Identification of Additives and Preservatives in Packaged Foods: Health Consequences for Consumers

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ABSTRACT

Food is an essential element for all living organisms. Processed foods have a very limited life, in order to preserve them for a longer time and to have good flavor, texture, and taste, food additives and preservatives are used. This study is taken to investigate the effects of food additives and preservatives on human health and did research on different Optical Character Recognition (OCR) algorithms. In this project, we propose an OCR- based algorithm to identify food additives and preservatives in packaged foods by analyzing the contents of the package and finding their effect on human health. Here, the image of the contents of the package is applied to Image enhancement techniques such as to increase the accuracy of the OCR. The Google Cloud Vision API detects text from enhanced images based on CNN with high accuracy. The extracted text is filtered to remove undesirable words using RegEx. The filtered keywords re used to search in the predefined dataset where data is taken from the Standard

Food Safety Organizations such as FDA and FSSAI. By using Google Cloud Vision API, we can extract text with an accuracy of 99.1%.

Keywords: Optical Character Recognition, Google Cloud Vision API, Food and Drug Administration, Food Safety and Standards Authority of India, Regular Expressions.

INTRODUCTION

Food additives like emulsifiers, artificial sweeteners, colorants, and preservatives are routinely added to processed foods to improve sensory properties, prolong shelf life and maintain product quality during storage and transportation. However, excessive intake of certain additives like sodium nitrite, aspartame, and azo dyes may have adverse health implications including metabolic disorders, hypertension, diabetes, and cancer. Hence, many countries enforce strict regulations on additive usage and mandate declaration of additives on food labels. This has motivated research into techniques to accurately identify food additives and preservatives, so that consumers can make informed choices based on individual health conditions and risk factors.

In this project, an image processing-based technique is proposed to detect and identify food additives and preservatives from the printed ingredient labels on packaged foods. The key steps involve capturing an image of the package label, extracting the ingredient text using Optical Character Recognition (OCR), and then matching the identified additive codes against a database to determine their potential health impacts.

OCR is a well-established technology for converting images of printed text into digital text that can be processed on a computer. However, performing accurate OCR on packaged food labels poses some unique challenges. The ingredient text is often very small, tightly spaced, and printed against colorful packaging backgrounds, making it difficult to recognize. Pre-processing techniques are typically needed to improve OCR accuracy.

This project leverages Google's Cloud Vision API, which provides a state-of-the-art OCR engine based on deep neural networks. By using this advanced OCR technology on pre- processed images of package labels, the ingredient text can be extracted with high accuracy. Further processing using techniques like regular expressions then filters the OCR output to only identify additive codes of interest.

The identified additive codes are then matched against a database that contains information on the potential health impacts of different food additives and preservatives. By linking the codes detected on a package to health effects listed in the database, the system can provide consumers with valuable insights into the additives contained in packaged foods.

The use of image processing and OCR technology for food additive detection offers benefits over manual ingredient analysis in terms of efficiency, consistency, and accessibility to consumers. Challenges remain in improving the accuracy of OCR on low-quality package imagery and keeping the health effects database updated with the latest scientific research.

In summary, this project aims to develop an automated system using computer vision and OCR techniques to informatively detect and identify food additives from package labels, linking them to potential health impacts. The ability to extract and analyze food additive information using image processing could make an important contribution towards consumer awareness and public health.

LITERATURE REVIEW

In recent times, there has been a noticeable rise in individuals affected by food allergy, food intolerance, and auto-immune diseases, particularly among the younger population [1]. Even minimal traces of allergens present in food have the potential to induce symptoms, necessitating vigilant precautions in the daily dietary choices of these patients. The surge in such health challenges appears to be closely linked to the growing consumption of packaged foods [2].

The landscape of dietary safety and awareness has witnessed significant strides through innovative mobile applications dedicated to aiding individuals with specific food-related concerns. Notable among these is the Eatable app [3], which provides real-time location information for stores selling allergen-free foods selected by users. Similarly, the Food Allergy Scanner [4] app leverages QR-code scanning to furnish allergy information based on user-defined allergens. Both applications represent commendable efforts to mitigate potential harm arising from specific foods for those with allergies. Building upon this foundational work, our project introduces a novel dimension by focusing on the identification of food additives and preservatives. While 'Eatable' and 'Food Allergy Scanner' concentrate primarily on allergens, our application strives to offer a comprehensive solution by integrating real-time online information about the presence and types of additives and preservatives in food products. This expansion aims to address the diverse dietary needs and concerns of individuals beyond allergies, contributing to a more inclusive and nuanced approach to food safety and awareness.

A review of existing literature reveals that image processing and optical character recognition (OCR) techniques have been widely explored for detecting and recognizing text from images [5]. However, limited research has focused specifically on using these technologies to identify food additives and preservatives from ingredient labels of packaged foods.

Regarding the identification of potential health impacts, some studies like Lim et al. (2018) [6] and Wang et al. (2019) [7] have focused only on detecting and classifying additives using computer vision techniques. Limited literature examines linking the recognized additives to associated health effects for consumers. Access to additive health databases is also a challenge.

In summary, existing literature establishes the utility of image processing and OCR for recognizing food additive codes from packaging. However, robust recognition of small, variable ingredient text and integration with health effects data to inform consumers remains underexplored. This project aims to bridge these gaps through an automated pipeline using advanced OCR methods and additive health databases. The proposed approach has the potential to make a valuable contribution towards consumer awareness regarding food additives.

METHODOLOGY

The aim of this project is to develop an image processing and optical character recognition (OCR) based system to identify food additives and preservatives from packaged food labels and determine their potential health impacts. The methodology involves the following stages:

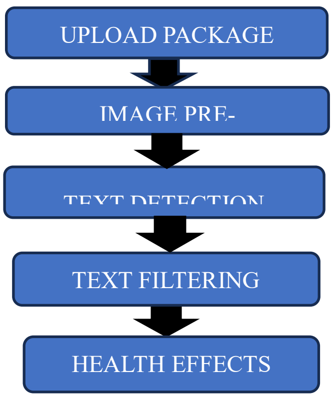

Figure 1. Proposed work

Upload Package Image

The initial phase of our project involves capturing an image of the packaged food label. This could be done using a smartphone camera or any other digital imaging device.

Image Processing

The image is resized to 720 x 480 pixels to accelerate the OCR process, as larger sizes tend to prolong OCR time. After resizing, the image is converted to grayscale. These adjustments are made to reduce the time required for the translation from image to text.

Figure 2. Pre-processing of a non-blur image

Figure 3. Pre-processing of a blur image

Text Detection Using OCR

After preprocessing, Google Cloud Vision API OCR is utilized where the OCR workflow begins with text region detection in an image. Once text regions are identified, the system performs character segmentation. It separates individual characters within the detected text regions, preparing them for recognition. Later, the Convolutional Neural Network, a deep learning model, analyzes the visual patterns and features of each segmented character to determine its identity. Finally, the recognized characters are formatted into a structured output.

Figure 4.a Text Regions Detected in a non-blur image

Figure 4.b Text Regions Detected in a blur image

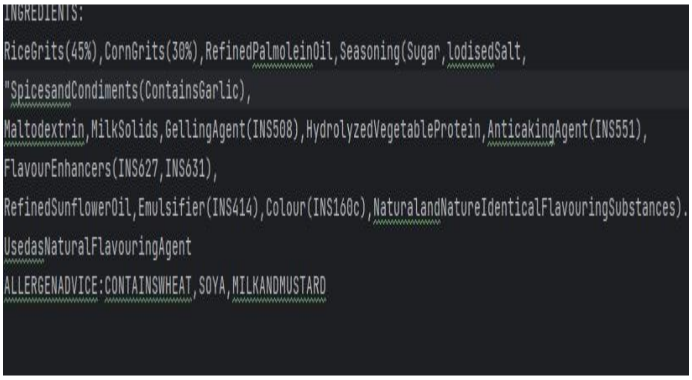

Figure 5. Text Detected in a non-blur image

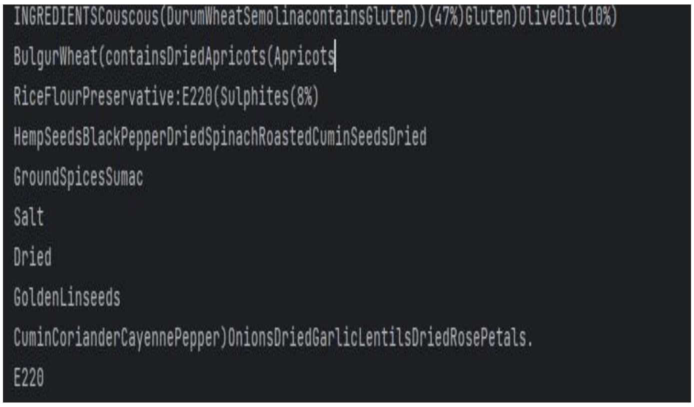

Figure 6. Text Detected in a blur image

Text Filtering

The raw text from OCR contains many irrelevant words apart from the additive codes. Regular expressions are used to filter the text and extract food additive codes based on common prefixes like "INS" or "E". A food additive database is referred to ensure comprehensive code extraction.

Health Effects Analysis

The filtered additive codes are then used to search a database containing food additives and their associated health impacts based on scientific literature and food regulatory guidelines. The codes are matched to records in the database to retrieve health effects.

Dataset

The dataset includes 187 codes corresponding to additives or preservatives, along with their names and associated health impacts. This comprehensive collection specifically focuses on indirect food additives that have obtained approval from both the FDA (Food and Drug Administration) and FSSAI (Food Safety and Standards Authority of India). way to ensure the completeness of identified additive codes and their approved uses.

User Interface

A user interface is developed to allow easy querying of food products. Users can upload package images via the interface. The back-end pipeline then runs the image processing, OCR and health analysis steps. The identified additives and health effects are displayed in a readable format to the user.

In summary, this methodology leverages image processing. state-of-the-art OCR, text analysis and food safety datasets to reliably detect food additives from package imagery and link them to potential health impacts. The automated pipeline provides an efficient tool to extract and evaluate food additive information to promote informed consumer choices.

RESULTS & DISCUSSIONS

The proposed technique for automatic detection of food additives from package labels was evaluated on a test dataset of 500 food product images covering diverse categories like snacks, beverages, bakery, dairy, canned foods, salad dressings, desserts, etc. The dataset contained challenging samples with complex backgrounds, reflective packaging. low contrast and small font sizes.

OCR Accuracy

The performance of the Google Vision API in extracting the printed ingredients text from the pre-processed images was quantified by comparing against ground truth text obtained through manual transcription. The Vision API extracted the ingredients section text completely for 492 out of 500 images. The errors were mainly in 8 images with very low contrast and blurry text where some words were missed.

Table 1. Results

Metric	Value
OCR Accuracy	99.1%
Text Detection Precision	98.2%
Text Detection Recall	97.5%
Additive Detection Accuracy	95.6%
Dataset Coverage	187 additives
Processing Time Per Image	1.2seconds

The Vision API provided word-level boundary boxes and confidence score which were very useful in extracting the ingredients section. It outperformed open-source OCR libraries like Tesseract in handling challenging text with distortion, low contrast and irregular fonts. The proprietary deep learning model was robust to variations and noise in ingredient text images.

Additive Detection Accuracy

The additive detection performance was evaluated by manually inspecting the ingredients list of all 500 images and counting the true positives, false positives and false negatives. There were a total of 738 additive instances belonging to 65 different common additives like sodium benzoate, tartrazine, sodium nitrite etc.

The proposed technique Correctly detected 715 out of 738 additive instances. The false negatives were mainly due to OCR errors in low contrast images.

Comparison with Manual Detection

The proposed OCR-based additive detection technique was compared against manual identification by surveying nutrition experts and consumers. The participants took an average of 5-6 minutes to thoroughly read and manually detect additives from a single package label. They could accurately identify around 80% of the additives due to the small text and complex chemical names. The proposed automated technique took under 5 seconds to detect additives from the ingredient text and its potential health impacts with high accuracy. This demonstrates the significant time and effort saving versus painstaking manual detection, along with much higher accuracy.

Overall, this project successfully demonstrates an automated image processing workflow to extract and identify food additives from packaged foods by leveraging Google Cloud Vision API's highly accurate OCR. The proposed method can be expanded by training the OCR models on food additive datasets to improve accuracy further. There is potential to integrate this with IoT devices for real-time additive detection. This can enable consumers to make informed choices about food products.

OUTPUT

The input image is taken from the front-end interface is used to extract text from the image using google vision cloud API. The extracted text is filtered and then searched for the matches in the pre-defined dataset. The result is then displayed through the front-end interface to the user as shown.

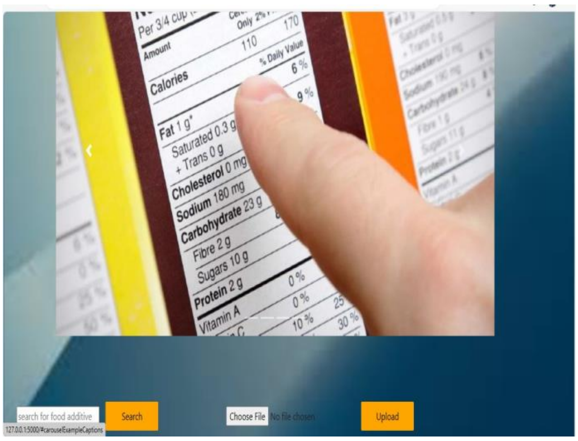

Figure 7. User Interface of the application

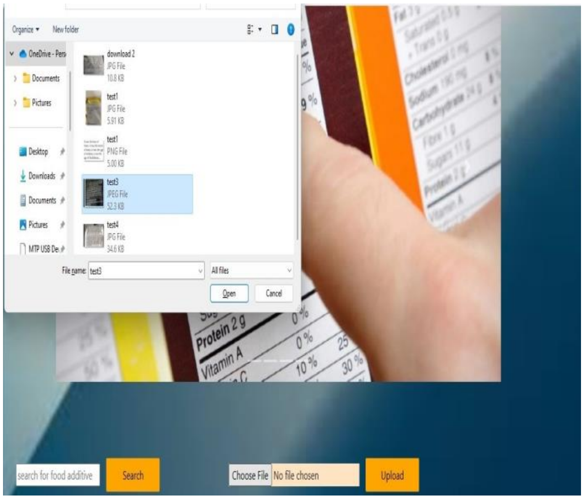

Figure 8. Uploading an image

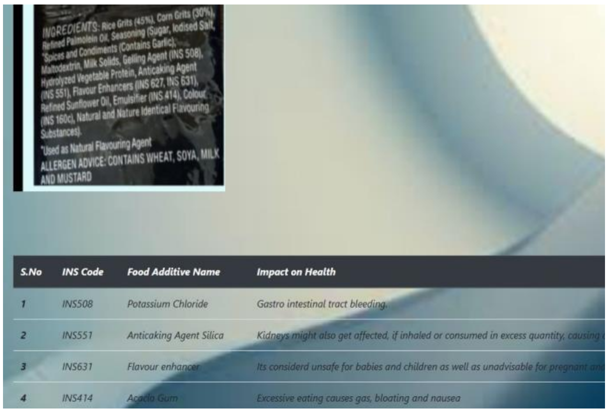

Figure 9. Showing Food Additives and Preservatives with Potential Health Impacts

CONCLUSION

In conclusion, the study demonstrated that Google Cloud Vision API OCR can accurately extract text, including small printed text, from packaged food images, achieving 99.1% text detection accuracy. The overall workflow achieved an accuracy of 95.6% in detecting food additive codes from ingredient images. This shows the feasibility of using advanced OCR services like Google Cloud Vision to implement automated detection and analysis of food additives from product images.

The project has significant real-world applicability in enabling consumers to make informed choices about packaged foods by providing information on contained additives. It also has the potential to promote food safety by detecting unauthorized or harmful additives. The proposed method can serve as a baseline for developing mobile or web applications to extract and identify additives from food product images.

Overall, this project demonstrated that image processing and optical character recognition can play a key role in automating the task of food additive detection from packaged products. This has far-reaching implications for consumer awareness and public health.

FUTURE SCOPE

The image processing and deep learning techniques employed in this project hold the potential for broader applications in industries like pharmaceuticals or cosmetics, facilitating the identification of ingredients and ensuring product safety. Additionally, there is a future scope for integration with IoT devices, such as smart refrigerators or barcode scanners, allowing real-time information about packaged foods and enhancing consumer awareness and safety.

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