A Recipe Recommendation App – Smart Cook

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Abstract - **An increasing number of users are using mobile applications to get cooking recipe information, but recommending the right recipe to each user is challenging. In this paper, a hybrid recommendation algorithm, which combines content-based filtering and collaborative filtering is used for a personalized recipe mobile application experience and to improve the recipe recommended effectiveness. In order to understand the various needs and challenges which people face in this situation we conducted a small survey and analysed the data to get design ideas for solving the same through the means of developing an Android based mobile recipe application .**

Index terms - mobile application; hybrid recommendation; content-based filtering; collaborative based filtering; prototyping;   development

I. INTRODUCTION

 "What to cook ?" is the one question that always arises in every household, every day. Considering this as the base of our study we conducted a small survey involving a few questions related to various cooking needs and understood that in general, people like to cook, but they have no idea about what to or how to cook. Furthermore, every person prefers to look at recipes suited to his/her tastes. There are many cooking recipe websites available, but none of them provide suggestions for the user based on user's food preferences. Also, nowadays, the smart phone industry is spreading in leaps and bounds to each individual throughout the world. In other words, apps officially dominate the desktop web, with 50% of the digital time of each individual spent on smart phones and Android holding almost 85% of the operating system. Hence we thought of a way to find an answer for this monotonous question through an Android app.

The app focuses on recommending the application user with recipe(s) based on their preferences using a hybrid recommendation algorithm, which combines content-based filtering and collaborative filtering. Content-based filtering is an algorithm that performs recommendation based on the content of the recipe and the user's preference which the application gets from the history of the user's likes and views. It finds the similarities between the features of an item that the user likes and then recommends another item which has the common features of the item that the user likes [1][2]. The collaborative filtering algorithm uses the preferences of similar users to predict a user's interest. In other collaborative filtering recommends an item by combining the opinions of other like-minded individuals [3],[4]

The rest of this paper is organized as follows: Section II highlights the survey taken and the analysis made which leads to the basic design ideas. Section III discusses the background study of the existing systems and the reason to choose a hybrid algorithm. Section IV involves the preliminary design and prototyping for the application to be developed. Section V elaborates the proposed solution, which includes the application development and the algorithm. Finally, Section VI concludes the paper.

II. SURVEY

We surveyed around 30 people majority of which were females belonging to the age group 16 to 55 and having varied occupations about what they would like to have as a part of their lives so that cooking is made easier, which gave us a clear objective about the features which we should incorporate in our project.

On analysis of the survey we understood that the main problem faced by them was deciding what to cook for which they often checked recipes online or asked their friends and families. Other challenges involved problems related to

online recipes which included understanding the steps, measurements, serves and also arranging for the ingredients given.

We understood the various criteria based on which they selected a recipe to make which involved ingredients, time, cuisine, diet, health, occasion and mood. We also came to know their need of maintaining a checklist of ingredients in order to remind them what they need and when. We even realised that only some of them preferred to buy ingredients online occasionally.

We concluded our survey by asking them to think of a solution which according to them might be appropriate to help them overcome all of their challenges; answers to which included having an application or website which provides with recipes based on their preferences and guides them throughout the process.

Thus our survey helped us understand the needs and formalize basic design ideas.

III. BACKGROUND STUDY

After reviewing a set of research papers on recommendation algorithms [5],[6],[7],[8],[9],[10] and understanding the different methodologies along with each of their advantages and disadvantages when used individually and together as a hybrid through experimental findings we concluded that using a hybrid recommendation algorithm of content based and collaborative based filtering is suitable for the considered problem as it will resolve issues like scalability, and the cold start problem which are certain drawbacks of individual methods, thereby allowing us to increase our efficiency by providing better user experience and accuracy.

After this we studied the existing systems [6], [11], [12], [13] and found out that very few apps considered ingredients at home before recommending recipes to the user. Also, filtering of recipes based on certain predefined criteria wasn't made available and also the type of recommendations used were either only content based or only collaborative based; which further supported our decision of creating a more effective version of recommendation through the hybrid of both and also helping us in creating a list of features which would be well suited to make our app in order to meet our objective.

IV. APP CONCEPTUALIZATION

A. Idea Generation

This brainstorming phase followed by our survey and background study lead to the finalization of all the features incorporated in our app.

Considering all the problems faced by our users which we collected from our survey we came up with below list of features to be included in our application.

Since the main problem faced by them was deciding what to cook, the most significant feature of our app included giving recommendations based on various factors such as ingredients available at your home, the user's mood and preferences along with filtering done according to cuisine, time limit, diets, course, meal, ingredients and mood. The recommendation algorithm is designed to create a hybrid version of both content and collaborative based recommendations to fulfil our primary focus which was to create a user-oriented experience.

Content based, and collaborative based recommendation algorithms are the ones which are most commonly used for recommendations. The Content based algorithm works by finding "Similar Content" i.e. it creates an Item-Item link and recommends products accordingly. For example, Recommendations are given on the basis of what the user searches, or what the user has liked previously. Collaborative based algorithm works by finding "Similar Users" i.e. it creates a User-User link and recommends other products viewed by users with similar interests. For example, if user A has viewed recipes 1, 2, 3 and user B has viewed recipes 1 and 2 then, recipe 3 would be recommended to user B.

Thus Collaborative filtering is used in order to match similar users whereas content-based filtering is being used in order to understand the specifics of what the users like. The combined product is a combination of both these algorithms thus resulting in a hybrid.

The app allows users to select from some predefined categories like festival special, sugar free, jain etc. Users can add recipes to favourites, so it can be easily accessed later or even share it on social networking sites or chats.

Display of nutrition content for health and cooking time along with number of serves is provided to give users detailed information of the recipe they will be cooking. The given number of serves can be converted to any value the user wants based on which the quantity of the ingredients will also be converted respectively

The app also allows the users to convert the quantity of each ingredient to a measure they are familiar with so they can easily follow the steps given.

Organization of meals by adding recipe to calendar can also be done for maintaining future schedules and getting timely reminders of the ingredients for the same.

Lastly the app also maintains a checklist of ingredients which can be used for comparing prices across online stores for shopping from the best place.

B. Analysis, Design and Prototyping

Based on the previous ideated features, analysis of each was done to create use case diagrams depicting the various users

and the functions which they perform. Further activity diagrams and sequence diagrams highlighting the flow of actions were moduled.

These diagrams helped us to understand and generate our database structure to maintain our data in a systematic way in order to provide recommendations along with generating first low-fidelity prototype sketches of our application to give us an idea about the look and feel of our application. These sketches were surveyed by our users, in order to get their feedback and recommendations before going on with the final development. Thus this stage helped us to further understand and specify the conceptual idea.

V. DEVELOPMENT

The app is developed using Android Studio and will work on an android powered device having version 3.2 or more. A minimum processor of 1GHz and a minimum of 20MB will be needed to install the application along with an internet access through Wi-Fi or data provider to make use of various features of our app. To store data records, we used web server to store the data and used MySQL to structure the data. We also used PHP as the backend server language.

The app allows the user to do all tasks required to find and make his/her favourite recipe. It does everything from recommending recipes, organizing them to teaching how to make it.

A. Modules

We started the development by building a database of our own consisting of a variety of different recipes to test our application and then proceeded with the development of the UI following the backend functionalities.

The App is divided into three main modules namely Recipes, Comparison and Recommendations each of which contain various sub-modules. The app consists of two small modules namely Tips and Category which complement the functionality of the main modules.

1. Recipe Module

In the Recipe Module (Tab 1) the user is presented with a list of recipes recommended based on their preference to select from. They can even filter or search for any recipe they wish to view by typing it in the search box as show in Fig 1. Filters can be given in the form of what ingredients you have at home or preferences such as cuisine, diet, course, mood cooking time can also be chosen by the user. When user clicks on any recipe, the recipe along with its details is fetched from the database and shown to the user as seen in Fig 2. Considering Fig 2, the Recipe Module consists of all the functionality the user can perform from selecting the recipe of his/her choice, viewing the directions of the recipe buy clicking on the drop down button to

performing various actions such as adding to favorites, sharing the recipe, converting the number of serves, rating the recipe, converting ingredient measure, adding the ingredients to the shopping list and adding recipe to the calendar by clicking on the respective buttons made available for each functionality. The user can perform any functionality he/she wants from these. With each recipe its nutritional content, cooking time as well as number of serves is shown. The number of serves can be modified by changing the value of the textbox given beside 'No of serves'. This will change the ingredient quantity as per the number of serves entered. The 'You May Also Like' section shows the user recipes similar to one he has currently chosen.
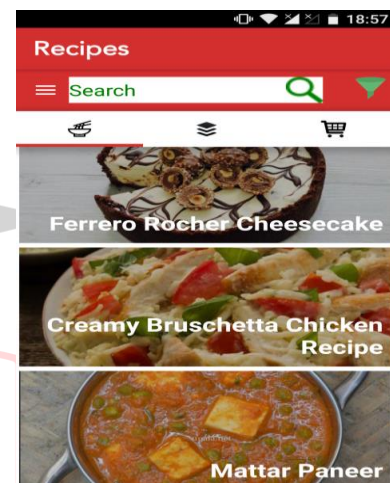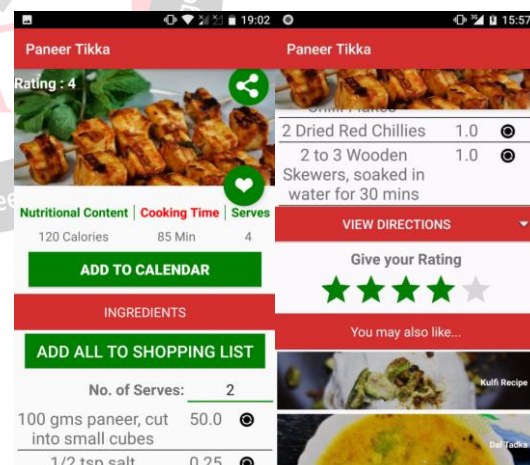

Fig 1. Recommended Recipe List

Fig 2. Recipe Details Page

1.1 Favorites (sub-module)

On the click of the favorite button i.e. the heart icon on the Recipe Details page (Fig 1), the recipe would automatically get saved to the Favorites page as shown in Fig 3 from where the user can access it whenever he/she wants. Once a recipe is in favorites, the color of heart icon would change to red.
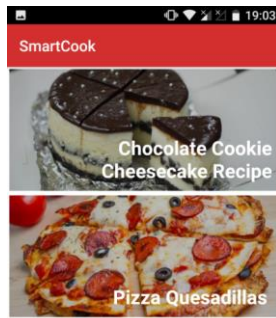
Fig 3. Favorite's page

1.2 Conversion (sub-module)

On click on the conversion button that is placed near each ingredient on the Recipe Details page (Fig 1), a Conversion page will come up as shown in Fig 4 where the user can select any one of the option made available which is of Dry ingredient and Wet ingredient based on what the ingredient type is. On selecting an option, the user is directed to a page where they can select the value of measure of what is to be converted to what with the help of two drop downs made available as shown in Fig 5. Enter the amount of the ingredient and click convert to view the conversion.

This same functionality of conversion is made accessible through the side bar made available in the app, on click of which the user has the same functionality made available to them along with the option of converting temperature and viewing the appropriate gas level as shown in Fig 6.
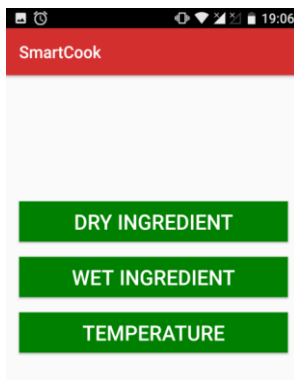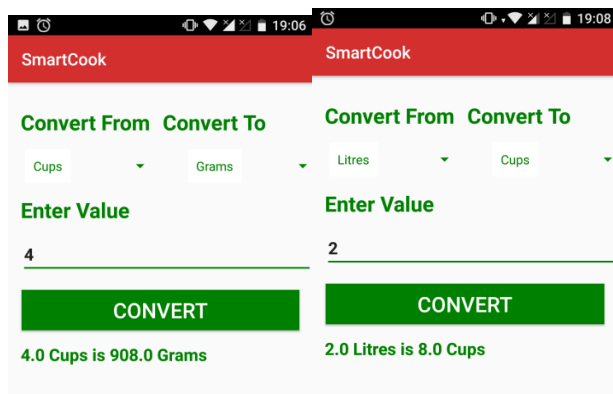

Fig 2: Type of Conversions
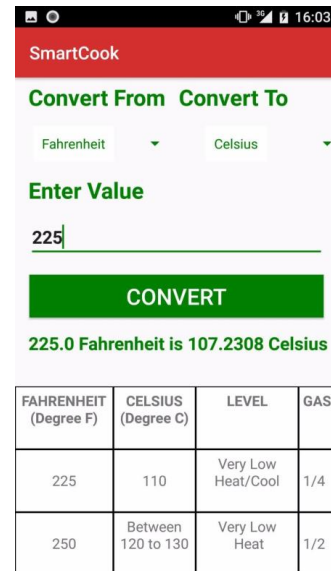

Fig 5. Dry and Wet Ingredient Conversion Pages

Fig 3. Temperature Conversion Page

1.3 Shopping List (sub-module)

The user can add ingredients to the shopping list using the 'Add all to shopping list' button on the Recipe Details page (Fig 1). The Shopping list page as shown in Fig 7 can be accessed from the side bar in the app also. Once, ingredients are added to the shopping list, they can be viewed on this page and also be deleted using the green cross button on the right side of each ingredient. Extra ingredient needed can be added by typing the item name and amount in the textbox provided and by clicking the 'Add' button on the top right corner of this page. The checklist option provided helps in managing the list by indicating that this ingredient is already present or brought.
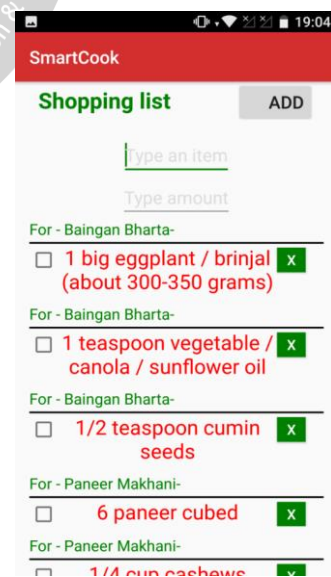

Fig 7. Shopping List Page

1.4 Calendar (sub-module)

Fig 8(a) shows the page which appears when the 'Add to Calendar' button is clicked on the Recipe Details page (Fig 1). The user can save the recipe for any further date of his/her choice. One day before, the user will receive a

reminder as shown in Fig 8(b) that the recipe has to be made tomorrow and you can start preparing for the same. In this example given as the recipe is set for 14th March, the user will get the reminder on 13th March on click of which the user can use further details of what they have to prepare.
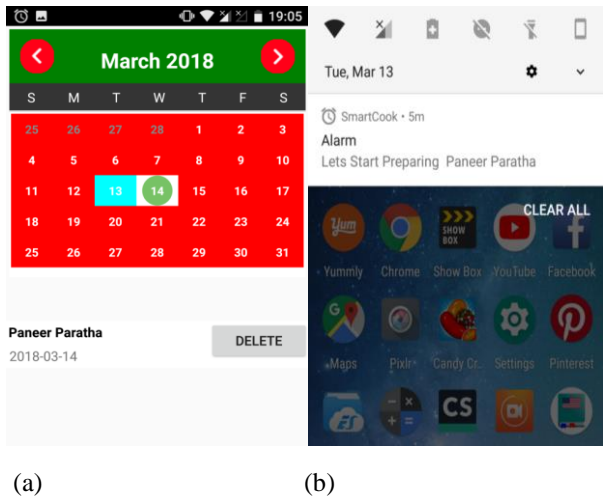

(a)   (b)

Fig 8. Calendar Page (a) and Reminders (b)

2. Compare Module

The Compare module (Tab 3) of this app enables the user to compare the prices of various ingredients across two online stores. In case the user wants to purchase ingredients of the recipe he wants to prepare, he can use this functionality to compare the prices of the ingredients across the stores. The ingredients are fetched from the shopping list page and shown to the user as shown in Fig 9(a) and compared on click of the compare button which opens the comparison page as shown in Fig 9(b). The app fetches the price of the least available quantity of the ingredient from the website and compares it. The page shows the amount of ingredient you need and what is given by the respective site. The quantity of each ingredient can be increased or decreased with the help of the buttons provided. After viewing both the prices, the user can choose to redirect to either of the sites by clicking the 'Visit site' button.
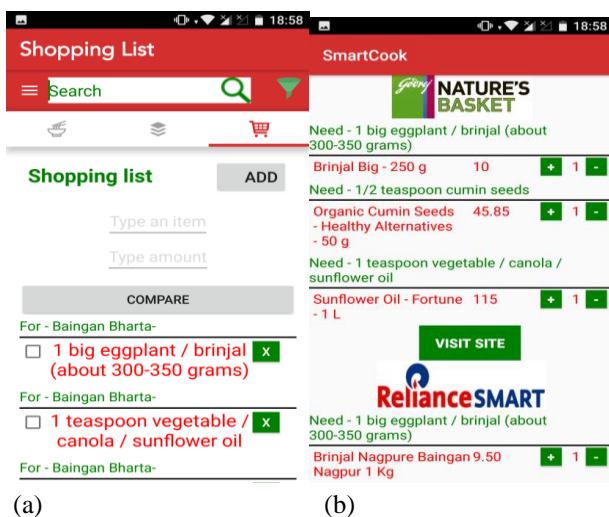

(a)   (b)

Fig 9. Shopping List (a) and Comparison Page (b)

3. Category and Tips Module

Considering Fig 10 the Category page (Tab 2) enables the user to choose recipes from a variety of categories. The trending category shows the recipes which are searched the most by our users. Various popular and useful categories like Sugar free, Jain, No bake/No egg desserts, Christmas special, Indian festival special are provided. On click of any category a list of recipes will appear to choose from.
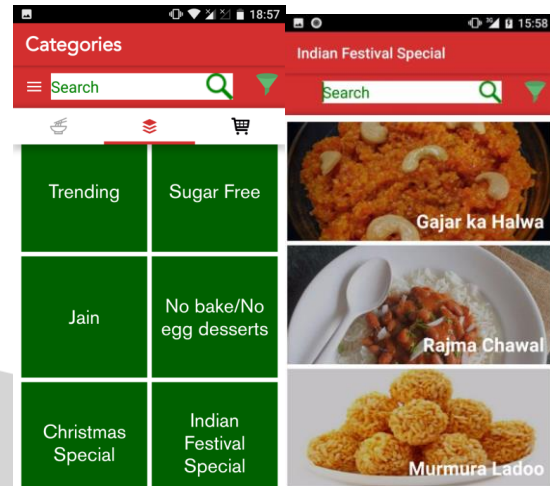

Fig 10. Category module

The Tips Module as shown in Fig 10 helps the users with general tips regarding cooking. The tips provided are pertaining to a broad range of categories such as Frying, Health, Baking, Shopping etc. These tips will help make cooking easier for users.
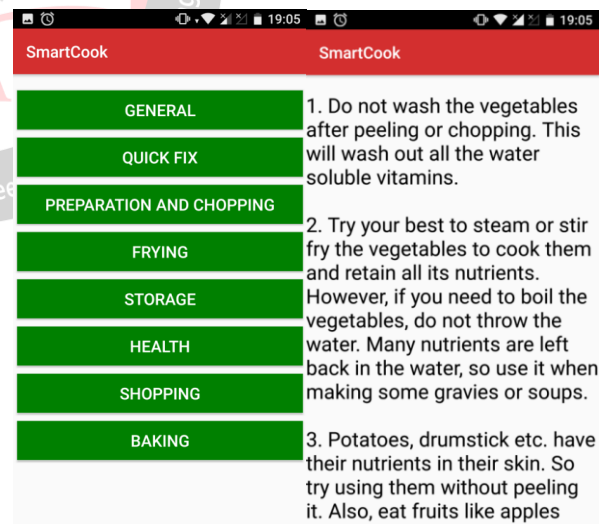

Fig 11. Tips Module

B.Algorithm

We have used hybrid version of content and collaborative filtering-based recommendation which we found to be the most appropriate for our project based on our research. Content based recommendation will provide suggestions based on the previous content searched or viewed by the user and Collaborative based recommendation will provide

suggestions based on the recipes viewed by other similar users.

As we have used a hybrid version of both filtering, we will be first searching for the similar users based on a user's previous searches and likes and then fetch all the recipes which are liked or searched by these users other than the ones already liked or searched by our user. These collected recipes will then be filtered based on the content most viewed by our user and the result will be finally shown to the user.

Considering all possible scenarios of our algorithm we have four types of users. Each user will be shown recommendations based on separate constraints considering the conditions. Each user has two places where they will be shown recommendations which include normal recommendation on opening of app and recommendation on filtering. Both of these will be different for different users. These are shown in the table below

Type of User	Recommendation Based on	Filtering Based on
New User	User – Start Information	Normal Filtering
Super User (user which has a super set of the recipes liked by others)	Content based recommendation	Content based recommendation (The content is based on what user selects)
Distinct User (user whose liked recipes does not match with any other users)	Content based recommendation	Content based recommendation (The content is based on what user selects)
Non-New User	Content and Collaborative recommendation	Content and Collaborative recommendation

The flow of our algorithm starts by collecting the user details and preferences such as type of food he/she likes, the cuisine and their diet preference. This is collected from the user through a questionnaire page presented to them when they sign up to tackle the cold-start problem which arises in recommendations. Then initially, recommendations are shown based on these details.

Further the recipes are recommended based on the collected data of user's searches and likes and other similar users.

Consider a user no. 49 who has the below shown recipes in Fig 12 as his/her searched or liked recipes.

Fig 12. Recipes liked or viewed by user

Consider Fig 13. The green boxes indicate the recipes searched by other users and which match with user no. 49. Thus making users 42, 15 and 36 the similar users based on which collaborative filtering will be done.

Fig 13. Recipes matching user 49 liked by other users

Considering users 42, 15 and 36 and their searched and liked recipes we find that recipes 7, 17, 22,462,468,276,470,474,414 are the recipes belonging to Italian, French or Indian cuisines which is the cuisine searched by our user no. 49. These are the recipes marked in red boxes in the below Fig 14.

user_id	recipe_id
46	322
46	16
42	341
42	16
42	459
42	22
42	7
42	468
42	474
42	322
42	1
42	414
42	470
42	462
42	17
42	276
41	106
41	16
41	18
15	1
15	7
25	25
28	22
29	163
34	163
35	77
36	77
36	22
37	77
37	18
38	77
40	77
41	77

Fig 14. Other recipes liked by users matching user 49

Thus, these will be recommended to user 49 based on content filtering algorithm. Thus this is how the algorithm works internally.

VI. CONCLUSION

Understanding how the algorithm works we can conclude that though content and collaborative algorithms work great by themselves, there are disadvantages of each [12], [13] which include the following

Collaborative algorithms

- Requires huge amount of existing data of users based on which a particular user can be given recommendations.

- It does not consider the item features which would give better results for recommendation.

Content algorithms

- When there's not enough information to build a profile for a user, the recommendation cannot be provided correctly.

- Content-based method provides a limit degree of novelty, since it has to match up the features of profile and items.

These disadvantages can be solved by combining both into a hybrid system which would improve the quality of recommendation. First, a set of similar users are searched by the algorithm after which those recipes with similar items in them i.e. in the form of similar cuisine and diet is recommended to the user. This helped improve recommendations for the user.

Hence, a hybrid method proves best to provide a user-oriented experience which is the main objective of the app.

VII. FUTURE DIRECTIONS

In future work should be done to further improve the application by providing recommendation of alternate ingredients, including video of the recipe preparation and enabling users to put in reviews for each recipe and use text mining to interpret the review and recommend accordingly. Work can also be done to improve the algorithm by using machine learning techniques of nearest neighbours, outlier analysis, association rules, matrix factorization or neural networks to further refine the recommendation and user experience.

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