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Fruit Freshness Detection Using IOT And Deep Learning

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Abstract: Automating fruit classification with computer vision is a promising application in agriculture. Traditional methods relyon manual visual inspection, which can be tedious, time-consuming, and inconsistent. Typically, fruit classification has been basedon their outer shape. However, recent advancements in computer vision and imaging technologies have proven to be more effectivein the fruit industry, particularly for quality control in terms of color, size, and shape. Research indicates that machine vision systems can enhance product quality and reduce the need for manual sorting. This article explores various imaging techniques used in fruit classification. Fruits and vegetables are crucial sources of nutrition worldwide. As the global population grows, agricultural enterprises aim to minimize product losses and improve quality and productivity. Therefore, farmers are increasingly adopting advanced technologies for sustainable, eco-friendly, and efficient agriculture. Intelligent agriculture, focusing on early detection and disease control, is a key research area in the fruit sector. Precision agriculture, which integrates technologies such as machine learning, deep learning, and the Internet of Things (IoT), is transforming the industry. Current research primarily investigates the impact of these technologies on specific fruit and vegetable species.

KEYWORDS:

Deep Learning, IOT, Open CV, Image Processing, Machine Learning.

I. INTRODUCTION

Fruits and vegetables are an important part of the daily diet. With the increase in cases of diseases in modern times, people are becoming more curious and cautious about natural and organic products, especially fruits and vegetables. Among them, people paymuch attention to the freshness of the fruits they eat. Therefore, this indicates the need to determine the quality of the fruit, as it hasbeen proven to affect human health.

Machine vision system for the classification of fruits is one of the current topics of agricultural research. As part of the current field of research, a classification of these fruits has been developed using image processing techniques. This fruit collection can beused to identify fruits and automatically calculate prices in stores or supermarkets. The initial step of this proposed method is to classify 7 fruits. When the vision of automation machines that classify different kinds of fruits and vegetables is removed, farmerswill also benefit.

This article analyzes a safe and economical way to monitor the freshness of fruit depending on its size, shape and color. The examination of the fruit should be carried out in a harmless way, since it is a very fragile material. The size of the fruit, its main physical characteristic is its color, which gives it visual properties. Therefore, the classification of freshness of fruits is very important in order to increase the market share and set high quality standards. If the classification and sorting is done by hand, the process canbe slow and sometimes full of errors. Humans classify the freshness of fruits on the basis of color, size, etc. Mapping these qualitymetrics into an automated system using appropriate programming languages will make it faster and without errors. This will speedup the process of sorting fruits and reduce costs. Recently, machine learning technology has been found to be very useful in the application of fruit industry, mainly in the detection of freshness of fruit.

This method will help to choose the right fruit and will teach us about the properties of a particular fruit. These conditions willhelp us educate our children and get used to their benefits. In addition, robots can use these methods to teach their users how to findthe right fruit, which is very important for robots used in tasks related to fruit harvesting. Another important application of fruit detection and recognition is the smart refrigerator. Nowadays, the smart refrigerator allows you to understand how fresh the fruit is,what kind of fruit is left, what fruits are in limited quantities and what should be included in the shopping list. As people have moreaccess to health information, we often find that healthy eating recommendations are much needed. When shopping, an automated fruit classification system linked to an information database enables consumers to choose healthy fruits with nutritional details. In addition, super stores have recently used these systems to provide customers with information about each type of fruit, to track salesand stock products, and to identify the most in-demand fruit products. Even online shopping sites can use this type of automation method very easily. All these tasks require appropriate fruit identification and recognition system.

A. Causes of loss of freshness of fruits

The main reason for this is the damage to the cell walls of the fruits several days after harvesting. As a result, the fruit ripens very quickly. Some important factors like wind, moisture, light and microbial growth cause the fruits to spoil. They also contribute to the deterioration of the cell wall of the fruit. It is generally accepted that the effect of microbes is the main reason for the easy spoilage of fruits. Microorganisms such as bacteria, yeast, and mold essentially need water and nutrients for their existence. Fruitscontain 90 percent of these essential elements, which facilitates microbial activity, and the fruits break down and spoil very quickly.Destroying the necessary nutrients in the fruit. When the fruits are damaged, it activates the enzyme that is naturally present in thefruits and accelerates the decay. This process is greatly accelerated when they are exposed to light as their outer layers begin to degrade. This process is commonly known as photo transformation, which causes discoloration, loss of taste, and nutrients from the fruit. Fruits can be recognized as rotten when they show discoloration, stains, thin stains, an unpleasant smell or taste. The temperature also determines the food. Excessive temperature (hot or cold) can affect the spoilage of fruits. If fresh fruits are frozen,they freeze the plant cells and turn them into ice crystals, causing the cell walls to expand and form a discolored, thin structure andappearance.

B. Effects of contaminated fruit on human health

Consuming contaminated food can lead to many diseases. Various microorganisms or pathogens that cause the disease can damagethe berries. They can also bring health to humans. Contamination of water, soil, dust, animals or birds, contaminants and foods by re-production or preparation by consumers. Indigestion, diarrhea, abdominal cramps, pain, heat exhaustion, constipation and colic are some of the diseases caused by the consumption of fruits. Every person has a lot of diseases caused by diet, not because of the loss of fruit or its repetition, but because some people overeat. People suffering from AIDS, cancer, parental problems or various types of serious diseases are at a higher risk. They are also at risk for the diseases described above.

II. OBJECTIVES

- Provide healthy food to people.
- Establish a safe food supply system.
- Improve accuracy in identifying freshness of fruits.
- Creation of an automated system to detect freshness of fruits.
- Diagnosis of diseases caused by eating rotten fruits.

III. DESIGN

The primary goal of the project is to develop a new prototype that highlights the significance of fruit. Currently, many people do not consider the importance of the fruits and trees they consume. This prototype incorporates various sensors, including a camera, load cell, and gas sensor, to enhance understanding and analysis.

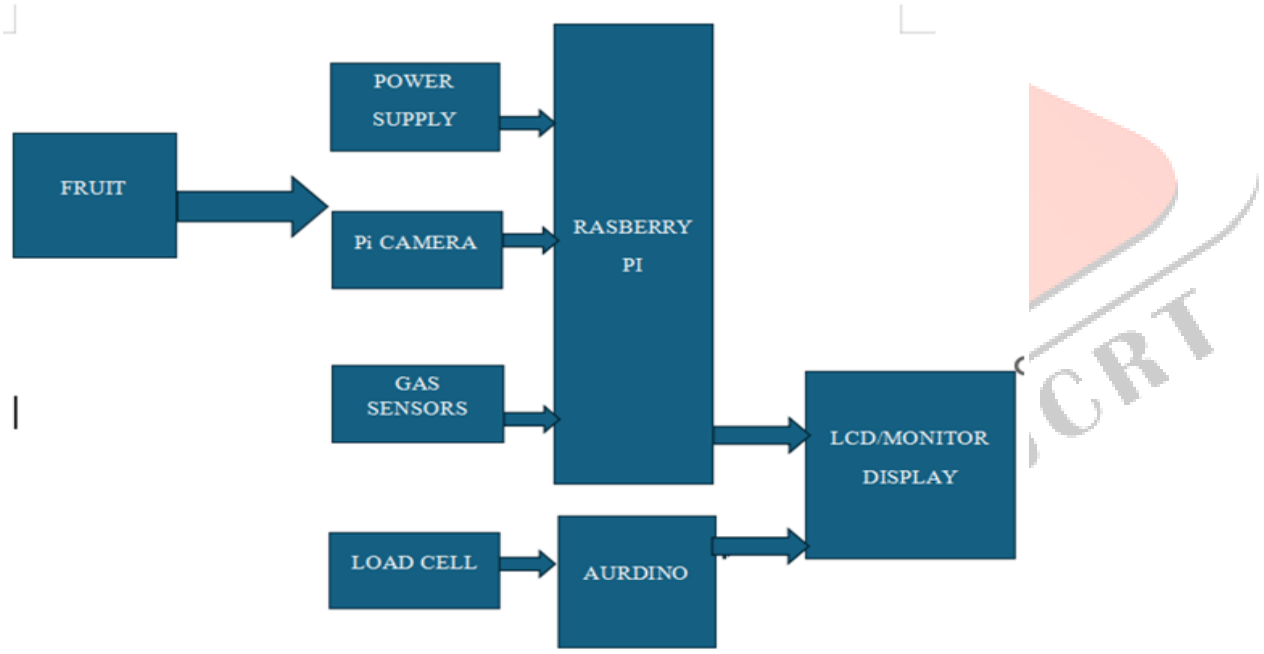
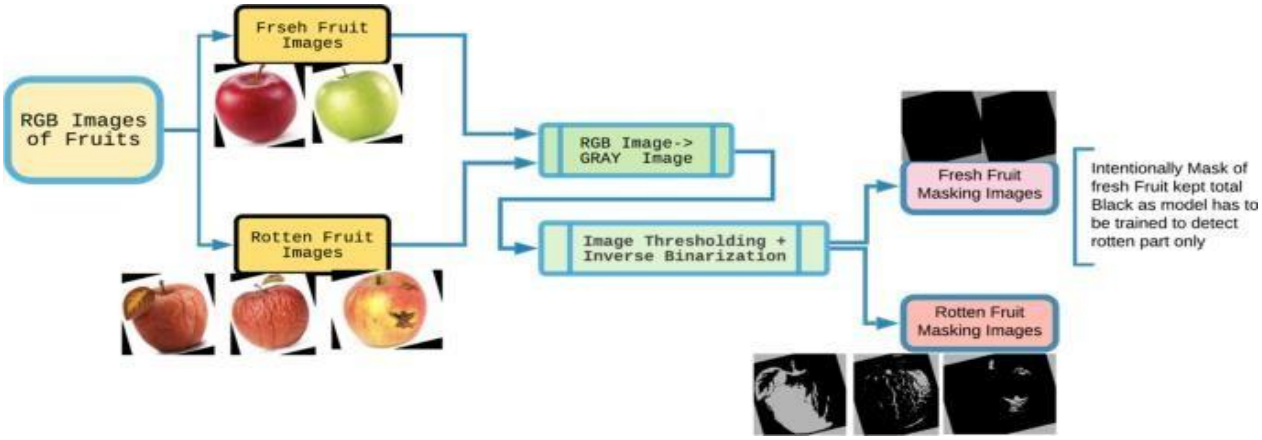
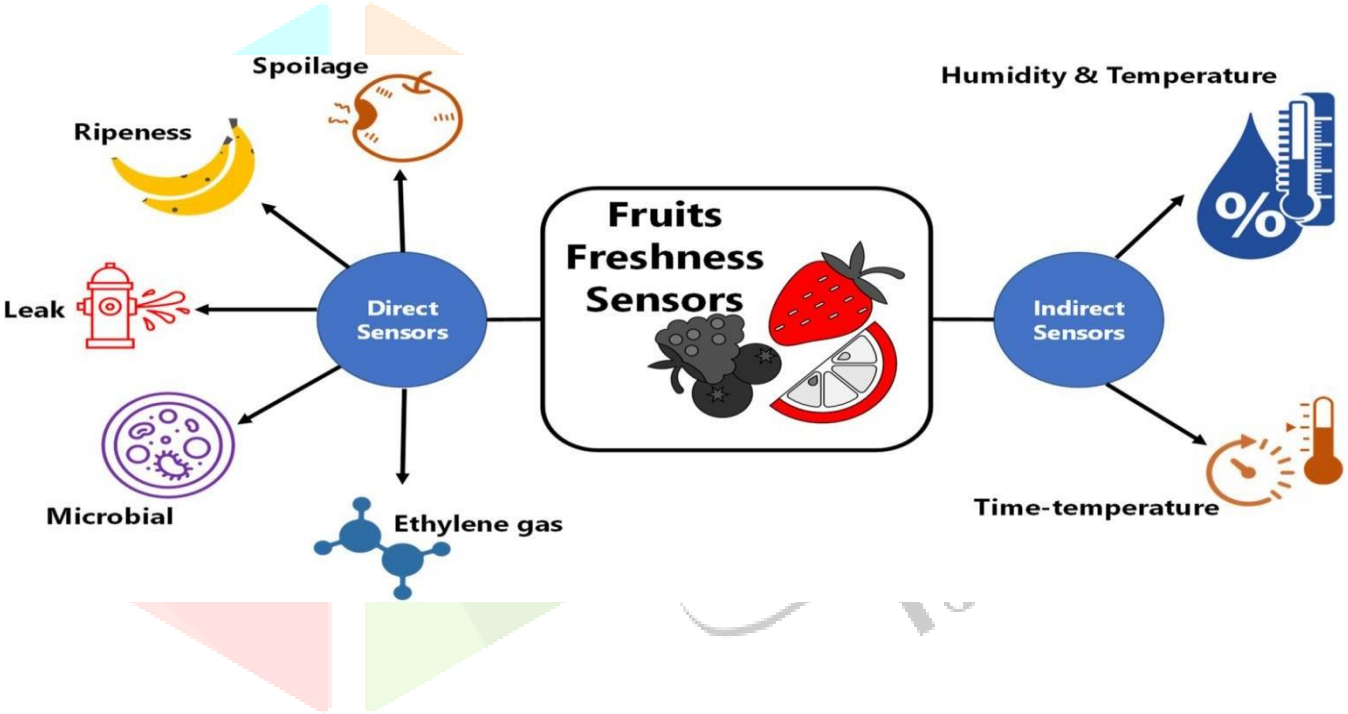


Figure 1. System Architecture

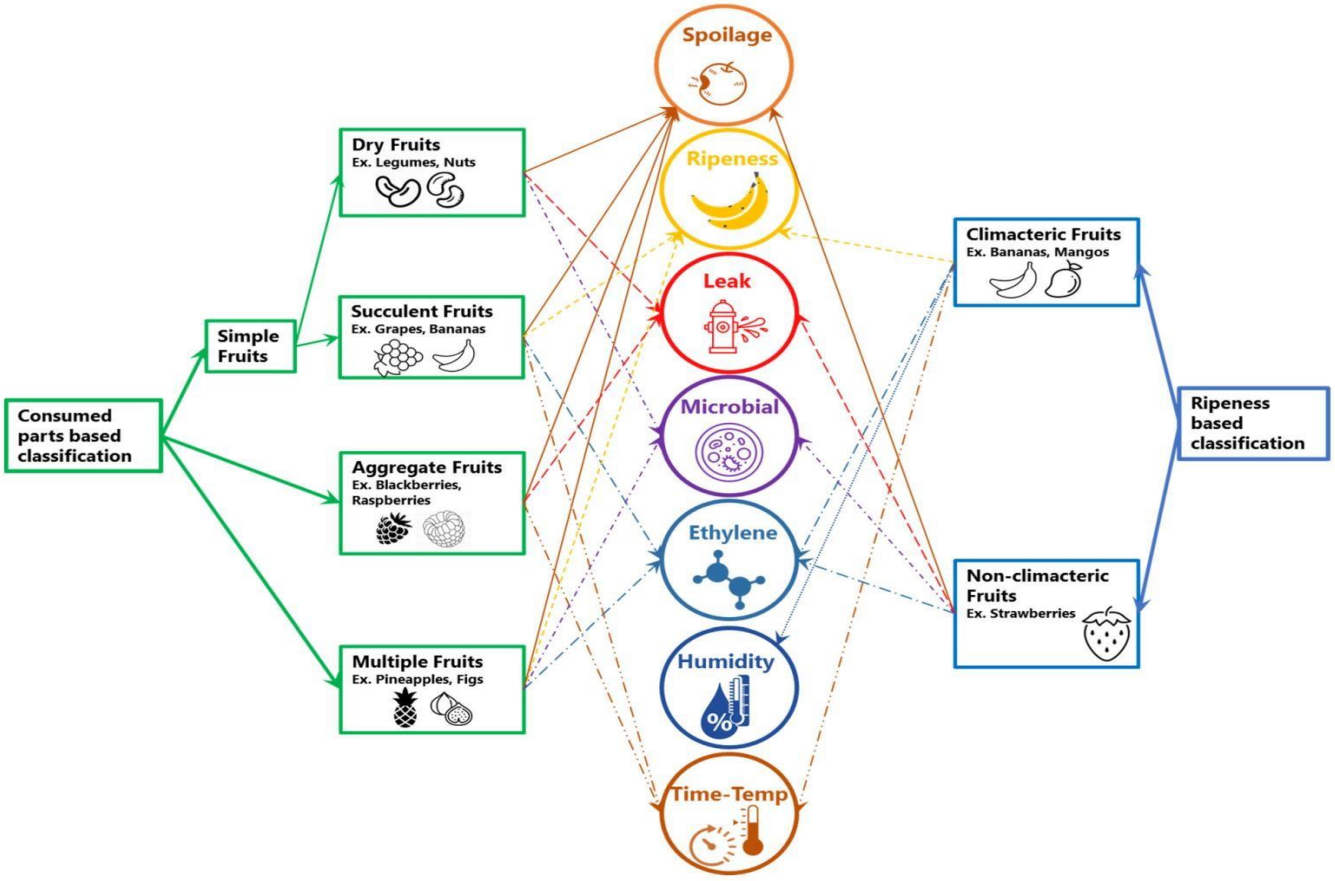
A. Detailed Design



B. High Level Design



C. **Low Level Design**



IV.METHODOLOGY

This review paper aims to conduct a comprehensive survey of existing Machine Learning, Deep Learning, And Internet of Things(IoT) approaches that are based on diagnosing and monitoring diseases in various types of fruits and vegetables. The research follows a systematic methodology to ensure transparency and unbiased selection of information, culminating in the identificationof eligible research papers.

The methodology is structured as follows:

Research Questions and Motivation

The study begins by formulating research questions and identifying the motivations behind them. This step helps in guiding thescope and direction of the survey, ensuring that it addresses relevant and significant aspects of fruit and vegetable disease detection.

System Implementation

The implementation is carried out on a Deep Learning 0W board running the Raspbian OS. The process initiates by capturing animage of the fruit or vegetable, which is then processed using OpenCV. This processing stage involves extracting key features such as color, shape, and size of the fruit samples.

Image Processing with OpenCV:

OpenCV is employed to detect the shape, size, and the fruit's color. The combined analysis of these features yields promising results in determining the condition of the fruit.

The captured image is segmented utilizing edge detection algorithms to identify any defects in the fruit. This segmentation helpsin isolating the defective areas from the healthy parts.

Load Cell Integration

A load cell is utilized for measuring the weight of the fruit samples. This weight measurement is a critical parameter in assessingthe freshness of the fruit. The program controlling the load cell is deployed on an Arduino board, which reads and averages the weights of the samples. This data is then used to help determine the fruit's freshness.

Gas Sensor Utilization

A gas sensor is included to identify any gases that might be present or applied to the fruit. The detection of specific gases can indicate spoilage or chemical treatment, impacting the fruit's freshness.

Freshness Calculation And Display

The system determines the freshness percentage for various fruits based on the collected data (color, shape, size, weight, and gaspresence). These freshness percentages are then displayed on a monitor, providing a clear and immediate understanding of the fruit's condition

V. Implementation

The implementation of fruit freshness detection system is divided into the following major modules.

- Data collection
- ML instruction creation and training
- Evaluation of the predictive effect of fruit freshness

❖ **Module description**

➢ **Data collection**

This module collects information from the Central Food Security website. This data covers variousaspects related to fruit freshness and is used to train our machine learning model.

➢ **Construction and Training ML Instructions**

We train the model using some machine learning algorithms in the data set. In particular, we use K-Nearest Neighbors (KNN) logistics regression and support vector machines. (SVM).

➢ **Prediction of fruit freshness**

In this module, the properties of the fruit are extracted from the image and determines whether thefruit is fresh or rotten. Image processing techniques are used to analyze the different properties of fruits.

➢ **Classification**

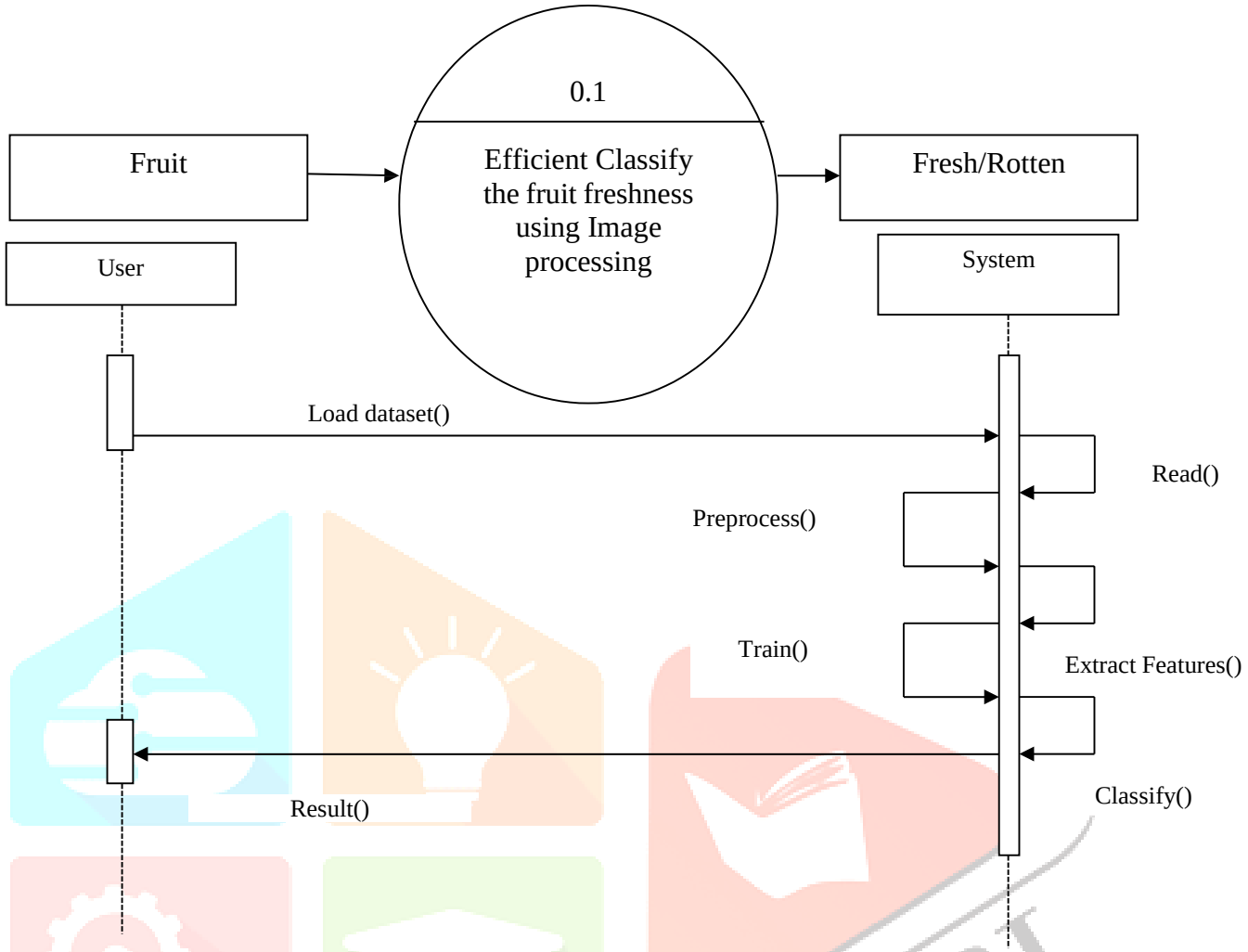
Using trained machine learning models, the system predicts whether the results are safe (new) orcorrupt. This classification is based on features extracted from the previous module.

❖ **Algorithms**

To improve the accuracy of fruit detection and classification, implement a material detection system basedon YOLO (you only see once). This innovative technology allows you to find the fruit of the image precisely in real time.

After the fruits are discovered, we use imaging technology to classify them as safe (fresh) or fermented. This is to analyze the color, texture, and shape characteristics derived from the image of the fruit. To run these classifications, use the Machine Learning model trained in the previous module.

VI. Sequence Diagram



VII. Test cases

Test Case 1	TC01
Test Name	User input format
Test Description	To test user input values
Input	Dataset as input
Expected Output	The file should read and display path
Actual Output	The file read and displayed path
Test Result 1	Success

Test Case 2	UTC02
Test Name	User input format
Test Description	To test user input values
Input	Dataset as null
Expected Output	Show alert messages select dataset
Actual Output	Shown alert messages select dataset
Test Result 2	Success

Test Case 3	UTC03
Test Name	User input test
Test Description	To test user input values
Input	Input as image
Expected Output	The file should read and display path
Actual Output	The file should read and display path
Test Result 3	Success

Test Case 4	UTC04
Test Name	Violation Detection
Test Description	To test whether its detecting the fruit freshness or not
Input	Fruit image
Expected Output	ItDetects home based on based on the historical data using the YOLOv3 model.
Actual Output	It successfully detects fruit freshness on the historical data using the Yolov3 model.
Test Result 4	Success

Test Case 5	UTC05
Test Name	Test case for importing valid python libraries
Test Description	To test whether an algorithm to implement congestion nodes works without sklearnand keras models
Input	Import all valid libraries sklearn, scikit-image,opencv, imutils and keras libraries
Expected Output	An error should be thrown specifying “error importing libraries sklearn, sklearn, scikit-image,opencv, imutils ,keras libraries”
Actual Output	An error is thrown

VIII. CONCLUSION

This method proves effective as it automatically presents the complete status of fruits and vegetables before consumption. Consumers can select produce based on their specific requirements, thereby potentially reducing food waste and contributing to a cleaner environment with less pollution. It provide real-time monitoring, predictive analytics, and automated alerts, enhancing supply chain efficiency, reducing waste, and ensuring food safety. As the prevalence of diseases has increased in modern times, people havebecome more aware of natural and organic food. Therefore, people pay more attention to the freshness of the fruits they consume. Currently, several methods are used to detect the freshness of fruits. However, most of them are time-consuming and unreliable.Sothe aim of this study is to propose a project that uses the latest information technology and sensor technology to solve these types of problems as a sustainable solution. The proposed method in this study is to predict the freshness of fruits by observing carbon dioxide emissions, water vapor release, and O2 absorption after fruit harvesting. Two fruit types, papaya and watermelon, were selected fromthree weight groups to collect data for this study. (500g -1kg, 1kg-1.5kg, 1.5kg-2kg). Carbon dioxide emissions, hydrogen emissions, and O2 absorption are measured on four selected days, including

the day of harvest, three days after harvest, one week after, and twoweeks after, to monitor changes in these three factors (CO2, O2, and humidity).

Sensor technology has been used with Arduino to measure the differences between the above factors. In addition, web technologies such as HTML and PHP are used. A database was developed using MySQL to store the collected data. After collecting the data, the data was analyzed to find the results. The results of the analysis showed that O2 consumption gradually increases over time and therelease of water vapor gradually decreases. Using this criterion, a machine learning model was implemented for analysis. 80 percentof the collected data was used for model training and 20 percent for model validation. This model could be used to predict the freshness of the fruit. As Sri Lanka is a developing country, it is vital to conduct such low-cost research.As a result of this,No conclusion section is required. Although a conclusion may review the main points of the paper, do not transcribe the abstract as a conclusion. A conclusion can elaborate on the importance of the work or suggest applications and extensions.

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