| PROJECT REQUIREMENTS SPECIFICATION  Recipe Recommendation Based On Ingredients  Recognition Using CV and ML  UE19CS390A – Project Phase – 1  ***Submitted by:***   | **Name**  **A R Manyatha**  **Amulya S Dinesh**  **Manasi Swain**  **Mihir Soni** | **<SRN >**  **PES2UG19CS002**  **PES2UG19CS035**  **PES2UG19CS216**  **PES2UG19CS232** | | --- | --- |   Under the guidance of   | **Prof. Swati Pratap Jagdale**  Assistant Professor  PES University | | --- |   **January - May 2022**  **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**  FACULTY OF ENGINEERING  **PES UNIVERSITY**  (Established under Karnataka Act No. 16 of 2013)  Electronic City, Hosur Road, Bengaluru – 560 100, Karnataka, India |
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# Introduction

Recipes are the universal language of cooking. Through a recipe you quickly understand how a certain dish can be made. In the world revolving around technology, people are always on the run, leading to a busy schedule with no time for self-cafe. Food, nutrition and fitness plays a vital role to help keep up. It is indeed sad to see that people are losing interest in spending time learning and cooking new recipes. There are many websites with plenty of recipes available online, however, they lack real time analysis of ingredients used for cooking. The main objective of the proposed system is to assist users to decide what they can cook with the available resources. By pointing the camera at the food ingredients, users can immediately build a plan or have an idea of what they will be cooking, based on our recommendations along with the nutritional value of the recipe.

There are three main parts to this project: Computer vision to scan the ingredients; Machine learning to label the ingredients; Search/Web Scraping to search for recipes from the dataset based on the ingredients, if the recipe is not present, perform web scraping.

# Project Scope

Work, kids, new opportunities, those are often the priority. Healthy eating becomes a secondary concern in your life. So you run down to the cafeteria, may solve the food problem but eventually it takes its toll on your health, either through weight gain, lost energy, or both. Our system will help overcome this issue, by providing simple recipes which can be made by using ingredients available in the pantry as home cooked meals are proven to be nutritious and healthy.

To help users avoid such adjustments, image recognition can be employed to identify food ingredients that are already available at their disposal and recommend recipes based on those ingredients.

The proposed project aims to recognise various items in the pantry which includes fruits, vegetables, meat etc. On recognizing these, a recipe list will be generated and provided to the user with calories. User has the option to choose the desired recipe.

However, spices, powdered ingredients and diced fruits and vegetables pose a challenge for ingredient identification. In such scenarios, the user has an option to manually enter them.

# Literature Survey or Existing System

* *Paper - 1: Keiji Yanai, Takuma Maruyama, Yoshiyuki Kawano, “A Cooking Recipe Recommendation System with Visual Recognition of Food Ingredients”, 2014*

*Description of the approaches used*: This paper proposed a cooking recipe recommendation system by employing object recognition for food ingredients such as vegetable and meat. By pointing a mobile phone camera towards food ingredients, a user receives a recommendation list instantly.This system uses color-histogram and bag-of-features with SURF extracted from multiple frames as an image representation and a linear kernel SVM as a classifier.

*Results*: This proposed system has achieved 83.93% classification rate for 30 kinds of food ingredients within the top six candidates.

*Advantages*: The model used in this paper helps users to cook recipes based on the ingredients found in grocery stores or kitchen.

*Limitations*: Improvement of the user interface, considering the amount, nutrition and prices of ingredients

* *Paper - 2: Lili Pan, Samira Pouyanfar, Hao Chen, Jiaohua Qin, Shu-Ching Chen, “DeepFood: Automatic Multi-Class Classification of Food Ingredients Using Deep Learning”, 2017*

*Description of the approaches used*: First, an overview of the state-of-the-art research in food detection and CNNs is provided in section. Presents the details of the proposed multi-class food classification. Analyzes the experimental results on three different CNN models.

*Results*: The above model gives an accuracy of 80.76% using caffnet.

*Advantages*: Accuracy comparison between different deep learning and feature selection methods is done

*Limitations*: Complicated system with large overhead

* *Paper - 3: Alkatai Gholve , Nidhi Mishra, Revati Gaikwad, Shruti Patil. “Recipe Recommendation System”, 2019*

*Description of the approaches used*: For this developing object detection app, TensorFlow API and Cumulative Knowledge-based Regression Models (CKRM) are used.

Results: The accuracy is 88%.

Advantages: The proposed system features a low computation cost and confidentiality of the training set.

Limitations: Small training dataset.

* *Paper - 4:Mona Mishra, Yifan Gong, “Recipe Recommender System Using Image Recognition of Food Ingredients”, 2018*

*Description of the approaches used*: Image processing, Machine learning, Recommendation system, SVM, 5-layer convolutional neural network and ResNet50.

Models used are SVM, a 5-layer convolutional neural network and ResNet50 provided by Keras library.

*Results*: We realized that in order to increase the number of categories, it is important to increase the number of images for all other categories to achieve the best possible result.

*Advantages*: User friendly interface, low overhead.

*Limitations*: We found that as we increased the number of categories of the food ingredients, the accuracy dropped significantly.

* *Paper - 5: Gangothri R. Sanil , Anusha Anchan , Vijetha Achar, Kavya Hegde, “KNN based Recipe Retrieval using Ingredient Recognition”, 2018*

*Description of the approaches used*: In this paper, we advent a Cooking Recipe Retrieval System with the recognition of food ingredients, which helps us to search for cooking recipes either by Image or Name. Feature Extraction of selected images is carried out by HARRIS and SIFT. Comparison of data of selected image with the trained data by using KNN Algorithm.

*Results*:The user sometimes may not know what an ingredient is just from its name. So images of the ingredients provided are more helpful to the user. It is helpful for both those who do not know the ingredient name but are familiar with the image and those who do not know the ingredient image but familiar with the names.

*Advantages*: Simple UI in the form of a mobile application. High accuracy.

*Limitations*: Should improve the object recognition, recipe recommendation functionalities

* *Paper - 6: Yudong Zhang,Shuihua Wang, Genlin Ji, Reetha Phillips, “Fruit Classification using Computer Vision and Feedforward Neural Network”, 2015*

*Description of the approaches used:* Proposed a hybrid feature set, containing color information, texture information, and shape information. Introduced a stratified k-fold cross validation to avoid overfitting. The FSCABC algorithm, and employed it to the training of FNN. Compare it with other algorithms. Gave the confusion matrix indicating which types of fruits the classifier does not work well on

*Results*: Classification accuracy of 89.1%

*Advantages*: Creation and usage of own dataset,which is customized for the required project.

*Limitations*: Limited to whole fruits and not diced, frozen or canned fruits.

* *Paper - 7: Horea Muresan, Mihai Oltean, “Fruit recognition from images using deep learning” , 2020*

*Description of the approaches used*: In this paper, Convolutional neural network is used for detecting fruits taking into account the structure of images while processing them. For the purpose of implementing, training and testing the network TensorFlow library which includes the features of Keras framework was used. The neural network was trained using different levels of data augmentation and preprocessing.

*Results*: The model trained with RGB images obtained the best performance i.e, 98.66% accuracy on the test set.

*Advantages*: Image recognition to detect fruits by considering the structure of images to categorize them efficiently.

*Limitations*: Dataset containing less variety of ingredients, no real time analysis of food ingredients.

* *Paper - 8: Frida Femling, Adam Olsson, Fernando Alonso-Fernandez, “Fruit and Vegetable Identification Using Machine Learning for Retail Applications”, 2018*

*Description of the approaches used*: Evaluated two Convolutional Neural Network architectures (Inception and MobileNet), as classifiers of 10 different kinds of fruits or vegetables. Images for the classifier are provided by a Raspberry Pi Camera Module v2, connected to a Raspberry Pi.

*Results*: Top 3 accuracy of MobileNet is 97%, top 3 accuracy of Inception is 96%.

*Advantages*: Dataset includes images from existing dataset and self collected images. Good accuracy.

*Limitations*: Uses extra hardware components like Raspberry pi.

* *Paper - 9: Dang Thi Phuong Chung, Dinh Van Tai, “A fruits recognition system based on a modern deep learning technique” , 2019*

*Description of the approaches used*: This paper explores a fruits recognition classifier based on EfficientNet algorithm. EfficientNet uses pre-trained convolutional neural networks for conducting image related functions as a base network. The user interface employed as a mobile application.

*Results*: Model achieved the best test accuracy of 98% in case 4 from 11 to 15 epochs and best training accuracy of 96.79% at epoch 13.

*Advantages*: Simple model with good accuracy.

*Limitations*: Model is trained to recognize only a few types of fruits.

# Product Perspective

We reviewed how visual content, context and external knowledge can be integrated effectively into food-oriented applications, with special focus on recipe analysis and retrieval, food recommendation as emerging direction.

We largely rely on contextual and prior information. Similarly, context and prior knowledge can be integrated in automatic food analysis systems.

People enjoy food photography because they appreciate food. Behind each meal there is a story described in a complex recipe and, unfortunately, by simply looking at a food image we do not have access to its preparation process, this inspired the project on inverse cooking.

Our project does the opposite of this i.e. we take pictures of ingredients and provide the user with the list of recipes.

# Product Features

1. Computer Vision - Object detection is a computer vision technique that allows us to identify and locate objects in an image or video. With this kind of identification and localization, object detection can be used to count objects in a scene while accurately labeling them. Here, we use a camera to scan the ingredients present in the pantry.
2. Machine Learning - In machine learning, data labeling is the process of identifying raw data (images, videos, etc.) and adding one or more meaningful and informative labels to provide context so that a machine learning model can learn from it. The ingredients scanned by using CV are now labeled using ML models for accurate results .
3. Search / Web Scraping - The recipe for the list of labeled ingredients obtained from the above steps is searched from the predefined database. If the ingredients do not match with the existing data, we will perform web scraping to do the same. The list of recipes which meet the requirements are returned to the user. The user has the option to choose from this list.
4. Mobile Application - A simple user friendly UI will be created where the user can login and create an account. These credentials are saved in the database. Once logged in, the user can upload the images of ingredients. These images are processed and the list of suitable recipes are recommended. Additionally, the calories of each recipe will be displayed.

# User Classes and Characteristics

Users of the system should be able to retrieve recipes with nutrition value, on uploading the images of ingredients from the database. The following are the target user class of our application:

* People who want to learn how to cook
* People who want to try new recipes
* People who are not sure what to cook based on the available ingredients
* Inspires new ideas and activities in the kitchen for new cooks, busy parents, foodies, and pro chefs alike.

The user should be able to do the following functions:

* Sign up/ Sign in
* Upload ingredient image
* Manually enter optional ingredients (spices, chopped vegetables, powdered ingredients, etc)
* Choose from list of recipes
* Logout

The admin should do the following:

* Authenticate user
* Provide choice of diet (diabetics, vegetarian, vegan, etc)
* Add/Update new recipes to database
* Display recipe list

# Operating Environment

* HardwarePlatform -> Smartphones/Desktop computers
* OS -> Windows 7 and onwards /MacOS OS X and onwards
* Distributed Database (MongoDB)
* Client/Server system

# General Constraints, Assumptions and Dependencies

* Hardware limitations:
  + low camera quality
  + low lighting (bad quality captured)
  + Storage limitations of the server
* Criticality of application: The most important component of the application would be the code that contains the ML model. It is vital that this piece of software must not fail.
* Safety and security consideration:

There is no safety consideration needed as there is no physical component in the project. Security concerns may include server attacks that may inhibit normal functioning of the application.

# Risks

* Failure to remove essential bugs
* Unable to upload photos to the server
* Unable to keep server up and running
* ML model might take time to process the images

# Functional Requirements

* Validity tests on inputs: Thorough preprocessing will be done to ensure that the datasets are clean and the pictures/videos sent by the user will be tested against the model.
* Sequence of operations: First the user will take pictures/videos and upload it into our mobile-app. Then our cv model will take that as an input to extract data points. These data points will be taken as input for the model which will output the recipe to print it to the user.
* Error handling and recovery: If the images/videos get lost in transit, then we will ask the user to resend the files.
* Consequences of parameters: The images will be processed and labeling will be done accordingly. This is then fed to the algorithm and desired output is generated.
* Relationship of outputs to inputs: Input will be given to the CV model by the user which will output to the ML model which will output the final answer to the users mobile app.

# External Interface Requirements

# User Interfaces

* Required screen formats with GUI standards for styles: When digital products are designed around responsive grid systems, UI Style Guides must address interface layouts across screen sizes. Typography is one of the most common interface design elements, so it’s not enough to merely list the names of typefaces used in a product. Clear instructions should be given for Titles, Subtitles, Headings (H1, H2, H3), Body Text, and Captions. One of the quickest ways to wreck an interface is inconsistent color use, so color palette need to be clearly defined
* Screen layout and standard functions : Size, position, density rhythm, background color will be taken into consideration while designing the screen layout. Standard functions such as pointers, icons, windows, menus, scroll bars etc will also be employed.
* Relative timing of inputs and outputs: The application should display the opened document within 10s after it is started. While a user scrolls the requirements table, the application should not display scrolling jerks longer than 200ms.
* Availability of some form of programmable function key: An Upload button will be available on the UI. A shortcut for this key is the “Enter” key. Shortcut for the Print button can be the “PrtScr” key. “Ctrl+C” can be used to logout.
* Error messages: Appropriate error messages along with error code will be displayed on failure of operations.

# Hardware Requirements

For our project the hardware required includes:

* Phone camera
* Server (running TCP/UDP protocols) which will run our model and provide results

# Software Requirements

* Name and Description- Recipe recommendation based on ingredients recognition using CV and ML(RRIR). Using camera to scan the ingredients present in the pantry and provide the user all the dishes and recipes possible
* Version / Release Number
* Databases - MongoDB
* Operating Systems-Windows 7 and onwards /MacOS OS X and onwards
* Tools and libraries- OpenCV , TensorFlow

# Communication Interfaces

We will be using a mobile phone camera to take the pictures/video and send it to our computer using wifi. It will only be using standard wifi to match the compatibility standards of modern handheld devices and for reliability.

# Non-Functional Requirements

# Performance Requirement

Availability: The server should be available on specified time as many users are waiting for the recipe to be generated .

Correctness: Accurate recipes should be recommended to the user in real time.

Maintainability: The administrators should ensure that the server is up and running and not overloaded, ensuring it is well maintained.

Usability: The model should handle multiple requests from multiple users.

# Safety Requirements

If there is extensive damage to a wide portion of the database due to catastrophic failure, such as a disk crash, the recovery method restores a past copy of the database that was backed up to archival storage (typically tape) and reconstructs a more current state by reapplying or redoing the operations of committed transactions from the backed up log, up to the time of failure.

# Security Requirements

Authentication of user whenever he/she logs into the system. The users will have private user profiles which will store data of the the recipes that they’ve used from our application previously on a MongoDB server which will be kept hidden from the public. MongoDB has a multitude of security features, such as encryption, authentication, role-based access control, TLS/SSL encryption and many more. We will have a user\_id and a password for authentication which will be logged in in the mobile application.

# Other Requirements

The model requires a server with high speed internet capability. The user should be equipped with fair network bandwidth to send images and receive recipes.

The system will be designed to be *highly scalable*, ie, it will be able to process a wide range of ingredients efficiently.

# Appendix A: Definitions, Acronyms and Abbreviations

* ML : Machine Learning
* CV : Computer Vision
* RRIR : Recipe Recommendation Based On Ingredients Recognition Using CV and ML
* Image labeling: It is the process of identifying and marking various details in an image. Image labeling is useful when automating the process of generating metadata or making recommendations to users based on details in their images

# Appendix B: References

* Keiji Yanai, Takuma Maruyama, Yoshiyuki Kawano, “A Cooking Recipe Recommendation System with Visual Recognition of Food Ingredients”, 2014
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