Kitchen Assistant - A Grocery Management and Recipe Recommendation Application

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***Abstract*—Home cooked food is a luxury that most of us crave for yet the effort required both in time and money to manage your kitchen and grocery supplies puts us off most days from cooking. A significant amount of time goes into planning the dishes you choose to cook, based on factors like taste and cuisine preferences, time, money, nutritional value, and diet plans. People buy groceries either in brick and mortar stores or through an internet based application, and cook a variety of dishes using these ingredients. Most people throw away the receipts of food items bought and never follow a systematic process to maintain the inventory or make a schedule of the recipes to be cooked for the rest of the week, even though this might save time, money, and help with healthy diet and eating habits. Most people only know about a handful of dishes that they can cook from these groceries and seldom search the internet for other ones, mainly because this takes unacceptable amount of time. We present an application for people to built and maintain an inventory of groceries with minimal manual intervention, on their phone, be able to view and edit it as they wish, and get recipe suggestions based on these groceries and user preferences to aid in cooking.**

I. Introduction

As students, we buy a variety of groceries and food items for our daily usage. In many instances the failure to utilize these items at the best possible way results in those turning stale and eventually being thrown away. This causes a lot of wastage of food and money. At other times, we do not understand what to do with the purchased items. We know none or only a handful of food dishes that can be made from these purchased groceries. The search for a recipe that best utilizes the available items usually requires a good amount of time and is inefficient with today's available resources. Ultimately this also leads to wastage.

Large share of the grocery and kitchen supply purchases are still done at the brick and mortar stores in spite of major business ventures attempting to popularize online grocery shopping. Nevertheless, ventures like Amazon Prime Air could soon see a major shift in the way we shop for grocery[1]. Irrespective of the mode of shopping the common factor is that we rarely keep track of receipts. This makes it very hard to keep track of the ingredients available when we choose to cook at home, leaving us with the only choice of scouring through the fridge and kitchen cabinets only to realize that we have run out of basic ingredients.

Although there are web resources available which allows searching recipes that could be prepared based on the available ingredients this is contingent on the tedious task that befalls on the user to feed into the system all the ingredients that are available in our kitchen. Also, purchasing a couple of additional items may result in a possibility of a lot of dishes. But we rarely have the luxury of time to scour through the recipes to see those common ingredients we should purchase or to keep track of how often we would need to purchase these ingredients.

There is no single resource available today that covers all these kitchen management tasks. At one place, we are able to buy groceries, but we need to go to the next application to find the dishes that can be cooked. Checking out the actual recipe may require using another application, while maintaining a list of food items might require another. This is a tedious process, and discourages us from maintaining our inventory, keeping track, and trying out different dishes.

We aim to create a mobile application to solve the above mentioned problems. Our application is targeted for users of all age, sex, nationality, etc.

II. Literature Review

The research on eating habits in America has revealed that people lack cooking skills and tend to eat outside[2], which negatively impacts the overall health. Unhealthy eating habits outside home may be attributed to lack of time to plan and prepare meals at home[3]. In fact, lack of time has been cited as the major cause for people not cooking their meals at home[4]. The amount spent on food outside home now is higher as compared to what it was 30 years ago[5]. Research has also shown that social eating alters our diet and we tend to eat more when we eat outside with people around[6]. This has become a cause for obesity, an upcoming issue in the health domain. Furthermore, one recent paper showed that for children, half of all energy from fast food is consumed at home, demonstrating that even foods consumed within the home are not necessarily home-cooked[7]. Fast-food consumption has also been linked with the presence of potentially harmful chemicals, such as phthalates, that can contribute to severe adverse health effects[8].

The use of technology to encourage people to prepare and consume home cooked healthy meals will be extremely beneficial. A few applications on Google Play Store have tried to achieve the same. BigOven is one such application, that has a smart grocery list function and the ability to search for, upload, and bookmark recipes. However, the grocery items have to be entered manually. This tedious manual effort can discourage people from using the application. Also, there are no recommendations based on personal choices and attributes such as taste, cuisine choices, location, etc. There are also tons of websites that show the recipe for a particular dish. But searching and then filtering based on users choices can be tedious. Users then tend to go for the easy option of buying food outside.

One popular mobile application is Kitchen Stories, which has a large number of filters to search for recipes based on cooking time, meat choices, etc. Once recipes are selected, it also auto-generates a shopping list. However, we see that these applications automates the steps once you select your recipe. We would like to take an inside-out approach for cooking management. Our aim is to add to this an important feature to auto-generate recipes for users once they purchase the daily groceries, and then recommend recipes based on these groceries.

III. User Study

User study is an important part of planning and developing an application, we created a short survey of ten relevant questions and gathered response from family, friends and colleagues. This user study was conducted to judge the feasibility and adaptability of a kitchen assistant. This survey included 200+ respondents which helped gain significant insights from the results presented here.

A. Employment status

This question was asked to analyse the background of target audience to better understand the lifestyle choices based on which should help adapt the design of the application. The following chart shows the distribution of people who have responded to the survey.

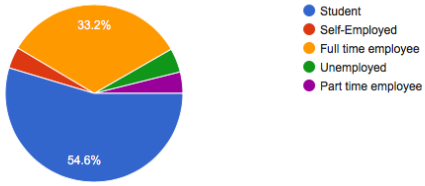

Fig. 1. Employment Distribution Chart.

The results have reaffirmed that the majority of the respondents fall into the two pools Students and Full time employees, which makes up of the main target audience, because these two groups tend to have less amount of time available for cooking at home.

B. How often do people cook?

The response to this question gives us insight on how often do people actually cook at home. This possibly shows the frequency at which people will be using our application.

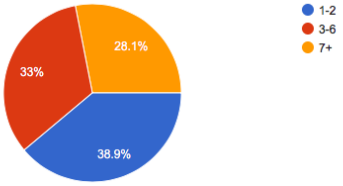

Fig. 2. Frequency of Cooking.

About 28% of the people cook more than 7 meals in a week. These will be frequent users of an application for cooking management. Around 33% people cook 3-6 meals in a week and another 35% of the people cook even less often. With the help of this application, we intend to push a part of this group into the 7+ bracket. The ease in mananging inventory and reducing time spend in finding the right recipe could encourage more people to cook at home, especially the groups that have time concerns and budget restrictions.

C. How do people prefer buying their groceries?

This question would help evaluate the approach to tackling the problem of managing the kitchen inventory with an automatic grocery ordering feature versus creating shopping lists with suggestions to buy the ingredients that the applications prediction algorithm predicts are the most likely to be used in the next one week.

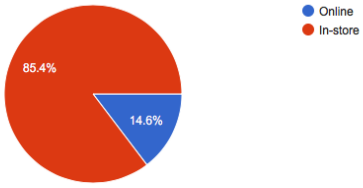

Fig. 3. Grocery Shopping Variety Distribution.

This chart shows that more than 85% of the people still rely on going to the store to buy their groceries. This could be because either they like checking out the product physically before they buy it or they are not aware or comfortable with the idea of ordering their groceries online. Only 14% of the people regularly use the internet to order groceries.
This tells us that most of the user base will not be comfortable with the application ordering groceries online for them. Thus we have decided to not focus on automatic ordering of groceries as a primary feature for this application at the moment.

Although, this would be part of future plans with the growth in popularity of online grocery shopping.

D. How often do people buy their groceries in a week?

This was asked to gain a measure of how much time people currently spend on buying groceries. In most cases additional trips to the store can be reduced with efficient planning of shopping lists and better usage of the avaliable ingredients

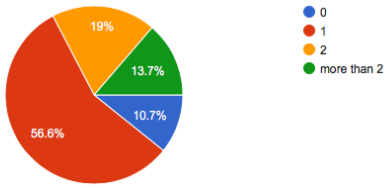

Fig. 4. Frequency of Grocery Shopping.

More than around 33% of people have to shop for groceries on an average 2+ times a week, and our goal would be to reduce this to once a week by helping them maintain shopping lists and predicting the groceries that they should be buying according to their consumption.

E. How much do people rely on the Internet for cooking?

This chart shows that around 60% of the people somewhat rely on the Internet for cooking. The application is targeted on this bracket of users as it brings ingredients, recipes, shopping lists, inventory managment all in one place rather than them having to scour the Internet to gather information. The user would recieve recipe suggestions based on on the users preferences, eating habits and the ingredients they have available at home. The user can also cook while taking a walk through the recipe as easily and efficiently as possible.

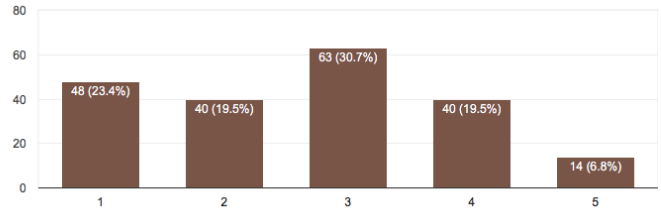

Fig. 5. Dependency on the Internet for cooking purposes.
1=very rare 5=very often.

F. How often do people have a problem in deciding what to cook and how many times have people realized that they are falling short of ingredients in a dish that they have wanted to cook?

These charts show us that more than 70% of the people face a difficulty in deciding what to cook for a meal. This application mainly targets this problem faced by majority of users by sending them the recipes they can make according to their eating habits, preferences and available ingredients. The solution involves intimating the user to buy ingredients beforehand so that they never miss out a chance on cooking their preferred meals.

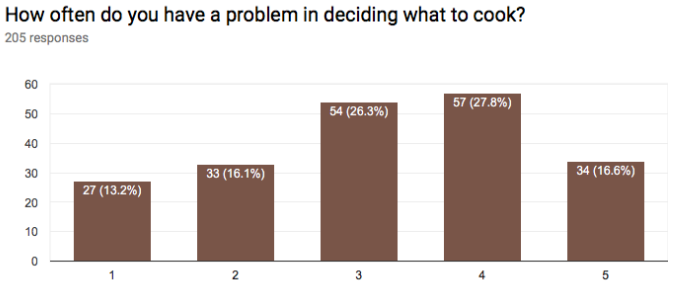

Fig. 6. Problems faced while cooking. 1=very rare 5=very often.

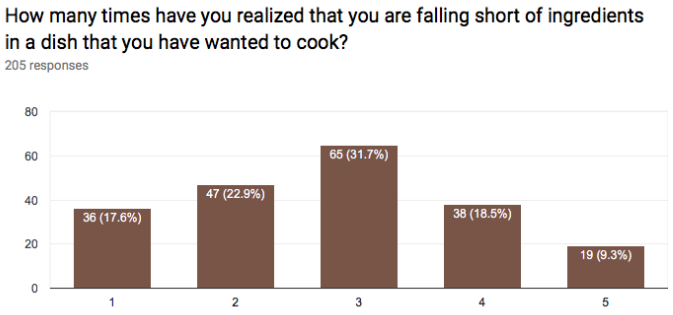

Fig. 7. Falling short on ingredients while cooking
1=very rare 5=very often.

1) What factors do people take into consideration while deciding what to cook?: This question was asked to identify the major preferences that people have in deciding what to cook or eat. This data can be used in setting user preferences so that we can suggest them better recipes.

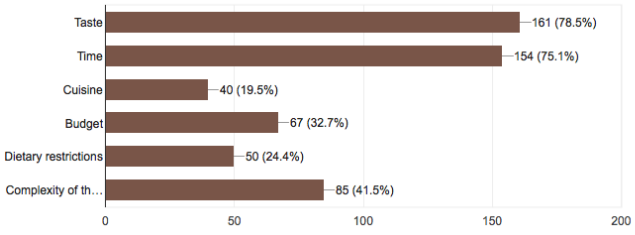

Fig. 8. Factors considered while deciding what to cook.

This chart shows that the major factors considered by people are taste, time and complexity of the recipe. The learning algorithm will cnosider using these factors to recommend recipes and create suggestion to buy groceries that could help in completing recipes.

G. Would people like to use a kitchen assistant which helps them manage ingredients and walks them through recipes?

These questions helps learn the feasibility of an application such as the kitchen assistant.

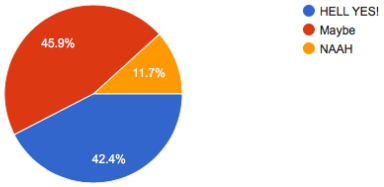

Fig. 9. Will users like to use a kitchen assistant.

H. What kind of an application do people think a kitchen assistant should be?

This question was asked to gather a public opinion on the platform they would like to use such an application.

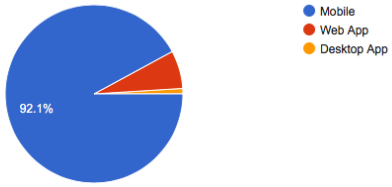

Fig. 10. What platform should the application be based on.

The results conform to the decision to make it a mobile application for ease of use.

IV. Proposed Solution

We plan to develop an application that works as a kitchen assistant and helps the users manage their ingredients, kitchen supplies and feeds them recipes based on their selected preferences. The following is a list of features that we plan to incorporate in the application

1) Inventory Management: There will be three ways to generate / edit an inventory:
   a) Manually add/delete/edit items and quantity.
   b) Using the phones camera to take a scan the paper receipt and convert them to electronic inventory.
   c) Accessing electronic receipts from emails to update the inventory.

   We intend to use image analysis and character recognition to convert the receipt users upload of their grocery purchases through the application. We will utilize Googles Vision API (Image Content analysis) to extract the food items and their quantity from the receipt. The receipt obtained after purchasing groceries manually is a piece of paper. Even when groceries are bought online, the receipt obtained as electronic version of the text. We needed a system to generate content for the inventory from all such formats. Googles Vision API (Image Content Analysis) was our choice for conversion of hard copies.
   When user chooses option (b) and (c), we shall send the image / pdf to Googles Vision API or use email integration API to build up the inventory. Since receipts are computer generated (and not handwritten), these APIs give accurate results. To improve the accuracy further, we shall store keywords (food items and quantity) on our end. We shall match the result from Vision API with these keywords and replace the result if there is a 90% match, and accordingly edit the contents of the inventory.
   The application will show an editable inventory of groceries utilized for the particular recipe that a user has selected to cook. Once user chooses a recipe and confirms that inventory is up to date or update it manually, the selected ingredients will be updated accordingly to update the users inventory. The application will use learning to notify the user about any particular ingredients about to exhaust from the inventory which the user would most probably require in the coming said, this will serve as a reminder.
2) Hybrid Recommendation engine: Recommendation system provides an information filtering mechanism to provide personalized suggestion to the user based on his previous history, interests and preferences instead of querying the databases. For this project we will be using content-based algorithm and and model-based Collaborative Filtering algorithm utilizing user profile, available recipe reviews, user preferences and available ingredients[9][10].
   Collaborative filtering is an approach to making recommendations by finding correlations among users of a recommendation system[9] Content-based methods make recommendations by analyzing the description of the items that have been rated by the user and the description of items to be recommended[9]. Our system will analyze user behavior using his browsing history, purchase made, location, check-ins. We will be doing feature engineering using multiple datasets involving user activity and preferences. The generated features will be used as weighted vectors to train the model. The current algorithm will perform continuous learning to calculate the weights using ANN, Decision Trees, Bayesian classifiers and Cluster Analysis to predict future interest of the user for recipe recommendation[11]. We will be using approaches like K-nearest neighbors and Pearson Correlation Coefficient to predict relevant recipes for the user[11].

3) Recipe Filtering: Now that we have the users inventory and a list of recipes that is going to be sent to the user, we will filter out all the recipes that the users can cook. The application should also be able to query the database and search for recipes with an 80% match

with the users current inventory. These recipes will also be suggested along with the missing ingredients so that the user has the option to add the missing ingredients to a shopping list. This will increase the scope of the recipe suggestions. User must be able to sort the recipes based on custom attributes like rating, nutritional values, cooking during.

4) Recipe Walkthroughs: The application will show the recipe and all its cooking steps once a user selects a particular recipe that he wants to cook. Let the user notify the application that he or she is starting a particular step. The application will walk the user through the recipe, one step at a time. It will set reminders for the user depending on the duration of the steps and send out notifications accordingly to make the process of cooking much more convenient and hassle free.

5) Shopping List: To reduce the time and fasten the process of shopping, this application will create a shopping list for the user. The missing ingredients from recipes that the user likes or wants to cook can be automatically added into the list. When the application notifies the user about the ingredients running low in the inventory, it will also give an option to add them into the shopping list. This process will be automated for the users most used ingredients.
6) Mobile application versus Web application: There were two possible ways of implementing this application, web and mobile. We have decided of going ahead with making it a mobile application as we feel that using a mobile in a kitchen is much more easier and efficient than using a laptop or a desktop computer. It is possible to use a web application on a mobile phone but that creates unnecessary hassle for users to do tasks like uploading images or using their mobile camera to scan receipts. The user survey has confirmed that users will be more comfortable in using a mobile application and thus we have to decided to stick that option.

V. Evaluation Plan

A. Testing various receipts from different stores with various contents

This would give us a fair idea about how Vision APIs are performing and whether we are able to detect majority of the food items in the receipts. As explained above, some receipts have abbreviations for some of the items. We would be maintaining some of them and try to utilize specific string search algorithms / external APIs to match commonly used items with their abbreviations. We would track if the user is satisfied with the inventory we automatically generate with the receipt or is he or she required to edit it. We can then think of improving our image content analysis algorithms according to the items the user needs to edit frequently.

B. Number of times users open the application

This would give us a better estimate about the utility of our application. Although survey results have justified that users are in need of such an application, we would like to know if our application actually serves the intended purpose.

C. Recommendation system evaluation

Will be dividing our dataset into training set and testing set and will be tuning classifiers to reduce Root mean square error of the models. Efficiency will be determined using similarity measures - ex. Cosine similarity, pearson correlation coefficients, log likelihood, maximum likelihood over multiple fold cross validation. We will be using precision, recall rates and f-measure to evaluate different models.

D. Number of times user clicks on a suggested recipe

This would give us a good understanding about how efficient our recommendation algorithms are. If the user is only searching for recipes rather than using the suggested recipes, we would need to vary our algorithms.

E. Number of times user is able to cook the recipe with available ingredients

Once a user starts cooking the recipe with our application, at the end we would ask them if they were able to successfully complete it with the ingredients they have. If not, we would need to adjust the ingredients for that particular recipe based on the number of times we receive an unsatisfactory response.

F. User purchases v/s suggested purchases

We would keep track of the items we suggested the users to purchase (to be able to cook more recipes). If some users actually purchase these items, we would understand that this feature has good utility.

G. Features used frequently

We would track the features that most users are using frequently to understand the distribution of efforts required on the application going further.

H. Performance Evaluation

We will be determining key performance indicators for various Api calls, response time of the application server, and load time of Graphical interface on client side.

VI. Conclusion

The research statistics and our survey results mentioned above indicate that although various solutions have been proposed for the problem of preparing healthy home cooked meals, people of all age are still looking for a better one. We present this by reversing the strategy proposed in other systems. Once the user purchases the daily groceries, we automate the entire process from recommending recipes that can be cooked from them. Our application will eliminate the need to remember the available groceries by creating and managing the inventory using his receipts. We shall also keep track of the users inventory and notify them with ingredients

they would need to buy soon. Our recommendation system is more suited to the users personal choices and attributes and also utilizes the time of the day to suggest the appropriate meal that can be cooked with the available groceries in the inventory. This application will be really useful in helping people manage their groceries, prepare more home cooked meals, avoid eating outside, and achieve better health.

VII. Future Score

The following list enumerates certain features that we do not plan to include in this proposal of our application due to requirement of monitory investment or

1) One important feature missing from our application is the ability to auto-order groceries based on the inventory for people who prefer to purchase their groceries online. In future, we would like to integrate our application with Instacart / ZINC to use their infrastructure to order groceries automatically for our users.
2) While analyzing receipts from various stores, we also realized that at times, precise contents are written in abbreviation. We would like to obtain this information from stores to improve our accuracy in generating the inventory using the receipts.
3) We also understand that new recipes are discovered by people all over the world. We would like to give them a platform to share these recipes with all the users of our application.

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