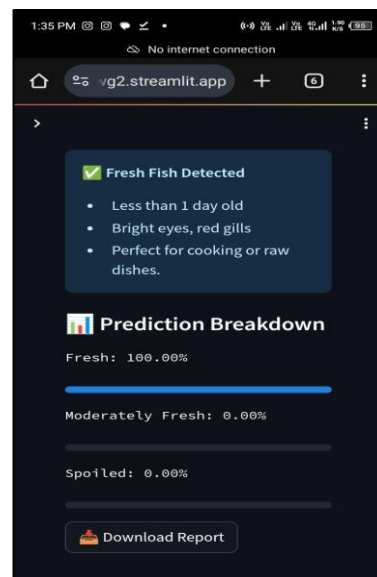
The Fish Freshness Detection App includes the following key features:

- **Image Upload and Processing:** Users can upload fish images from their device to be analyzed. (Alternatively, use camera input if available).
- **Machine Learning Prediction:** The app runs a trained image classification model in the backend to assess the fish quality. (Franceschelli *et al*)



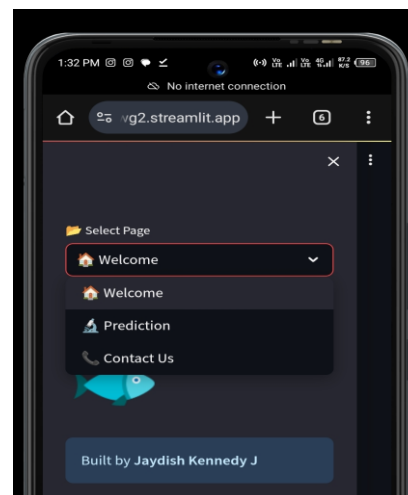
- **Clear Output Display:** Results are presented in an easy-to-understand format with class labels and possible explanations.
- **User Guidance:** The interface may include tips on how to capture good quality images (e.g., good lighting and clear view of the fish skin/gills).
- **Responsive UI:** Built with Streamlit, the interface updates interactively without page reloads.

These features mirror best practices for app descriptions — highlighting what the app *does* and *why it matters* rather than simply listing all code details.(Prabhakar *et al*)



### 3.3 Technical Stack

- **Python:** Core programming language.
- **Streamlit:** Front-end interface framework for deploying ML apps in Python.(Khoshnoudi-Nia *et al*)
- **Machine Learning Model:** A classification model (e.g., TensorFlow, Keras) trained on labeled fish images.
- **Image Preprocessing:** Resizing, normalization, and augmentation used during model training.?(Kim *et al*)
- **Hosting & Deployment:** Streamlit Community Cloud or similar hosting service.



### 4. Working Workflow

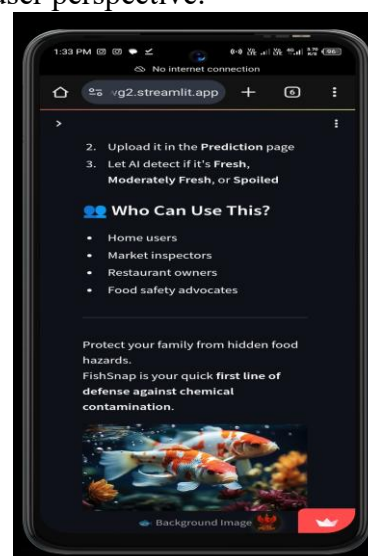
The following steps outline how the app works from a user perspective:

#### Step 1: Open the App

The user loads the web app in a browser. The landing page welcomes the user and explains the purpose of the system.

#### Step 2: Upload Image

The user uploads a photo of the fish using the upload button. The app validates the file type and ensures the image quality meets minimum standards (e.g., correct lighting and focus).



### Step 3: Model Analysis

Once the image is submitted, the machine learning model processes it in real time. Internally, image data passes through preprocessing layers (resize, normalize, etc.) before entering the prediction pipeline.

### Step 4: Display Results

The app displays the prediction class — such as “Fresh,” “Moderately Fresh,” or “Spoiled.” Optional confidence scores or graphical indicators can be shown to help users interpret the results.

### Step 5: Interpret and Act

The user interprets the results and decides whether the fish is safe to consume or requires immediate processing or disposal.

This workflow is similar to real academic and commercial systems designed for quality detection and freshness assessment using images

## 5. Benefits & Impact

### 5.1 For Consumers

- **Instant Assessment:** Quick determination of whether fish is fresh enough to eat.
- **Cost-Effective:** No need for lab tests or expert evaluation.

### 5.2 For Vendors and Small Businesses

- **Quality Control:** Enables sellers to ensure consistent quality for customers.
- **Trust Building:** Clear quality indicators can increase customer confidence.

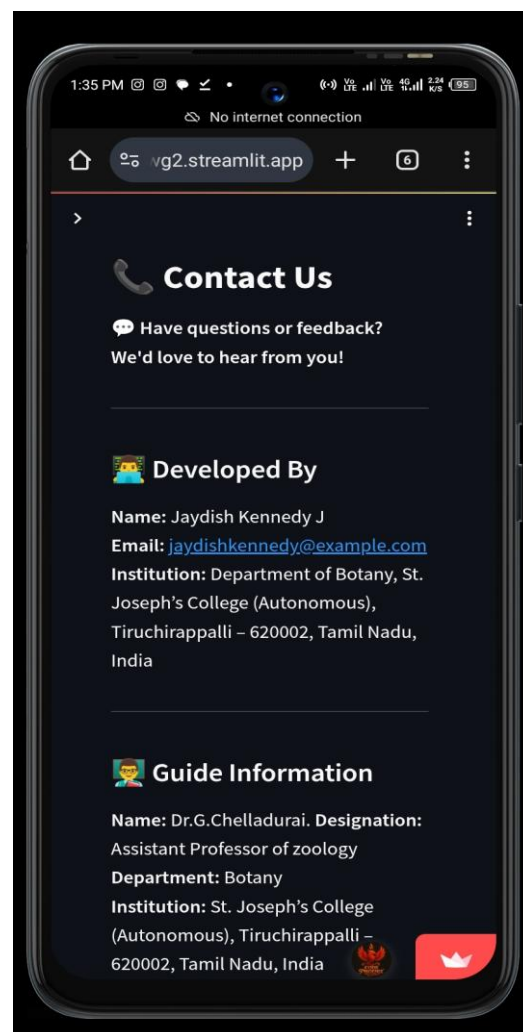
### 5.3 For Food Safety and Public Health

- **Prevents Illness:** Helps avoid consumption of spoiled fish that may cause health issues.
- **Awareness:** Educates users on factors affecting fish quality.

By focusing on value and benefits instead of only features — a recommended strategy for effective app descriptions — the app tells a story about how it improves user life, not just what it does. (Cho *et al.*)

## 6. Future Enhancements

The app establishes a foundation for future improvements, such as:



- **Mobile Camera Integration:** Enabling direct capture rather than upload.
- **Multi-Language Support:** Making the app accessible in local languages.
- **Expanded Dataset for Improved Accuracy:** Including more fish species and conditions.
- **Interactive Usage History:** Allowing users to save past predictions. (Kundu *et al*)
- **Nutritional Advice & Preservation Tips:** Adding contextual food safety guidance.

These enhancements will make the system more versatile and user-centric. (Kumaravel *et al*)

## 7. Conclusion

The **Fish Freshness Detection App** is a practical, intelligent, and accessible tool that brings **machine learning-based quality prediction** to everyday users through a simple web interface. It bridges the gap between complex scientific methods and real-world needs by putting actionable insights in the hands of consumers, vendors, and food safety advocates.

Through its intuitive workflow, real-time predictions, and clear interfaces, this app stands as an example of how AI and data science can contribute meaningfully to **food safety, waste reduction, and health awareness**.

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