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Monitoring Fresh Fruit and Food Using Iot and Machine Learning to Improve Food Safety and Quality

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Abstract
Consumer demands and expectations have an effect on the general quality of a good or service. Another way to describe "quality" is as the whole of all the characteristics that go into creating products and services that satisfy the consumer. Thanks to the efforts of importing nations, the quality of several imported goods has recently improved. By ensuring that imported food is secure for human consumption before it is released, it also protects food from other countries. This article discusses a method for keeping track of perishable commodities based on machine learning and Internet of Things. The suggested system involves taking pictures using high-resolution cameras and uploading them to a cloud server utilisingIoT devices. Before being uploaded to a cloud server, these photos are segmented using the K-means clustering algorithm. Following the extraction of attributes from the pictures using the principal component analysis approach, trained machine learning models are used to classify the images. This proposed approach makes use of Internet of Things, image processing, and machine learning to monitor perishable food.

Keywords- *IoT, Machine Learning(ML), Food safety, KNN, K-means,Naive Bayes.*

1. Introduction

As agriculture provides food for the populace, it is vital to the economy of the nation. This implies a connection and interdependence between all of the largest firms in the nation. If agriculture is the mainstay of a nation's economy and civilization, such nation is seen as wealthy. In great majority of nations, agriculture is the primary source of employment. Large farms may need to hire more people to maintain the plants and animals. The majority of these enormous farms produce and process their agricultural products in nearby processing plants[1-3].

IoT has been increasingly important in recent years for increasing productivity, improving operational efficiency, and simplifying the procedure. The Internet of Things is what the word "IoT" refers to. IoT, in its simplest form, refers to a network of sensors-equipped devices that can gather, process, and communicate information and commands[2,4,5,6]. IoT has expanded significantly over the past few years across a number of industries, including healthcare, manufacturing, transportation, and supply chain. When it comes to the food business, IoT has made a significant contribution to lowering costs, improving food quality, and minimising food waste[7,8].

IoT is the process of integrating artificial intelligence into technological objects like computers and smartphones. IoT is without a doubt the game's biggest boss[9,10]. IoT has demonstrated its importance in recent years in a variety of industries, including manufacturing, healthcare, mining, and even the military. The Internet of Things plays an almost unique role in the food and beverage sector[11,12,13,14].

A industry that the world needs to flourish with contemporary technologies is agriculture because of the exponential expansion in global population[15-20]. The food industries may greatly improve themselves with

the aid of IoT to guarantee improved food production quality, safety, logistics, and keep an eye on manufacturing costs[21-26], waste [27]reductions, and risk management[28-30].
There is no official definition of the food industry, but in simpler words, it may be described as a network of farmers[1,4,12,22] and a collection of different enterprises that feed the world's population with a variety of meals[31]. Three categories can be used to categorise the food industries:

- **Primary Food Industry:** These industry consists of converting agricultural foodstuffs into consumable measurable.Itinvolve of cleaning &processing food resources[12].
- **Secondary Food Industry:** These Industries, consumable food stuffs are transformed into eatable food items[22].
- **Tertiary:** They consists of preserved and frozen food items. E.g., frozen snacks & food stuffs.

Using nonlinear, time-dependent, and many unknown components, automated machine learning approaches[33-35] may be utilised to analyse the intricate relationship between the inputs and outputs of agricultural systems.
IOT-based and ML-based approach to monitor perishable goods is presented in this article. In the suggested paradigm, high-resolution cameras are used to take pictures initially, which are subsequently sent to a cloud server through IoT devices[18]. These Images are segmented on the cloud server using the K-means clustering technique. The principle component analysis technique then extracts characteristics. Following that, the photos are categorised using ML_machine learning predictions that have been learned. To monitor perishable food, the suggested strategy uses Internet of Things(IoT)[4-35], Image Processing(IP)[15,18,30], and Machine Learning(ML)[1-35].

2. Methodology

IoT and ML-based methodology for monitoring freshfood items is accessible in this section. In the suggested paradigm, photos are initially taken using high-resolution cameras and then sent to cloud server via IoT devices[20]. These photos are segmented on the cloud server using the K-means clustering technique. The PCA-principle component analysis technique then extracts characteristics. Following that, the photos are categorised using machine learning predictions that have been learned. Figure 1 displays the model's block diagram.

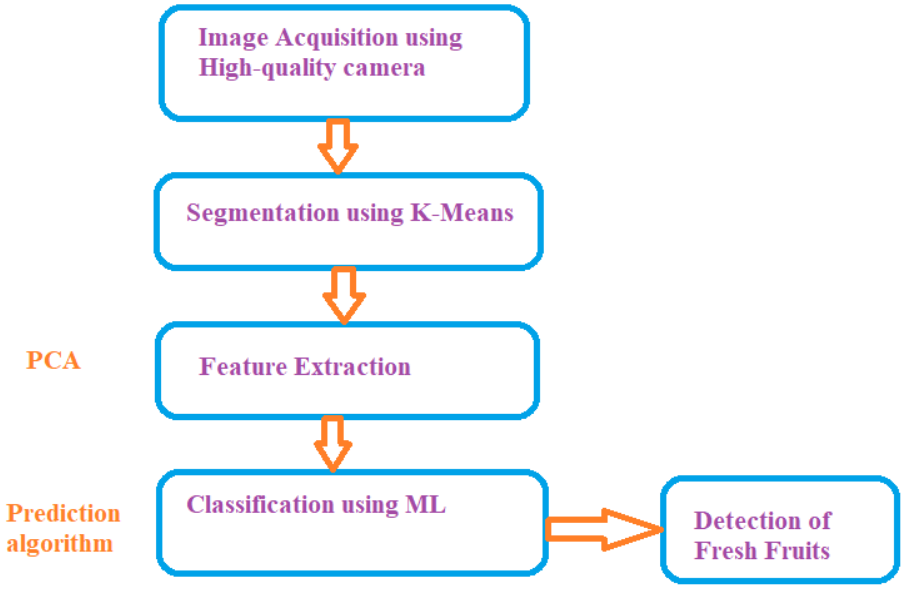

Figure 1-Model ofmonitoring fresh fruits & Food Items

Image Segmentation
Image segmentation is the process of locating and classifying elements of an image according to common traits. Region-based and edge-based segmentation methods are two different categories. Anatomical or functional aspects can be categorised into groups using region-based segmentation based on patterns in the intensity values around a cluster of nearby pixels[21].
K-Means Clustering-
To allocate each distinct observation to a K-means cluster, the local mean is used as a clustering pattern. The total number of groups indicated by the variable k is the basis on which this programme searches for data clusters. By computing squared Euclidean distances, on-the-fly data point closeness is calculated. According to

the qualities of the input, data points are assigned to one of the k categories. Using a similarity metric, data points are grouped.

Classifiers for Predictions-

- KNN's basic classifier- which makes use of the tuple that is closest to the unknown, is used to categorise classification data. It forecasts new instances using similarity metrics like the Euclidean distance, Manhattan distance, Pearson correlation, and others. The hammering distance must be established and standardised for categorical values using the numerical variables 1 and 0.
- Naive Bayes- A subset of Bayes' theorem is naive Bayes. It is a controlled, secure system. When creating a Naive Bayesian model, a simple approximation of iterative parameters is not necessary. The Bayes theorem, which considers the prior probability of P(c), P(x), and P(x|c), may be used to compute the posterior likelihood of P (c|x). In order to determine the posterior probability, a frequency table for the relevant attribute must first be created. The posterior likelihood for each group is then determined using a Naive Bayesian formula based on the frequency tables. The calculation's outcome is the category with the highest posterior likelihood.

3. Results and Discussions

High-resolution cameras are used to capture images, which are subsequently sent to a cloud server by IoT devices. These photos are segmented on the cloud server using the K-means clustering technique. The principal component analysis approach then extracts the features, and the pictures are then categorised using trained machine learning predictions.

Image segmentation is accomplished using the K-means clustering method. Then, KNN, and Naive Bayes machine learning methods are used to classify the fruit images. These algorithms establish the quality of a piece of fruit. In Figures 2-3, accuracy and sensitivity are displayed.

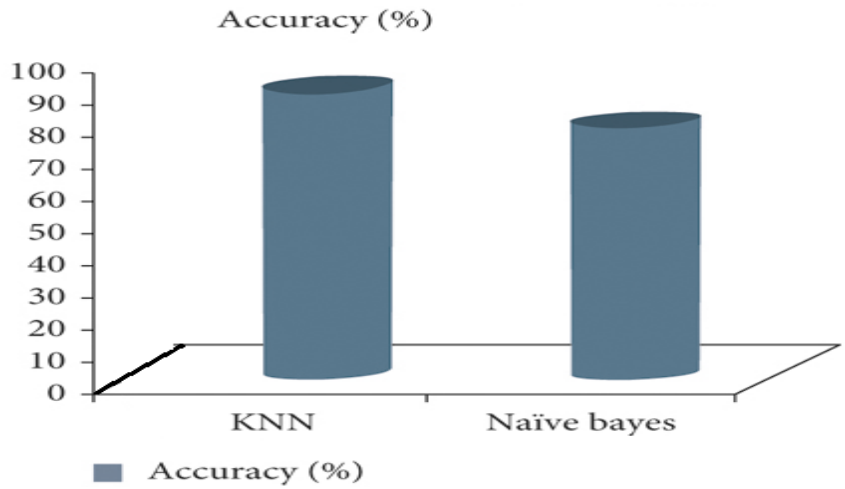

Figure 2- Accuracy of classifiers

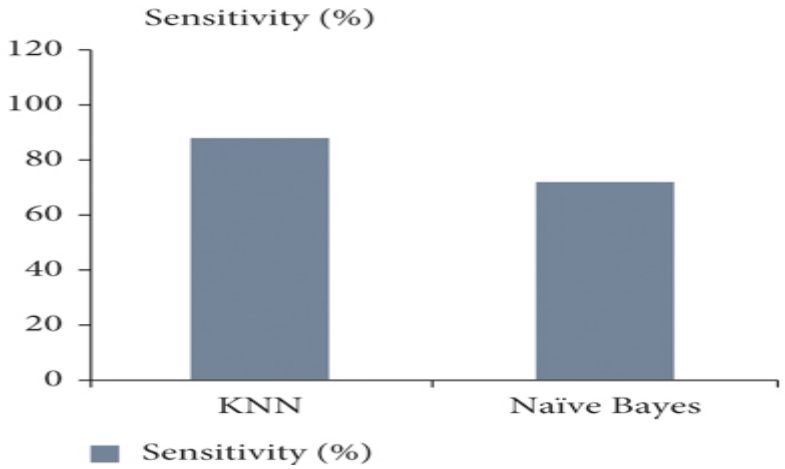

Figure 3- Sensitivity of classifier

4. Conclusion

In terms of smart agriculture, monitoring Fresh food products is a crucial study field. To reliably monitor perishable food products, IoT, image processing, and ML are required. Increased sales of the same kind of goods are not nearly as important to purchaserconsummation as a high-quality product. The general quality of a product or service is influenced by the consumer's requirements and expectations. An alternate definition of "quality" is the whole of the qualities that go into creating products and services that satisfy consumers. Due to efforts made by importing nations, the quality of certain imported goods has lately improved. The monitoring system for freshness of goods described in this article is based on ML and IoT. This suggested design uses IoT devices to transmit photos that are taken with high-resolution cameras and stored on a cloud server. These images are segmented using the K-means clustering technique before being uploaded to cloud server. Then, using trained machine learning models, the photos are categorised after characteristics from the photographs are extracted using PCA approach.

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