Advancing Fruit Quality Control through Machine Learning

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Abstract— **Ripening of fruit is a typical process. Fruit matures as a result of ethylene, which is produced naturally by fruit. Dealers and sellers, however, frequently employ chemicals like CaC_2 to expedite this process so their product will reach the market sooner and they may maximize profit. Fruits are preserved in storage using chemicals. When this substance and moisture interact, ethylene is produced, which ripens the berry. Contrary to how naturally occurring ethylene in fruits is distributed, which causes uneven ripening, when ethylene is present in high quantities and comes into touch with the surface area of the fruit, it consistently causes the fruit to ripen. The suggested method then compares the properties of the fruit being tested to those of naturally and artificially ripened fruit before producing an output with likelihood. This method makes use of an Android-powered Smartphone.**

I. INTRODUCTION

On the packaging of contemporary food products, "Best By" or "Use By" dates are usually written. The producer conducts regulated food testing. However, while being moved from the farm to the refrigerator, it encounters management blunders and temperature changes. The stated expiration date on the packaging is therefore incorrect, and this uncertainty greatly increases food loss globally. Farmers commonly store their food goods in depots for a long period before distributing them to the market, which results in severe food loss because one damaged batch typically ruins the entire batch. Farmers experience large losses, which increase prices and harm the industry. The technology in food storage facilities can be used by producers, the food processing sector, and retailers to monitor food quality in real-time and help customers gain full transparency about the food they consume. If people are informed of the exact day that the food will expire, they can eat it, donate it, or compost it. This greatly reduces food waste and avoids the traditional methods of food disposal that increase CO_2 levels. One of the agro-benefits is that a farmer may predict and plan the distribution of his goods. When one lot of the product is ripe and ready, the grower will be notified, at which point he can sell it immediately away. When bananas are stored together, ethylene gas emitted from the first banana triggers a wave of ripening. Other fruits ripen more quickly as a result of this process, which results in food becoming overripe earlier than expected. Therefore, reducing food waste necessitates ongoing monitoring. Previous studies have used computer vision to identify the stages of banana ripening, but these methods are computationally expensive and memory-intensive for storing the data and executing machine learning algorithms. Instead, we employed sensors, such as temperature, humidity, and gas sensors, to detect the emission of flammable gases from the food products.

II. METHODOLOGY

Although the process of fruit ripening is natural, retailers use chemicals to accelerate it. The manufacturer subjected the food to regulated testing. However, it runs into managerial errors and temperature changes while being transported from the field to the refrigerator. The stated expiration date on the packaging is therefore incorrect, and this uncertainty greatly increases food loss globally. Instead, we employed equipment, such as temperature, humidity, and gas sensors, to detect the emission of flammable gases from the food items. We shall be able to obtain numerical numbers using this strategy. Agro benefits are obvious when a farmer can predict and arrange the distribution of his output. When one lot of the product is ripe and ready, the grower will be notified, at which point he can sell it immediately away. The device will also alert him if a batch begins to turn overripe so that he may rescue the other products. Additionally, this will lessen the market's volatility for food globally.

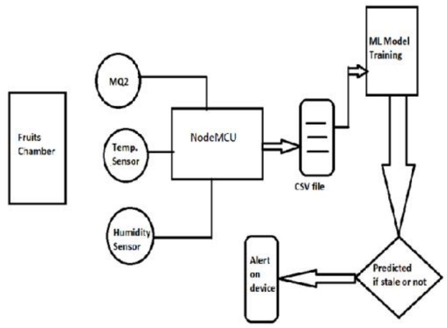


Fig.1: Block diagram of freshness analysis of fruits

III. LITERATUREREVIEW

Singh Gill H et.al.[1]: In this article, a novel deep learning method for categorizing fruit photos is proposed. This method combines Long Short Term Memory (LSTM), Recurrent Neural Network (RNN), and Convolution Neural Network (CNN) techniques. The chosen and chosen ideal characteristics have an impact on the classification precision. To categorize the vegetables, CNN, RNN, and LSTM were all employed as deep learning programmes.

Sonwani E et.al.[2]:Because grains are susceptible to spoilage as a result of wetness, humidity, temperature, and a number of other factors, researchers are developing novel techniques to preserve food quality in an effort to increase the shelf life of grains. Systems that effectively track food deterioration are necessary to uphold current requirements for food quality. In order to monitor food quality and control home storage systems, we have created a prototype. To differentiate between the many types of fruits and vegetables, they first employed a Convolutional Neural Network (CNN) model. After that, the suggested system uses sensors and motors to assess the extent of food rotting by monitoring the temperature, humidity, and gas emission levels of fruits and vegetables.

FaudNet.al.[3]: Support vector machines (SVM) and k-nearest neighbor (kNN) are two approaches for identifying EEG data that are studied in this work. A classifier might, for instance, create a classification model using input features from a dataset and tuning parameters, and then use the model to predict the appropriate class of incoming input in an unknown dataset. EEG data are non-stationary, have a low signal-to-noise ratio, are non-linear, and are contaminated with a variety of sounds and artifacts. (SNR).

San M et.al.[4]: This research presents a features fusion strategy to identify the five different types of fruits in the fruit 360 dataset. The next four processing phases are preprocessing, boundary extraction, feature extraction, and classification. To reduce noise with the median filter during pre-processing, the morphological method is paired with boundary extraction. They extracted structural and color features separately from the image during feature extraction. Utilizing a machine learning RGB color channel, color characteristics from fruit freshness research are taken into consideration. Morphological features were recovered from the image that showed the fruit border using morphological methods.

M.Alongiet.al.[5]: It is challenging to increase the shelf life of ready-to-eat greens because they lose quality after 6-7 days and are exceedingly perishable. An atmospheric pressure plasma jet (APPJ) was used in this investigation to surface-decontaminate freshly cut lettuce baby leaves. The efficiency of the APPJ antibiotic on the native bacteria and its impact on some physicochemical parameters of cabbage were evaluated as a function of the treatment time. (0–30 s).

AnandGet.al.[6]: In this essay, a feature-fusion approach is proposed. The purpose of this study is to propose a new type of smart refrigerator that has sensors, a camera, and an image recognition system added to it. Refrigerators are widely used for long-term food storage and preservation. Because of the current lifestyle, people are more focused on their employment and have less time to consider what they eat each day. Over time, they become unaware of the quantity and calibre of food stored inside frequently. Food waste contributes to both rising greenhouse gas emissions and food insecurity, particularly in developing nations.

Akhtar Met.al.[7]: Food transportation problems are frequently caused by ageing bread. We created a prototype that uses an Arduino Nano computer and MQ series sensors to detect CO and CO2 in bread shopper sacks in order to gather data for this investigation. This data is subsequently analysed using a variety of machine learning approaches to ascertain the current condition of the bread at these establishments. The information that these tools collected, though, was scattered.

AdekanleMet.al.[8]: This study's goal was to evaluate the microbiological viability of uncooked fruits and vegetables. In the Shagamu market in Ogun State, Nigeria, twenty different samples of fruits and vegetables were randomly selected from ten different vendors. The levels of aerobic plate counts, total coli form counts, yeast and mould counts, and antibiotic resistance study findings were calculated using conventional microbiological methods.

KagayaHet.al.[9]: Convolutional neural networks were employed in this study to recognize and classify food photographs. (CNN). It is frequently exceedingly difficult to identify photographs of food products due to the wide range of food varieties. Although CNN is a state-of-the-art deep learning technique, deep learning has recently been shown to be a very successful image identification method. We employed CNN to perform the tasks of food identification and categorization through parameter optimization.

Salcedo-SanzSet.al.[10]: This paper provides an overview of the support vector machine (SVM) technology and shows how it can be applied to resolve real-world engineering problems. This study's objectives are to review the SVM technique's state-of-the-art and to illustrate some of its most recent effective results in real-world engineering issues. The paper starts out by explaining the underlying concepts of kernel techniques and SVMs.

N.Patel et.al.[11]: A fruit recognition method based on enhanced multiple attributes is described in this study. The produce is recognized using a picture analysis system that has been trained. efficiently assemble attributes. The method's objective is to choose a number of weights for the properties of the incoming test image, such as intensity, color, orientation, and border.

Lee D et.al. [12]: Color grading is a crucial step in the processing of fruits and vegetables that directly affects profitability because the quality of agricultural goods is commonly connected with their color. The majority of currently in use automated color grading systems either measure product color directly against a predetermined and fixed set of reference colors or employ a set of color separation criteria, frequently in three-dimensional color spaces, to evaluate color quality. These methods hinder users from making quick adjustments to their chosen color schemes or grading criteria.

S. Gunasekaran et.al.[13] : The usage of computer vision technologies in the food business to monitor quality is growing. In terms of evaluating various qualities of raw and cooked foods, these devices essentially replace human inspectors. Over the past few years, computer vision technology has undergone numerous significant breakthroughs as a result of the swift development of computer hardware and software.

Civille E et.al.[14]: The identification of the product is an essential part of the suggested system for assessing food quality measures that demonstrate particular qualities and their qualities. The specification of sensory items is greatly influenced by both descriptive analysis, which is used to describe products, and customer feedback, which is used to measure affective responses. Key consumer qualities, general consumer acceptability, and customer acceptance for look, flavour, and texture are all covered by descriptive information.

S.P.Burget.al.[15]: ethylene is always present in a fruit before the respiratory climacteric starts in an amount sufficient to promote ripening, according to a new study utilizing gas chromatography. The findings of studies in which fruits were exposed to ethylene oxide, varying concentrations of oxygen and carbon dioxide, or partial vacuum all support the idea that ethylene is a hormone that stimulates fruit ripening.

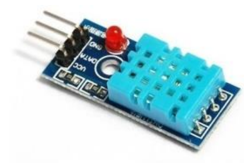
III.PROPOSEDSYSTEM

A. *Hardware components*

MQ2Sensor

The MQ2 sensor uses an energy of +5V to function. Its conventional output voltage varies from 0V to 5V, and its digital output voltage is either 0V or 5V. Preheating requires 20 seconds. It can serve as a digital or conventional display. The adjuster can be used to modify the strength of the digital pin.

DHT11Sensor



The DHT11 is a small device that runs on three to five volts. 2.5mA is the greatest current that can be measured. The four lines that make up the DHT11 sensor are VCC, GND, Data Pin, and a Not Connected Pin. Between 5 and 10 kilohms of pull-up resistance are readily available for transmission between the sensor and the CPU.

NodeMCU

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266.

B. *Software Components*

NodeMCU

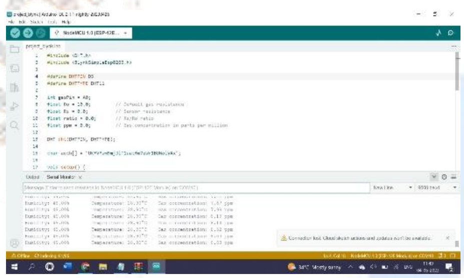
NodeMCU is a low-cost open source IoT platform. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). Strictly speaking, the term "NodeMCU" refers to the firmware rather than the associated development kits. The most common models of the NodeMCU are the Amica (based on the standard narrow pin-spacing) and the LoLin which has the wider pin spacing and larger board. The open-source design of the base ESP8266 enables the market to design new variants of the NodeMCU continually. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds. However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

Proteus Software

For managing electrical design, there is a special toolkit called Proteus Design. Engineers and employees use the programme mostly to generate electronic printouts and drawings for printed circuit board manufacture. The programme used to create diagrams and run real-time circuit models is called ISIS. By permitting human interaction while it is operating, the simulation offers real-time modeling.

III. RESULTS

These sensors can be incorporated into a system that measures the gas concentrations over time, allowing for the monitoring of changes in gas concentrations as the fruits ripen or decay. Another approach is to use gas chromatography, which is a more sophisticated method of analyzing gas concentrations. This involves separating the different gases in a sample and then measuring their concentrations using specialized detectors. In both cases, the data collected from the gas concentration measurements can be analyzed using machine learning algorithms to identify patterns and predict changes in gas concentrations over time. This can help in developing models for predicting the freshness of fruits and determining the optimal storage conditionsto extend their shelf life.



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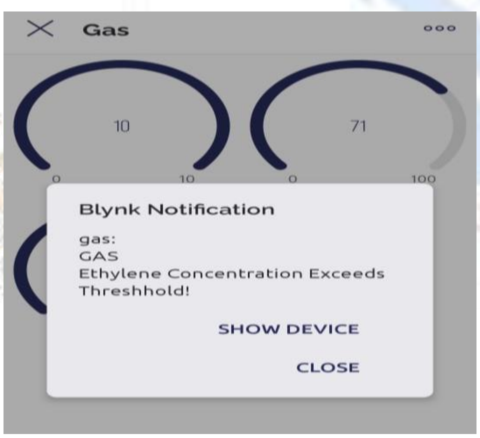

IV. CONCLUSION

Food loss can be avoided by using technologies like the Internet of Things (IoT) and machine learning to predict when foodstuffs will go bad. The example may be made portable and user-friendly for those working in a range of industries, including horticulture, supply chain management, and food preparation. It can be used by people to inform them of the actual expiration date of their products.

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