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COOKPAD: KNN based Recipe Retrieval using Ingredient Recognition

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ABSTRACT: This paper proposes a cooking Recipe Retrieval System. The system proposed, does the real time recognition of the ingredient by name or image. It helps a user to retrieve set of recipes including those food ingredients. The user can go for the Diet Restriction option, which displays the recipes that are preferable for patients with different dietary restrictions, as well as for healthy individuals. This system also provides the facility for the user to view the images of ingredients. The system is developed using MATLAB. Harris Corner Detector, K-Nearest Neighbor technique and Scale Invariant Feature Transformer (SIFT) are used to build this system. The design and implementation of the system is such a way that it can be used intuitively and effectively.

KEYWORDS: Harris Detector, SIFT, KNN, MATLAB, COOKPAD.

I. INTRODUCTION

Search engines have made access to information easy. One only needs to get connected to the internet to get the information one needs. When searching for cooking recipes, sometimes user may prefer to search based on ingredients. It will be more helpful if the search also suggests similar recipes. The user sometimes may not know what an ingredient is just from its name. So images of the ingredients provided to select, is more helpful to the user. Normally cooking a recipe is very difficult for the user they will not be aware of the recipes and what kind of ingredients it is. It leads to set of problems like; user may not know the idea about the ingredients and recipes and what recipes can be prepared using the given ingredients. Sometimes user may get the required information only after visiting the multiple pages. Also sometimes only ingredient name will be displayed to select. So that user will not knowing about the ingredient without displaying its image. Output may contain unwanted information.

The proposed system works as a recipe suggestion tool, to suggest a set of recipes. Users can search based on ingredients name or image. When user selects an ingredient image one can able to see the image displayed on screen and set of recipes that can be prepared by using selected ingredient. Even the user can search the ingredients by using the option search by name, which will again display the image and the set of the ingredients on the screen. The user can go for the option Diet restriction which displays the recipes that are preferable for the user.

By using MATLAB, initially Harris detection will detect the features of selected ingredients. Then classifier called K-Nearest Neighbor technique will be trained, which has the values of ingredients. When a user selects an ingredient, feature values of ingredient should match with the nearest value of the KNN classifier. The system should be trained properly for the efficient work. Finally it will display the name and description of recipes.

II. RELATED WORK

Smart cooking has recently become the center of increased interest as shown by the development of related workshops such as the Workshop on Multimedia for Cooking and Eating Activities [7]. In this domain, the increasing importance of food related tasks in computer vision has motivated the creation of many related datasets. In order to solve more complex tasks, other initiatives provided richer sets of images. For example, [8] proposed the Food-101 dataset,

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containing around 101,000 images of 101 different categories. Super Cook [9] is a recipe search engine that lets user search by ingredients they have at home. This helps to find set of recipes, the user can make with the ingredients that are available at home. Super Cook can help users save hundreds on grocery bills by showing how to fully use the ingredients a user have at home. But this website has some issues when handling by the user that is when a user search for a dish it displays only the image of the dish to be prepared along with the name and if a user need the description then it will be displayed in multiple pages. Which creates a problem of buffering and user should have the network connection for searching needed information.

In this paper, we propose a system, which uses Harris Corner Detector [2], a mathematical operator that finds features in an image. It is simple to compute, and is fast enough to work on computers. Also, it is popular because it is rotation, scale and illumination variation independent. Harris Detector and SIFT based strategies have been successfully used to detect the features of the images. KNN addresses the pattern recognition problems and also the best choices for addressing some of the classification related tasks. The simple version of the K-Nearest Neighbor classifier algorithms is to predict the target label by finding the nearest Neighbor class. The closest class will be identified using the distance measures like Euclidean distance. In the proposed system, the K-Nearest Neighbor technique will be trained, which has the values of ingredients. When a user selects an ingredient, feature values of ingredient should match with the nearest value of the KNN classifier.

III. SYSTEM IMPLEMENTATION

System Implementation is the stage where the theoretical design is converted into a working system, replacing an existing manual, or automated system or it may be a major modification to an existing system. This system is implemented using MATLAB 2016a and GUI provided by MATLAB. The system is implemented using following set of functions.

Conversion of RGB Image to Gray Image

The use of color in image processing is motivated by two principal factors; First color is a powerful descriptor that often simplifies object identification and extraction from a scene. Second, human can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. In RGB model, each color appears in its primary spectral components of red, green and blue. This model is based on Cartesian coordinate system. Images represented in RGB color model consist of three component images. One for each primary, when fed into an RGB monitor, these three images combines on the phosphor screen to produce a composite color image. The number of bits used to represent each pixel in RGB space is called the pixel depth.

In this system `rgb2gray` function is used converts RGB images to greyscale by eliminating the hue and saturation information while retaining the luminance. Because RGB image is not feasible to find corner points. But when an image is converted to gray scale one can easily draw the points.

Harris Corner Detector

The Harris corner detector is a popular interest point detector due to its strong invariance to rotation, scale, illumination variation and image noise. The Harris corner detector is based on the local auto-correlation function of a signal; where the local auto-correlation function measures the local changes of the signal with patches shifted by a small amount in different directions. Harris corner detection algorithm is found out by calculating each pixel's gradient.

In this system user defined function `harris()` considers the pixels of a selected image. If the absolute gradient values in both the directions are great, then consider the pixel as a corner and all the required features of the selected corner will be extracted.

Scale Invariant Feature Transform (SIFT)

SIFT is an image descriptor for image-based matching and recognition function. This descriptor as well as related image descriptors is used for a large number of purposes in computer vision related to point matching between different views of a 3-D scene and view-based object recognition. The SIFT descriptor is invariant to translations, rotations and scaling transformations in the image domain and robust to moderate perspective transformations and illumination

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variations. Experimentally, the SIFT descriptor has been proven to be very useful in practice for robust image matching and object recognition under real-world conditions. In its original formulation, the SIFT descriptor comprised a method for detecting interest points from a grey-level image at which statistics of local gradient directions of image intensities were accumulated to give a summarizing description of the local image structures in a local Neighbourhood around each interest point, with the intention that this descriptor should be used for matching corresponding interest points between different images. Later, the SIFT descriptor has also been applied at dense grids (dense SIFT) which have been shown to lead to better performance for tasks such as object categorization and texture classification.

In this system SIFT descriptor has been implemented using user defined function, `find_sift()`, which is very stable in regard to change in rotation, scale and transformation. This function is based on features extracted from the image using Harris corner detection.

K-Nearest Neighbor Algorithm (KNN)

KNN is the algorithm used for classifying the data. It uses the Nearest-Neighbor classifiers which are based on learning by analogy, that is, by comparing a given test tuple with training tuples that are similar to it. The training tuples are described by n attributes. When $k = 1$, the unidentified tuple is allocated the class of the training tuple that is nearby to it in pattern space.

In this system user defined function `knnsearch()` is used for classifying data based on the closest training examples in the feature space. First the datasets are divided into a ingredients testing and training set. For each row in the testing set, the K nearest training test objects are found and the classification of test data is determined by majority vote with ties broken at random. If there are ties for the K^{th} nearest vector, then all the instances are included in the vote.

Flowchart of COOKPAD System

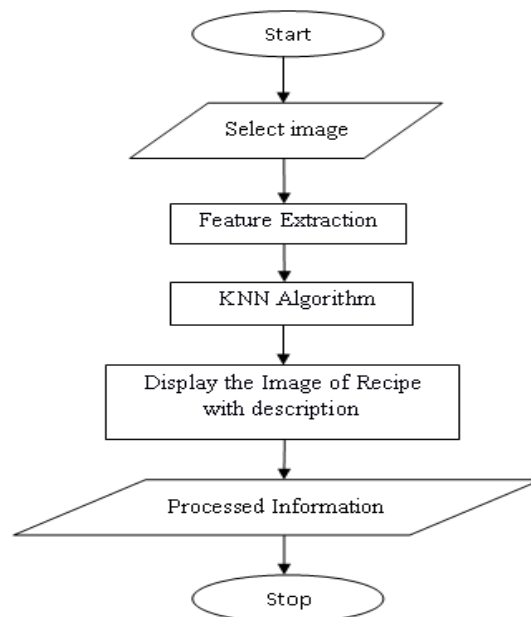


Figure 3.1: Flowchart of COOK PAD System

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Figure 3.1 shows a Flowchart of the COOKPAD System which takes image as an input. Features of selected image will be extracted and KNN Algorithm will be used for comparing, features of selected image with the trained data. Finally Recipe of selected ingredient will be displayed as output.

Algorithm for COOKPAD

- Step 1:** Image Acquisition is done and training dataset is created.
- Step 2:** Ingredient is selected either by Image or Name.
- Step 3:** Feature Extraction of selected image is carried out by HARRIS and SIFT.
- Step 4:** Comparison of data of selected image with the trained data by using KNN Algorithm.
- Step 5:** Display the image of Recipe with Description.

Initially training will takes place for set of images stored in a file. After training, features will be extracted to create a dataset. When user selects an ingredient by image or name, the system will display selected ingredient image as well as set of recipes that could be prepared using selected ingredient. This system also provides a feature for suggesting healthy diet related information.

Data Flow Diagram for COOK PAD System

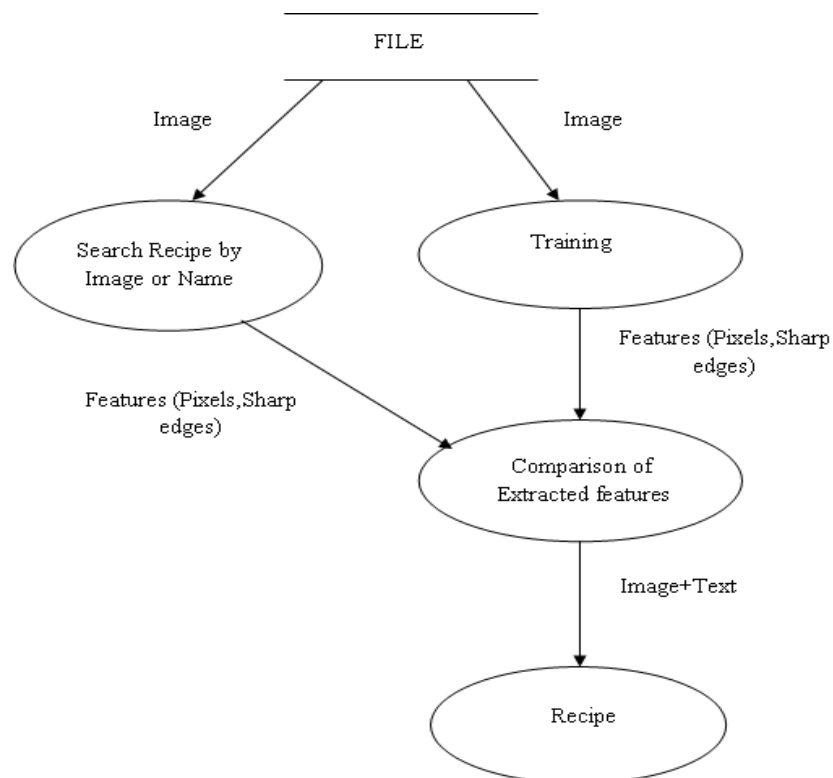


Figure 3.2: Data Flow Diagram for COOK PAD System

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Figure 3.2 shows a Data Flow Diagram for COOKPAD system. Acquired Images stored in a file are used for training. During training Harris and SIFT functions are used for extracting the features such as pixels and sharp edges. Result dataset of extracted features will be stored in a system and it can be used for Recipe Retrieval. User can choose any one of the two options provided, i.e Search by Image or Search by Name. Whenever user request for recipe, system will display the Description of Recipe prepared by that ingredient along with Image.

IV. EXPERIMENTAL RESULTS

Figure 4.1 shows training option where training of the stored images will takes place. It will randomly display all the images on the screen one by one. A small delay is given for displaying each image.

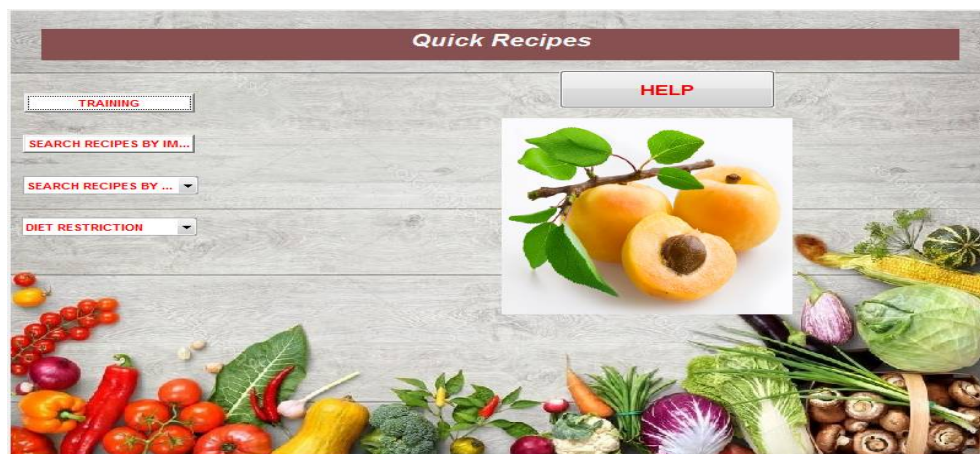


Figure 4.1: Training Option

Search by Name option is shown in Figure 4.2. While selecting the name of an ingredient, Image of the Recipe will be displayed to the user along with Image of Ingredient.

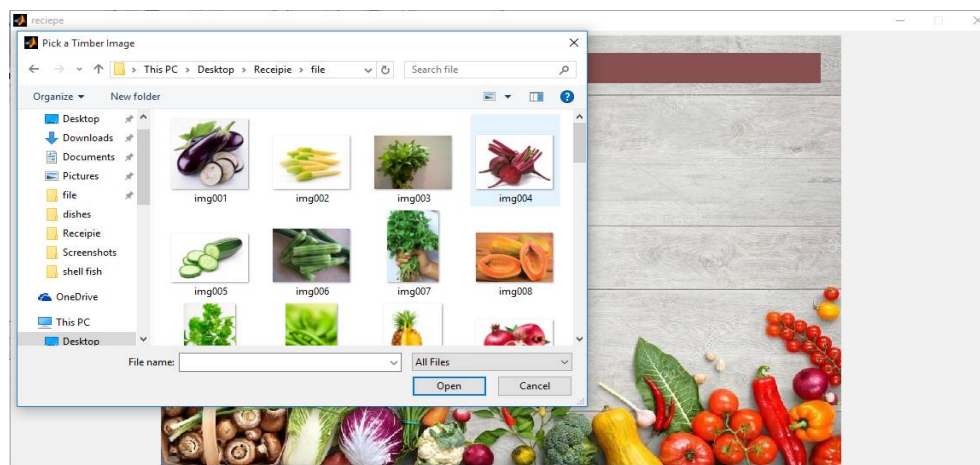


Figure 4.2: Search by Image Option

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Search by Image option is shown in Figure 4.3. While selecting the image of an ingredient, Image of the Recipe will be displayed to the user along with Image of Ingredient.

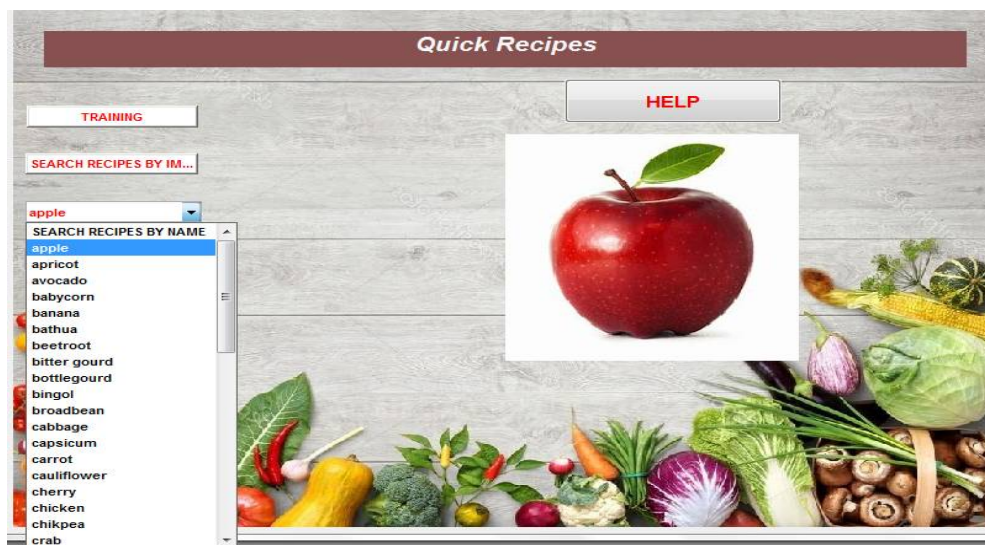


Figure 4.3: Search by Name Option

Recipe Description of selected ingredient either by Name or Image is displayed as result along with the Image of the recipe, which is shown in Figure 4.4.

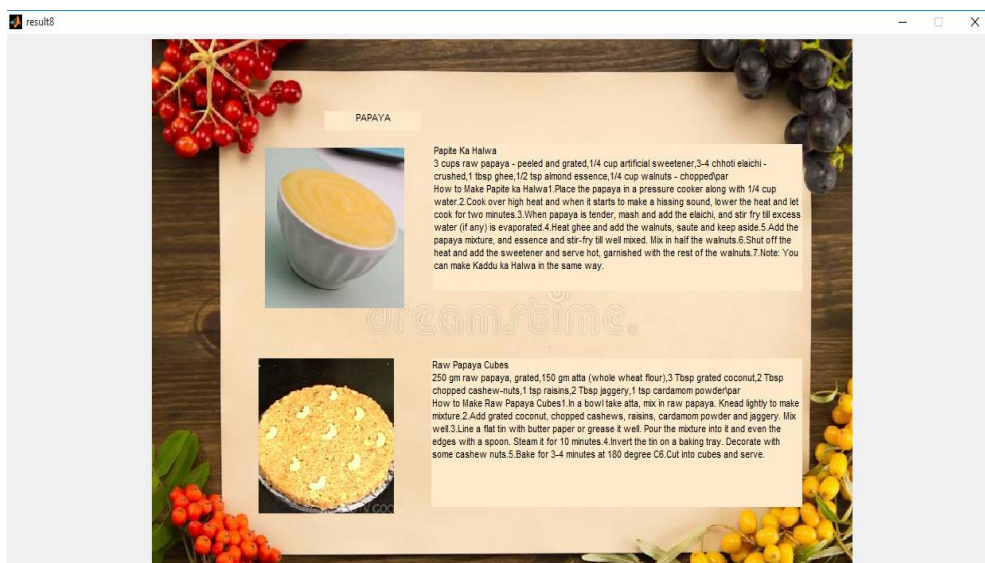


Figure 4.4: Recipe Description

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This system provides Diet Restriction option with three sub options like Breakfast,Lunch and Dinner which is shown in shown in Figure 4.5.



Figure 4.5: Selecting Diet Restriction Option

The result of Diet Restriction option is shown in Figure 4.6 for Dinner Option.

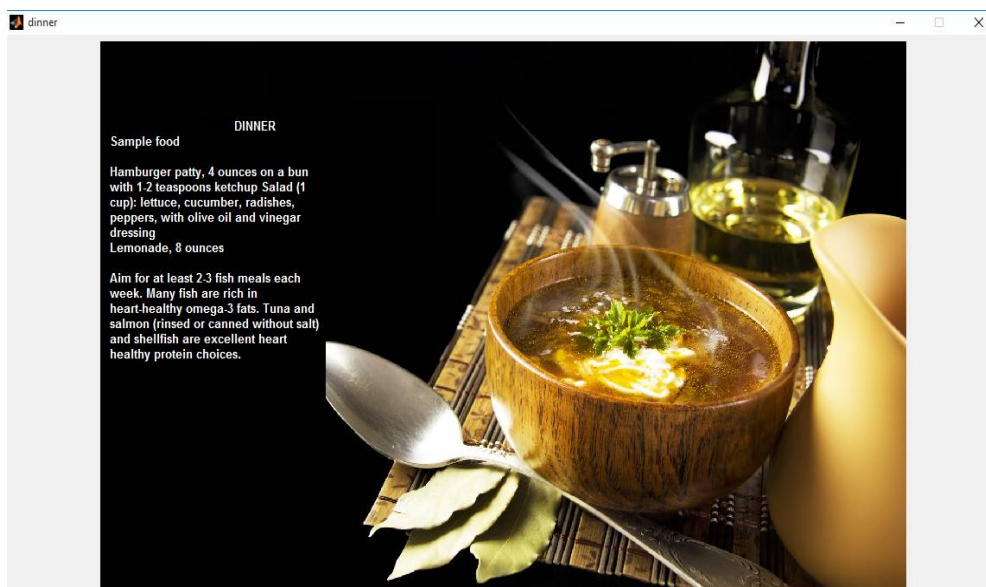


Figure 4.6: Result of Dinner Option

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V. CONCLUSION

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. 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 who do not know the ingredient name but familiar with image and who do not know the ingredient image but familiar with the names.

For future work, the plan is to improve the object recognition, recipe recommendation and the system user interface. This system can be enhanced by adding the combination of two or more ingredients combined as one, along with their nutrition and the budgets. As a future work even the more and more features of food image can be given as an input. Also Recipes can be classified based on the time required for the recipe to cook.

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