

## Automatic Vegetable Detection and Recipe Suggestion

Swati Kalyanasundar<sup>1</sup>, Sangeetha Rajesh<sup>2</sup>

<sup>1</sup>(MCA 2015-18, K.J. Somaiya Institute of Management Studies and Research, India)

<sup>2</sup>(Assistant Professor, IT, K.J. Somaiya Institute of Management Studies and Research, India)

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**Abstract:** Image processing is one of the fastest growing technologies now a days. It converts an image into digital form, perform operations on it and gets some useful information which can be used for various applications. There are many ways to use image processing which will help us in day to day life crisis. In this paper, we propose a system that suggests recipes by identifying vegetables available with the user. We use image processing technology to identify the vegetables. The system will search for the recipes based on the identified vegetables via Internet. We also discuss case scenarios which portrays the working of the proposed system.

**Keywords:** Gray level threshold, Histogram based database, Image processing, Recipe suggestion, Texture classification, Web crawlers.

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### I. Introduction

After a long, tiring day at work, the day does not end for most Indian women. Dinner is to be prepared for the family. Now, the most common question that arises for them is, “What should I cook today?” The proposed system will automatically detect the vegetables available and suggests a variety of amazing dishes that can be cooked. This is achieved by using the techniques of image processing and pattern matching. Object detection and identification is an important process in image processing [15] and computer vision [4]. This process involves uploading images to the system, extraction [1] of various features from the input image such as color, shape, size, density, texture, etc. The Internet is filled with information on multiple subjects across the globe. The general tendency of people is that they have to manually type the search string on any of the search engines that they prefer. It is a tedious and time-consuming process. The proposed system aims at simplifying this process and automatically directs the result generated as search string over the network and searches for recipe links which includes the identified vegetables from the set of URLs.

The paper starts with introduction to the topic and is followed by related works in section 2. Section 3 details the working of the proposed system. It also includes the algorithm proposed to implement the system. Few case scenarios are discussed along with the User Interface for the proposed system. The paper ends with conclusion and future scope given in the last section, section 4.

### II. Related Work

In this paper, various techniques are used to find out the best matching image based on features such as color, shape, texture and size. One of the techniques used is by comparing Histograms of the captured image and the stored image. Another technique is to classify based on the texture of the vegetable in the image. These two methods help in identifying the parent class of the vegetable that is to be identified. If there are multiple vegetables belonging to the same parent class then another method called Gray level threshold levels. [1]

Web Crawlers are used to search through all the Web Servers to find information about a particular topic. This paper shows various ways to implement a personal Web Crawler and also portrays its various advantages or regular Web Crawlers. The paper also shows how seed generation takes place and how it is used to fetch the necessary pages automatically at regular intervals. [3]

Improvement in the relevance prediction is important. This paper [2] talks about how this can be achieved. In this paper, a new method is implemented which improves the relevance prediction for focused web crawlers to help distinguish between a relevant and irrelevant URLs with respect to the search performed. The method includes classification of input and output based on classifiers. This paper also discusses about the algorithm created to predict URL relevance.

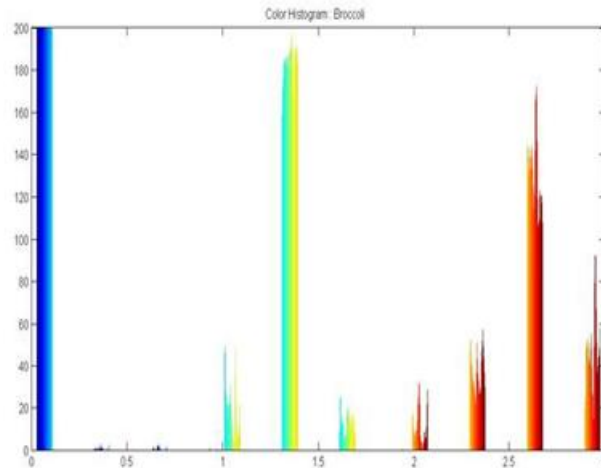
### III. Proposed System

The primary task of the system is to identify the vegetables from the image. Image can be captured by the system at pre-defined intervals, such as 10:30 am for Lunch and 7:30 pm for Dinner, or whenever the user of the system prompts for it. The system will capture a lights-off image and a lights-on image and upload.

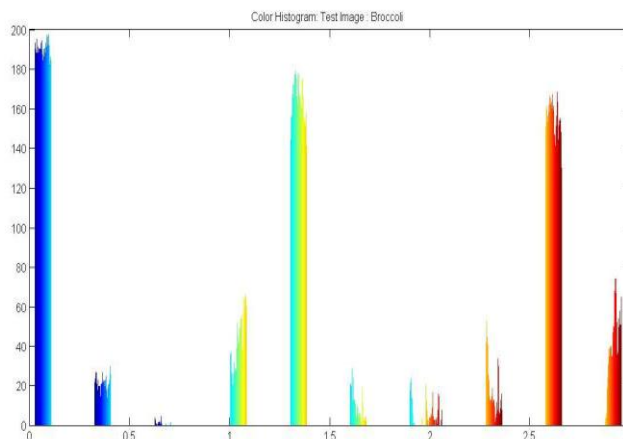
According to the authors of [1], the automatic vegetable recognition system (Vegetable Vision) can recognize, analyze, and process images based on various features. The process involves the following steps:

1. Capturing image
2. Converting the image into HSV model
3. Processing and analyzing the image
4. Compare between learnt images and the captured image
5. Match image and give final result

After the captured image is uploaded, the system converts the image into HSV model to avoid illumination effects. Further, histogram is calculated and compared with stored histograms. Fig. 1 shows the color histogram of broccoli from the trained database whereas Fig. 2 shows the tested broccoli and its color histogram.



**Fig. 1** Color Histogram of broccoli for trained database [4]



**Fig. 2** Tested broccoli and its color histogram [5]

On analysis of the image based on its features and on comparing their histograms to find the best match, we obtain the parent class of the vegetable. After detecting the parent class, child class is determined on the basis of texture, shape and other features. The paper uses the example of Zucchini and Beans. Both these vegetables will first be identified as Green Vegetables (Parent Class). Further, to detect child class, the system uses Gray level threshold to calculate connected component size after eliminating smaller blobs. The closer the objects are, the larger will be the connected component.

Fig. 3 shows sample image of Zucchini and Fig. 4 shows sample image of Beans.

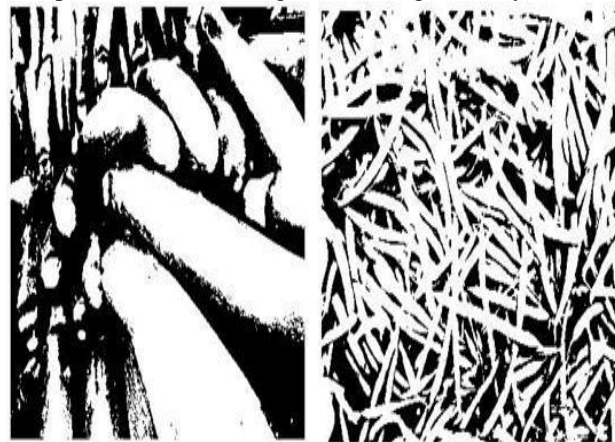


**Fig. 3** Zucchini



**Fig. 4** Beans

Fig. 5 shows the connected component of the two vegetables using the Gray level threshold.



**Fig. 5** Zucchini and Beans Connected Component [8]

The white area in Fig. 6 represents the connected component of the vegetables. Beans have a larger connected component than Zucchini.



**Fig. 6** Zucchini and Beans largest connected component (White area) [4,8]

On the basis of the area covered in the connected component figure, the system can identify the vegetables. The experiments conducted in the paper shows an accuracy of 96.55% in identifying the vegetables. After identification of the available vegetables, the next step is to search for recipes which include these vegetables. The proposed system will receive the names of vegetables using MQTT protocol which is a lightweight protocol that is used for machine to machine communication. This protocol doesn't require a continuous connection. When the names of vegetables are listed, the user can select the vegetables he/she wants to cook with. This selection is then used as a search string to obtain a list of recipes that can be prepared with the selected ingredients.

### 3.1 Assumptions:

1. A list of selected URLs of blogs or chefs who have their recipe pages called "RecipeList"
2. An empty list of vegetables to search
3. An empty list called "RecipesFound"

### Pseudo Code For Finding Recipe Links:

```

1. Receive names of vegetables identified by the system.
2. Add these names to the empty list of vegetables to be searched called "Input".
3. while (there are unvisited links in RecipeList)
{
Pick one URL from RecipeList
while(HTML text contains another link)
{
if opened link is an HTML file
{
if URL is not marked as searched then
mark as searched
if link contains vegetables identified as Input then
add link to RecipesFound
}
else
Pick the next link from RecipeList
}
}
}

```

### 4. Return RecipeFound list to the system.

The algorithm receives names of vegetables identified by the image processing system as "Input". There is a list maintained which has the URLs of bloggers who write recipes on the Internet. This list is called "RecipeList" according to the algorithm. Once the user selects the vegetables to be cooked with, it is added to the list of vegetables to be searched. This works similar to the search string in various search engines available on the Internet. Recipes that use those ingredients are searched from RecipeList and a new list is created if the system finds matching recipes. This list is called "RecipesFound". This is repeated as long as there are unvisited links in the RecipeList. In the next iterations, recipes are added to the RecipesFound list that was created in the first iteration. The user is then shown RecipesFound list as the output recipe suggestions after there are no unvisited links in RecipeList.

### 3.2 User Interface:

The User Interface for the proposed system looks like this - Fig.7 shows the first screen which has a camera button and the image can be uploaded to the system. Fig.8 shows the output of image processing and lists down the identified vegetables as per the image uploaded. Here, the user can select one or all of the checkboxes of ingredients displayed in the list. Fig.9 illustrates the list of suggested recipe list (i.e. RecipesFound) as the output. This list shows the recipe suggestions based on the checked ingredients in the previous screen.

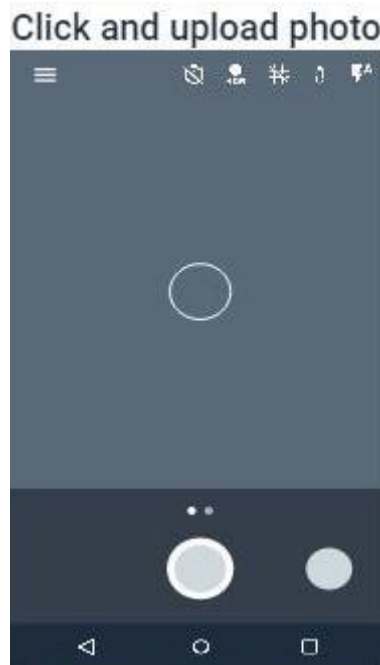


Fig. 7 Screen 1 to capture and upload picture

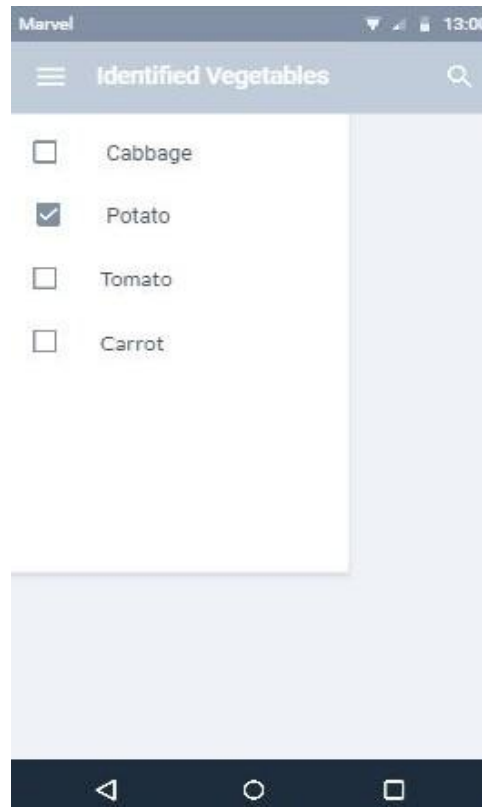


Fig. 8 Screen 2 displaying the list of identified vegetables

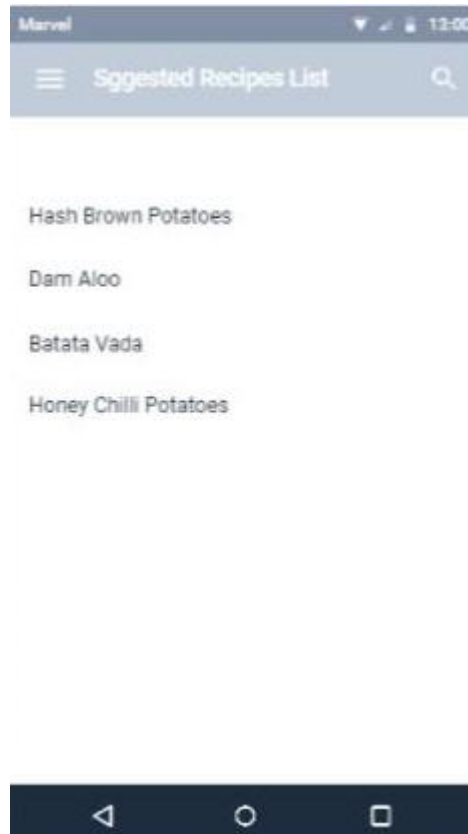


Fig. 9 Screen 3 displaying the list of suggested recipes using Potato

### 3.3 Case Scenarios:

#### Case 1:

In this case, we consider that there are few URLs in the list called RecipeList such as [www.swatiskitchen.com/recipes](http://www.swatiskitchen.com/recipes), [www.kitchensofindia.com/recipes](http://www.kitchensofindia.com/recipes), [www.mykitchenchronicles.com/recipes](http://www.mykitchenchronicles.com/recipes), [www.merakhaanakhazaana.com/recipes](http://www.merakhaanakhazaana.com/recipes), etc. The system identified vegetables like Potato, Capsicum, Onion. Now the algorithm knows the vegetables identified (i.e. input). The proposed system then searches for recipes that use potato, onion and capsicum from RecipeList. When the first matching recipe is found (e.g. Stuffed Capsicum from [www.swatiskitchen.com/recipes](http://www.swatiskitchen.com/recipes)), a new list is created called RecipesFound and it is added to the list. This process keeps repeating for all the unvisited URLs in the list RecipeList. Once all the URLs are visited (i.e. checked), the RecipesFound list is returned to the user as suggested list of recipes (i.e. output).

Variables and their values:

1. Input (i.e. identified vegetables):

- a) Potato,
- b) Capsicum,
- c) Onion

2. Recipe List:

- a) [www.swatiskitchen.com/recipes](http://www.swatiskitchen.com/recipes),
- b) [www.kitchensofindia.com/recipes](http://www.kitchensofindia.com/recipes),
- c) [www.mykitchenchronicles.com/recipes](http://www.mykitchenchronicles.com/recipes),
- d) [www.merakhaanakhazaana.com/recipes](http://www.merakhaanakhazaana.com/recipes)

3. RecipesFound:

- a) Stuffed Capsicum,
- b) Aloo Capsicum,
- c) Potato and Onion Gratin,
- d) Potato Onion Capsicum Paratha stuffing

**Case 2:**

In this case, we consider the same list called RecipeList which has URLs such as [www.mykitchenchronicles.com/recipes](http://www.mykitchenchronicles.com/recipes), [www.swatiskitchen.com/recipes](http://www.swatiskitchen.com/recipes), [www.kitchensofindia.com/recipes](http://www.kitchensofindia.com/recipes), [www.merakhaanakhazaana.com/recipes](http://www.merakhaanakhazaana.com/recipes), etc. The system identified vegetables like Cabbage, Potato, Tomato and Carrot. Now, if the user selected only Potato from this list as shown in Fig.8, the algorithm gets the input as Potato and not the other vegetables. The proposed system then searches for recipes that use potato from RecipeList. When the first matching recipe is found (e.g. Hash Brown Potatoes from [www.mykitchenchronicles.com/recipes](http://www.mykitchenchronicles.com/recipes)), a new list is created called RecipesFound and it is added to the list. This process keeps repeating for all the unvisited URLs in the list RecipeList. Once all the URLs are visited (i.e. checked), the RecipesFound list as shown in Fig.9 is returned to the user as suggested list of recipes (i.e. output).

Variables and their values:

1. Input (i.e. identified vegetables):

- a) Cabbage,
- b) Potato,
- c) Tomato,
- d) Carrot

2. Recipe List:

- a) [www.swatiskitchen.com/recipes](http://www.swatiskitchen.com/recipes),
- b) [www.kitchensofindia.com/recipes](http://www.kitchensofindia.com/recipes),
- c) [www.mykitchenchronicles.com/recipes](http://www.mykitchenchronicles.com/recipes),
- d) [www.merakhaanakhazaana.com/recipes](http://www.merakhaanakhazaana.com/recipes)

3. Recipes Found:

- a) Hash Brown Potatoes,
- b) Dam Aloo,
- c) Batata Vada,
- d) Honey Chilli Potatoes

Process performed by the proposed system:

The identified vegetables are first stored as “Input”. Next step is where a list of blogs/websites is maintained called as “RecipeList”. The algorithm checks for unvisited URLs in this list and as long as there are unvisited URLs, it keeps searching for recipes that match with Input. Once the system finds a match, another list called RecipesFound is created and updated on every iteration. This list is the recipe suggestions given by the proposed system.

Table 1 depicts the above two cases with respect to Identified Vegetables, Selected Vegetables in Checklist and Recipes Suggested (i.e. output).

**Table 1.** Values for identified vegetables, selected vegetables, and recipes suggested

Case No.	Identified Vegetables	Selected Vegetables in Checklist	Recipes Suggested
1	Potato, Capsicum, Onion	Potato, Capsicum, Onion	Stuffed Capsicum, Aloo Capsicum, Potato and Onion Gratin, Potato Onion Capsicum Paratha stuffing
2	Cabbage, Potato, Tomato, Carrot	Potato	Hash Brown Potatoes, Dam Aloo, Batata Vada, Honey Chilli Potatoes

#### IV. Conclusion

The proposed system uses the technology of image processing and computer vision to identify the various vegetables available with the user based on its various characteristics. Once the vegetables are identified, the proposed system generates a list of recipe suggestions for the user to cook. In this way, we can achieve our purpose of obtaining recipes on the go as per the vegetables available with the user. The system addresses the day to day crisis of food making. The working of the system is quite simple to handle. Extensive knowledge of technology is not needed for using the system. One important aspect in the working of the system is “availability of Internet” as all the recipe suggestions will be accessible online. There are some limitations in this system like the quantity of the vegetables present should also be considered while suggesting the recipes. Women may find some suggestions complex to follow even if they are suggested on the basis of available vegetables. It can also happen that recipes for given vegetables are not available, and the system can’t do

anything about it. Thus, we conclude that, by proposing this system we can achieve following objectives like – suggestions of new recipes, solution to the daily question of “What to cook?”, ease of getting newer recipes by just clicking the available content. Regarding all these limitations, there is a future scope to work on.

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