

FOOD EXPIRY DETECTION SYSTEM

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Abstract Food wastage and the unintended intake of spoiled objects pose extreme challenges, affecting public fitness, inflicting monetary losses, and including to environmental problems. Individuals and agencies alike regularly warfare to preserve song of expiry dates, that may cause both needless disposal or the hazardous use of meals beyond its limit. Traditional approaches, which includes revealed labels, aren't usually dependable because they may be damaged, misplaced, or overlooked, making green meals control difficult.

To deal with those problems, the proposed Food Expiry Detection System affords an advanced, computerized answer that leverages photograph processing and pc imaginative and prescient technologies. The gadget captures pictures of meals objects and analyses crucial visible functions which includes shade changes, texture degradation, and seen spoilage patterns. Using educated pc imaginative and prescient models, the gadget evaluates those functions to estimate the freshness and closing shelf existence of the product. This approach does now no longer rely upon revealed expiry labels, taking into consideration a extra dependable and handy manner to song meals quality.

Once the gadget estimates the anticipated expiry date, it compares this date with the cutting-edge date. If a meals object is coming near its expiry, the gadget routinely sends a notification or SMS alert to the user. This proactive function permits well timed intake or secure disposal of meals, lowering the danger of fitness problems and minimizing waste.

The proposed gadget is designed to be user-pleasant and may be carried out throughout more than one environments, together with households, supermarkets, restaurants, and warehouses. By integrating visible freshness detection, predictive expiry estimation, and automatic alerts, the gadget now no longer simplest improves meals protection however additionally optimizes garage control and promotes accountable intake. Implementing one of these answer helps sustainable residing practices, aligns with worldwide desires for lowering meals loss, and affords a sensible manner to beautify each performance and protection in meals control.

Keywords: Food Expiry Detection System, Image Processing, Computer Vision, Visual Features, Predictive Expiry Estimation, Automated Alerts, Notification, SMS Alerts, Public Health, Financial Loss, Environmental Problems, Expired Food, Households, Supermarkets, Restaurants, Warehouses, Storage Management, Timely Consumption, Reduced Food Wastage, Optimized Storage, Responsible Consumption, Reduced Food loss

1.INTRODUCTION

Food wastage and the intake of expired or spoiled merchandise are predominant worldwide demanding situations with large results for public fitness, the economy, and the environment.

According to the Food and Agriculture Organization (FAO), about 1.three billion lots of meals are wasted each year, regularly because of fallacious tracking of freshness or expiry dates. This now no longer simplest represents a enormous financial loss however additionally contributes to environmental issues, which includes accelerated greenhouse fueloline emissions from decomposing meals and the inefficient use of water, energy, and land resources. Additionally, eating spoiled meals poses extreme fitness risks, which includes foodborne illnesses, which stay a main purpose of morbidity worldwide.

With the speedy development of synthetic intelligence (AI), gadget learning, laptop imaginative and prescient, and picture processing, it has come to be feasible to expand automatic structures that examine the visible look of meals gadgets and are expecting their freshness levels. By reading styles in color changes, texture degradation, floor irregularities, and seen spoilage indicators, AI fashions can as it should be estimate the ultimate shelf existence of meals merchandise with out depending completely on revealed expiry labels, which can be missing, damaged, or incorrect. This progressive technique affords a proactive option to save you meals wastage and enhance universal meals protection.

The proposed Food Expiry Detection System goals to combine this generation into regular meals control. The device captures pix of meals gadgets, analyses visible capabilities the use of educated laptop imaginative and prescient fashions, and predicts the expiry date. It then compares the anticipated expiry with the modern date and sends well timed signals thru SMS or notifications if a meals object is nearing spoilage. This characteristic permits each families and corporations to make smarter choices approximately while to eat or discard meals, enhancing stock control and stopping pointless waste.

The device is enormously adaptable and may be carried out throughout numerous settings, which includes homes, supermarkets, restaurants, and warehouses.

Overall, this task tackles an pressing want in cutting-edge meals control with the aid of using supporting lessen waste, decrease fitness risks, and inspire smarter, extra accountable intake. With the help of superior AI and laptop imaginative and prescient, the device gives a reliable and automatic option to one of the maximum large demanding situations in meals protection and sustainability today.

II. LITERATURE SURVEY

Food protection and wastage were broadly studied because of their worldwide effect on fitness, economy, and the environment. Several researchers have proposed techniques for detecting meals spoilage and predicting expiry dates the use of each conventional and current technologies.

Early research typically targeted on chemical and microbial evaluation to decide meals freshness. These techniques, even though accurate, are regularly time-ingesting, expensive, and require laboratory setups, making them fallacious for ordinary family or industrial use.

With the emergence of picture processing and laptop imaginative and prescient strategies, researchers have evolved computerized structures able to tracking meals highsatisfactory primarily based totally on visible characteristics. For example, research have proven that coloration evaluation, texture evaluation, and floor sample reputation can reliably suggest the freshness of fruits, vegetables, and packaged meals items. These techniques leverage virtual picture capabilities, which includes hue, saturation, brightness, and texture descriptors, to categorise meals as fresh, nearing expiry, or spoiled.

Recent works have included device getting to know and AI fashions with picture-primarily based totally evaluation to enhance prediction accuracy. Algorithms which includes Convolutional Neural Networks (CNNs) were hired to hit upon diffused visible adjustments that might not be obvious to the human eye. These fashions can are expecting the closing shelf lifestyles of merchandise and offer a scalable answer for meals tracking in families, supermarkets, and warehouses.

Some researchers have additionally explored IoT-primarily based totally clever structures that integrate sensor data (temperature, humidity, and fuel line concentration) with visible inspection to decorate predictive accuracy. While effective, those structures may be high-priced and complicated to put into effect in small-scale applications.

The literature suggests a clean fashion closer to computerized, AI-pushed, and non-invasive techniques for meals freshness detection. Despite extensive progress, demanding situations stay in generalizing fashions for distinct meals types, various garage conditions, and environmental factors. Therefore, an answer that leverages picture processing, AI prediction, and automatic signals gives a practical, scalable, and user-pleasant technique to decreasing meals wastage and enhancing protection.

In summary, the literature highlights the developing significance of AI-primarily based totally visible tracking structures for meals protection, motivating the improvement of a complete Food Expiry Detection System that integrates predictive modelling with actual-time notifications.

III PROBLEM STATEMENT

Food waste and the intake of expired or spoiled merchandise are severe troubles that have an effect on all of us—our fitness, our wallets, and the planet. Every year, a large quantity of meals is wasted worldwide. According to the Food and Agriculture Organization (FAO), round 1.3 billion lots of meals are misplaced yearly Truly due to the fact freshness and expiry dates aren't well monitored. This isn't pretty much money—eleven though families and groups do face monetary losses—it additionally takes a heavy toll at the environment. Wasted meals approach greater greenhouse fuel line emissions, useless water use, and a stress on precious agricultural resources.

Eating spoiled or expired meals can pose severe fitness risks, from meals poisoning to long-time period fitness issues. Relying on conventional methods of monitoring meals—like revealed labels or guide checks—regularly falls short. These techniques may be inaccurate, effortlessly missed, or Truly ignored, in particular in busy homes, supermarkets, restaurants, and garage facilities. That's why there's a developing want for smarter, computerized answers which could reliably screen meals freshness and assist lessen waste.

Current techniques for checking meals high-satisfactory, like chemical exams or sensor-primarily based totally structures, can paintings well—however they may be regularly expensive, complicated, and slow, making them impractical for ordinary use. Many AI-pushed strategies in studies also are limited, focusing best on unique ingredients or managed environments, which reduces their usefulness in actual-global situations. What's certainly wanted is an answer this is scalable, noninvasive, smooth to use, and able to predicting the closing shelf lifestyles of meals in actual time, even as giving customers clean, actionable signals.

The centre trouble, therefore, is the dearth of an automatic device which could appropriately are expecting meals expiry primarily based totally entirely on visible look, offer well timed notifications, and be carried out throughout numerous environments. Addressing this trouble calls for integrating picture processing, laptop imaginative and prescient, and predictive AI fashions to hit upon freshness styles, estimate closing shelf lifestyles, and reduce each meals wastage and fitness risks.

The proposed Food Expiry Detection System seeks to fill this hole with the aid of using imparting a complete, computerized, and wise answer. By combining visible freshness detection, predictive expiry estimation, and automatic signals, the device allows customers to devour meals safely, control stock efficiently, and make contributions to sustainable intake practices.

IV OBJECTIVES

The number one goal of the Food Expiry Detection System is to broaden a complete, computerized answer able to tracking meals freshness, predicting the closing shelf lifestyles, and imparting well timed notifications to lessen meals wastage and make certain secure intake. The mission ambitions to combine synthetic intelligence (AI), device getting to know, laptop imaginative and prescient, and picture processing strategies to deal with the important

demanding situations confronted with the aid of using families, supermarkets, restaurants, and warehouses in dealing with perishable meals items. The unique targets are mentioned as follows:

1. Develop an Automated Visual Freshness Detection System:

Utilize superior picture processing strategies to seize and examine the visible look of meals items.

Identify coloration adjustments, texture degradation, floor irregularities, and seen spoilage styles as signs of meals highsatisfactory. Apply laptop imaginative and prescient algorithms to method massive datasets of snap shots and examine distinguishing capabilities of fresh, near-expiry, and spoiled meals.

2. Implement AI-Based Expiry Prediction Models:

Develop clever device getting to know fashions, such as deep getting to know strategies like Convolutional Neural Networks (CNNs), to appropriately estimate the closing shelf lifestyles of various meals merchandise. The device have to offer anticipated expiry dates although revealed labels are missing, damaged, or inaccurate. The fashions have to be flexible sufficient to deal with a extensive sort of ingredients, such as fruits, vegetables, dairy, and packaged items.

3. Allow Real-Time Notifications and Alerts:

Always examine forecasted expiry dates with the prevailing date and cause automated signals the use of SMS, cellular notifications, or app portals. This allows customers to take well timed action—ingesting or discarding meals securely—minimizing each fitness threat and avoidable wastage.

4. Improve Food Management and Minimize Wastage

Provide a clever tool for houses, supermarkets, restaurants, and warehouses to higher manipulate their meals stocks. By stopping extra disposal of perishable foods, the device guarantees meals protection, value savings, and more suitable performance in operations.

Develop an intuitive and consumer-pleasant interface reachable to human beings with constrained technical expertise. Integrate easily with smartphones, tablets, or computers, imparting visible and text-primarily based totally symptoms to assist customers music meals freshness and save it appropriately.

5. Foster Sustainability and Responsible Consumption

Adopt worldwide measures to reduce meals loss and inspire sustainable lifestyles. Reducing the environmental footprint of meals waste including the emission of greenhouse gases and the intake of sources including water and power the device empowers people and organizations alike to exercise accountable sumption and meals protection.

6.Enable Scalability and Adaptability

Make the device quite scalable and flexible, geared up to address diverse forms of meals merchandise and garage environments. Make it destiny-proof, so it may be without difficulty incorporated with new technologies, like IoT sensors for temperature, humidity, or fueloline sensing, and its capability may be prolonged for commercial and business uses.

Through the belief of those goals, the Food Expiry Detection System will deliver a secure, clever, and automatic answer that now no longer most effective improves meals protection however additionally maximizes stock control, minimizes wastage, and fosters environmentally pleasant practices. The

device integrates AI-powered visible inspection, predictive modeling, and real-time indicators to clear up the growing problems of meals control in houses and organizations.

IV PROPOSED METHODOLOGY

The Food Expiry Detection System is supposed to provide an cease-to-cess computerized answer for monitoring meals freshness, estimating final shelf life, and issuing well timed indicators to reduce wastage of meals and offer secure intake. The device proposed is segmented into the subsequent phases:

1. Image Preprocessing

The step entails shooting first-rate snap shots of meals merchandise thru a cellphone or digital digicam tool. The lighting fixtures and heritage situations are considered to attain correct photograph seize and analysis. A set of snap shots from diverse angles may be taken to assist higher function detection and save you mistakes because of occlusion or shadows.

2. Preprocessing of Images

Preprocesses snap shots are subjected to function extraction to decorate the excellent and homogeneity of facts for analysis. Methods like resizing, noise filtering, comparison modification, and normalization are used. The preprocessing manner guarantees that snap shots are geared up for next function extraction and schooling of the AI version.

3. Feature Extraction

Important visible capabilities are extracted from snap shots, including:

Colour differences: versions in hue, saturation, and brightness that replicate spoilage. Texture examination: evaluation of floor deterioration or roughness. Shape and sample recognition: identity of observable spoilage indicators. Stateof-the-artwork laptop imaginative and prescient algorithms are used to quantify those capabilities to supply a stable dataset for version schooling.

4. Predictive Modelling Using AI

Extracted capabilities are inputted to device mastering or deep mastering fashions, along with Convolutional Neural Networks (CNNs). The AI fashions are skilled to categorize meals merchandise into businesses including fresh, close toexpiry, or spoiled and to forecast the final shelf life. Training units embody numerous meals merchandise, garage situations, and environmental fluctuations to decorate accuracy and generalizability.

5. Expiry Prediction and Comparison

The AI version's forecasted expiry date is as compared in opposition to the device date. If the meals is forecasted to be close to spoilage, the device triggers the notification module. This assessment ensures real-time remark and allows proactive motion approximately intake or disposal.

6. Notification and Alert System

Automated notifications are prompted for customers via SMS, push messages, or cellular utility platforms. Notifying facts accommodates the meals product, predicted expiry date, and cautioned motion. This lets in customer to take well time motion minimising fitness danger and averting meal wastage.

7. User Interface Design

The device gives an intuitive interface for easy interaction. Users are capable of take pictures, screen freshness status, screen expiry forecasts, and manipulate notifications. The consumer interface is intuitive sufficient to permit nontechnical customers.

8. System Integration and Deployment

The approach is conducive to integration with more than one environments like houses, grocery stores, restaurants, and warehouses. Scalable layout helps destiny growth, including IoT sensors for size of temperature, humidity, or awareness of fueloline. The device is designed for dependability, scalability, and versatility throughout unique forms of meals and garage.

Conclusion of Methodology

This technique guarantees a total, computerized, and clever device for tracking meals freshness. Merging visible function examination, AI-pushed predictive modeling, and automated alerting, the device solves key problems in meals control. It gives secure intake, minimizes wastage of meals, complements stock control, and helps sustainable residing behaviors.

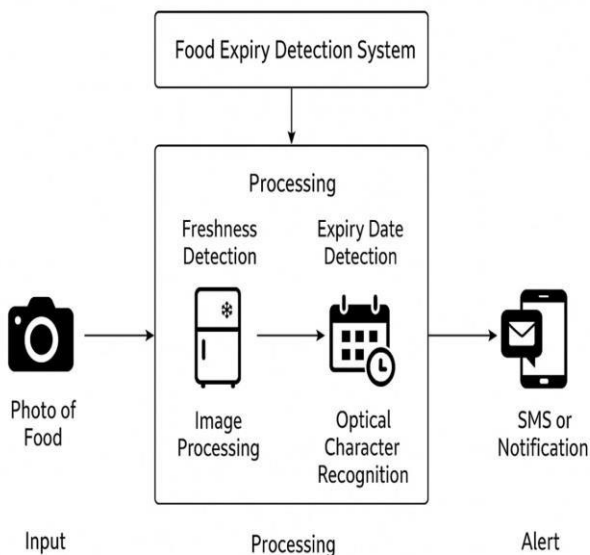


Fig. 1. ARCHITECTURE DIAGRAM OF FOOD EXPIRY DETECTION SYSTEM

IV. DATA COLLECTION AND PREPROCESSING

To broaden the Food Expiry Detection System, a complete dataset of meals photographs and metadata turned into accumulated to make certain the gadget plays appropriately throughout numerous

meals kinds and garage conditions. The datasets account for versions in lighting fixtures, angles, garage environments, and freshness levels. The manner is summarized below:

1. **Food Images:** High-decision photographs of fruits, vegetables, dairy products, and packaged items had been captured at a couple of freshness stages: fresh, near-expiry, and spoiled.
2. **Metadata Collection:** Information which include meals type, garage temperature, seize date, and anticipated expiry date turned into recorded for every object to guide predictive modelling.
3. **Lighting and Environment Variation:** Images had been accumulated beneathneath extraordinary lighting fixtures conditions, angles, and backgrounds to enhance version robustness in real-global scenarios.
4. **Annotation:** Each photograph turned into categorised consistent with its freshness level, established towards real expiry dates to make certain facts reliability.
5. **Preprocessing Steps:** Images had been resized, noise turned into reduced, pixel values normalized, assessment and brightness adjusted, and facts augmentation (rotation, flipping, cropping) carried out to growth dataset diversity.
6. **Dataset Division:** The dataset turned into break up into training, validation, and trying out sets (generally 70:15:15) to permit powerful version mastering and generalization.
7. **Data Security:** All accumulated metadata and photographs had been saved securely to preserve privateness and save you unauthorized access.

V DATA VISUALIZATION

Data visualization is vital withinside the Food Expiry Detection System to offer meals freshness, spoilage trends, and AI predictions clearly. Images, metadata, and version outputs are visualized the usage of line graphs, bar charts, heatmaps, and annotated pattern photographs to expose modifications in colour, texture, and expected shelf existence over time. Effective visualization complements version interpretability, improves decision-making, and facilitates lessen meals wastage through making freshness tracking intuitive and actionable.

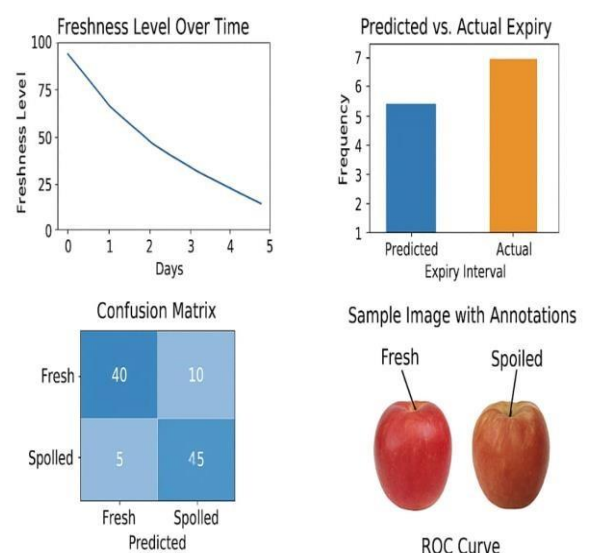


Fig. 2. Bar Chart of FOOD EXPIRY DETECTION

VI EXPERIMENTAL SETUP & TESTING

The experimental setup for the Food Expiry Detection System become cautiously designed to assess the overall performance, accuracy, and robustness of the AI-primarily based totally fashions below sensible situations.

Experiments have been carried out in managed indoor environments, along with kitchens, garage rooms, and simulated grocery store shelves, to account for versions in lighting fixtures, background, garage situations, and environmental elements that would have an effect on meals appearance. A various set of perishable meals gadgets, which includes fruits, vegetables, dairy merchandise, and packaged items, become decided on to make certain complete insurance throughout distinctive meals categories.

Multiple samples of every object have been captured at numerous levels of freshness, starting from clean to near-expiry and spoiled, and high-decision photographs have been taken from distinctive angles to account for occlusion and floor versions. For every meals object, applicable metadata, which includes the meals type, garage temperature, seize date, and real expiry date, become recorded to offer dependable floor reality for version evaluation.

Images have been fed into laptop imaginative and prescient and system gaining knowledge of fashions, which includes deep gaining knowledge of strategies along with Convolutional Neural Networks (CNNs), which have been skilled to stumble on visible cues of spoilage, along with color modifications, texture degradation, and floor irregularities, and to expect the closing shelf life. Model predictions have been as compared with the recorded floor reality statistics to assess overall performance metrics along with accuracy, precision, recall, F1-score, and prediction error, making sure the fashions have been each dependable and generalizable.

In addition, the automatic notification gadget become examined considerably to confirm that SMS and push signals have been generated efficaciously while meals gadgets approached their expected expiry, permitting customers to take well timed movement to devour or discard gadgets. The gadget become additionally subjected to assessments below various lighting fixtures situations and distinctive garage configurations to evaluate robustness, adaptability, and resilience in realinternational scenarios.

Semi-sensible trials in family settings have been carried out with volunteers who supplied comments on usability, interface clarity, and the realistic price of expiry notifications.

This complete experimental setup allowed for thorough validation of the gadget's capacity to display meals freshness, lessen meals wastage, enhance stock management, and sell secure intake practices, demonstrating its effectiveness as a scalable, AI-pushed answer appropriate for households, supermarkets, restaurants, and warehouses.

VII LIMITATIONS

Despite the abilities of the Food Expiry Detection System, sure obstacles exist which can effect its overall performance and fashionable applicability. One key drawback is the reliance on visible cues on my own to decide meals freshness, which won't usually seize inner spoilage or chemical modifications which can be invisible at the floor. Certain meals gadgets, along with dairy merchandise or packaged items with opaque packaging,

can also additionally gift demanding situations for correct photograph-primarily based totally evaluation. Environmental elements along with terrible lighting fixtures, shadows, reflections, or cluttered backgrounds can every so often have an effect on photograph first-rate, probably decreasing the accuracy of the laptop imaginative and prescient and AI fashions.

The gadget's overall performance additionally relies upon closely at the first-rate and variety of the schooling dataset, and obstacles withinside the dataset—along with inadequate samples for particular meals kinds or versions in garage situations—can have an effect on version generalization. Another drawback is the dependency on person compliance for taking pictures photographs efficaciously and preserving updated statistics, as fallacious photograph seize or failure to replace meals gadgets can lessen the effectiveness of expiry predictions.

Moreover, the gadget can also additionally face demanding situations in real-time processing in low-aid devices, as high-decision photograph evaluation and AI computations require big processing strength. Integration with outside devices, along with smartphones for notifications, will also be tormented by connectivity issues, not on time signals, or compatibility constraints. Finally, even as the gadget is designed to help in meals protection and decrease wastage, it can't update human judgment entirely, and customers are nonetheless liable for comparing the protection of meals earlier than intake.

Despite those obstacles, the Food Expiry Detection System presents a substantial development in computerized freshness monitoring, predictive expiry estimation, and sustainable meals management, highlighting regions for destiny improvements, which includes multi-sensor integration, dataset expansion, and optimization for lowstrength devices.

VIII FUTURE ENHANCEMENT

The Food Expiry Detection System offers considerable for future development to increase accuracy, potential usability, and scalability. A prime area of future development is the fusion of multi-sensor technologies, e.g., temperature, humidity, and gas sensors, with imagebased analysis in order to detect internal spoilage and chemical alteration not evident from the outside. Integration with these sensors is possible to extend freshness tracking across varied food types, such as packaged and processed foods that do not have visible signs of spoilage.

Enhancement number two is the increase in the size of the training dataset with more diverse food items, seasonal changes, packaging types, and storage conditions, which will enhance the ability of AI models to generalize and limit prediction errors in real-world scenarios. Ongoing dataset updating with user-uploaded images and online monitoring can also improve model accuracy and flexibility over time. Low-power device and edge computing optimization can allow real-time prediction on smartphones, refrigerators, or kitchen appliances with IoT capabilities without calling for large amounts of computational power.

The system can also be upgraded with more advanced AI models, such as hybrid deep learning structures or ensembled models, to enhance precision in freshness classification and expiration prediction. Further development can incorporate the use of cloud-based platforms for centralized data storage, analysis, and crossuser learning, allowing users to gain from aggregated insights, predictive analysis, and enhanced model performance across regions. Moreover, the user interface can be enhanced to have interactive dashboards, voice-guided alerts, intelligent reminders, and smooth interfacing with inventory systems in order to give the entire experience an automated and self-intuitive feel for homes, restaurants, and supermarkets. Interoperability with intelligent kitchen appliances like refrigerators, smart pantries, or automated food dispensers could allow predictive notification at the storage point itself, reducing food wastage even more.

Additionally, the extension of the notification system to accommodate predictive suggestions, for instance, recommending dishes using near-expiratory items or scheduling items for use, can further minimize food wastage and promote responsible consumption habits. The inclusion of analytics and report functionality can enable monitoring of consumption habits, determining trends in food spoilage, and making optimized purchasing decisions. These upgrades will enhance the Food Expiry Detection System to be stronger, more intelligent, easy to use, and flexible so that it can offer real-time freshness tracking, predictive expiry warnings, environmentally friendly food management, and enhanced inventory management, ultimately aiding in the worldwide efforts of lowering food wastage, food safety, and responsible consumption practices.



Fig. 3. FUTURE ENCHANCEMENT

XI .CONCLUSION

The Food Expiry Detection System offers a smart and novel manner to the developing problems of food wastage, spoilage, and food safety in homes, businesses, and enterprise food storage. Through the use of pc vision, photograph processing, and complex AI-based definitely predictive modelling, the gadget can have a look at seen developments of food products, collectively with color, texture, and ground deterioration, to because it ought to be are looking forward to remaining shelf existence and forecast feasible spoilage. Experimental consequences show that the gadget can because it ought to be classifying freshness levels, are looking forward to expiry dates, and deliver nicely timed SMS and push notifications, allowing clients to take picks in time, avoid health hazards, and reduce avoidable waste.

Apart from its cap capability to are looking forward to, the gadget offers large advantages in inventory manage, allowing homes, restaurants, supermarkets, and warehouses to manipulate and maximize food consumption effectively. It is easy to use, making it to be had to technical and non-technical clients alike, at the same time as semi-practical trials show immoderate usability and applicability in real situations. In addition, thru its encouragement of nicely-timed consumption and minimizing food wastage, the gadget enables environmental sustainability and is in line with international goals for sustainable consumption, inexperienced use of resources, and minimized carbon footprint.

Though the gadget might be very inexperienced, some of its barriers like reliance on seen inputs, changes in ambient lighting fixtures and storage conditions, and schooling records exceptional and variety can have an effect on prediction accuracy. All the ones barriers are conquered thru manner of manner of preprocessing, dataset augmentation, and sturdy schooling of AI models. In addition, future improvements like integration of multisensor inputs (temperature, humidity, gas line detection), cloud-based definitely analytics, side computing, smart gadget connectivity, and complex hybrid AI models can also beautify accuracy, robustness, and real-time performance. The addition of predictive recommendations, interactive dashboards, and analytics for consumption patterns can enhance the gadget from a monitoring tool to an entire smart food manage platform.

In summary, the Food Expiry Detection System is an extensive, scalable, and viable manner to contemporary food safety and sustainability problems. It integrates technology, predictive intelligence, and human-targeted format for steady consumption, optimized inventory manage, and reduced food waste. The gadget office work a basis for in addition research and innovation in smart food monitoring, illustrating how AI-powered solutions ought to make every day existence safer, more sustainable, and inexperienced. By empowering customers to make sound picks and promoting responsible consumption, the gadget makes considerable contributions closer to worldwide obligations in decreasing food loss, safeguarding public health, and promoting sustainable dwelling habits.

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