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CUSTOMIZED FOOD AND RESTAURANT EXPANDING FUZZY LOGIC

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Abstract: Everyone loves to eat delicious food, in a good environment and within affordable budget. The ever increasing work load in the workplaces, the fast life, and busy schedules have set the trends for the people to eat in a restaurants .This trend has made the Food and Restaurant Industry to flourish in our country and more and more restaurants are opening in the market now a day. The huge number of restaurants in the market with different food offerings and different environment has made it really difficult for a simple person to select and choose the appropriate restaurant according to his taste, budgetary and mood requirements. Therefore, most of the times, people end up wasting their time and money on the restaurants, food and the locations those don't provide food according to their taste buds. Prime objective was to make use of the Computer technology to suggest the appropriate restaurant to the people according to their budget, taste, and environment of the restaurant. Web Interface was also developed for user ease and comfort. Android application was planned so that users can order by simply using their cell phone. Virtual environment feature was also added so that users can select the factors like taste spicy, sour, and crispy or multiple taste in the same way user could also select the internal or external view of environment like whether he/she wanted to sit near play area, near LED all can be selected just clicking on android application. Results were calculated according to android user's usability and it was 100% for those who frequently use mobile phones, Tools used while designing this system are MATLAB and APACHE.

Keywords: Android; fuzzy food recommender; food engine.

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1. INTRODUCTION

With the passage of time a lot of improvements have been made in computer technology starting from the first generation to the fifth generation wide range of work has done. Food is also getting improved just like technology, different kinds of food, new taste, and different environments are attracting people towards restaurants. A wide range of restaurants have opened everywhere offering different food items with different prices and offers, because of this it is difficult for people to select which restaurant they have to choose that's why we have designed such app which will be helpful for people in selecting restaurant of their choice.

Many algorithms are used in different fields for sorting, searching and many other purposes. If we move towards food searching it would be difficult to find any efficient and smart algorithm because algorithms can find out the food through their name or taste but not with all factors. For making search more reliable, easy and with many factors we have used fuzzy logic for assigning scores to different food items and according to that scores preference level of each food can be calculated. We have taken 5 variables taste, environment, budget, location and user review as input then by applying fuzzy logic an output menu will be prepared that will be closely related to user preference. Yelp and Foursquare are the two most famous searching platforms but they did not focus on food taste like food is spicy or crispy or both, our main focus is to control taste and preference level of each food factor through fuzzy logic.

2. LITERATURE REVIEW

A fuzzy inference is designed by Garcia [1] which provide learning objects recommendation system. In this system student can select learning objects like lectures, videos, images according to their preferences. An algorithm is designed to check the system according to user requirements. Fuzzy Ant Based Recommender System is proposed by Nadi, Saree [2] composed of two phases modeling and recommendations. Users requirement are taken in first phase and then results are used in online recommendation. Fuzzy logic is best for giving certain results and Ant algorithm is used for solutions so by combining these two techniques fuzzy ant recommender system is used for giving accurate results to users.

An intelligent recommendation system is developed by Xiaowei [3] using fuzzy logic, the main feature of this system is simulating human intelligence for recommending anything. Fuzzy user profile, fuzzy filtering and recommendation agents are the key factors of this system. Through this system it is easier for user to select things of their choice. A Fuzzy Theoretic Method (FTM) is recommended by Zenebe [4] to deal with inaccurate data, FTM also used in designing fuzzy recommender, moreover FTM give features of items and take feedback from users. Simulation is used to evaluate the results and context algorithm is used to find out accurate data. After the simulations and algorithms result it is seen that Fuzzy sets improve the performance of context based recommender system.

A multi agent based framework is proposed by Pandey [5], in this paper a fuzzy recommender agent is designed which give learner study material according to his/her requirements. Simulations have been done in MATLAB and get accurate results. . Authors of nutrition control by fuzzy system Priyono [6] has designed a fuzzy controller to solve calorie need problem, it tell users how much calories they should take daily. Two models are used in this technique and it is shown that calorie need problem can be solved by using fuzzy inference method.

Another Fuzzy system namely Fuzzy Expert System for Heart Disease Diagnosis is designed by Adeli [7] which is based on three hospitals database. The system takes 13 input fields and gives one output field. The output fields are the parameters of fuzzy logic and they can be 0(no disease) to (1-4) with little to high disease symptoms. Using tags and factors according to user preferable taste and recipe a food recommender is designed by Elahi [8]. An algorithm is used which give accurate results after matching the user preferences, prototype is also given with it and shows high usability after reviewing from users. System is designed in MATLAB.

A context dependent search engine is purposed by Han, Schmidtke [9] which is light weight, secured and give relevant information on user's phone without connecting to external server. The search results of context search engine forwarded to context model for giving exact information to user. Moreover in online recommender system by Ojokoh [10] a fuzzy logic based recommender system is developed for online shopping of laptops it will give specifications of those laptops that are exactly related to user needs. Fuzzy Near Compactness (FNC) concept is applied here for comparing customer needs and laptop requirements and after implementing this logic on 50 laptops it is shown that system is performing effectively. Hybrid recommender system is developed by

Ramírez-García [11] this system finds out the interesting restaurants in the city. A diet recommender fuzzy system is designed by Sambare [12] for giving users diet plan according seasons, Different diet plans from different dietician have been reviewed and then a method is developed to recommend people diet according to their prakriti (energy maintain physical and mental state) and season.

Fuzzy Recommender system is designed for eElections by Terán and A. Meier [13]. Basic purpose of eElections Fuzzy recommender is to give users information about candidates closest to their preferences and its use for government is this it will reduce overloaded information. In Velusamy [14] an ad recommender system is designed to give ads according to the type of audience they use different factors like viewer interest, program timing etc.

Fuzzy intelligent recommender system is designed by which is based on customer online reviews. After using semantic analysis technology and designing fuzzy inference from user reviews this system show how intelligently it tells about customer needs. A multi criteria collaborative filtering recommender system is designed by Zhao [15]. A suitable recommender system is designed according to user requirements in different aspects. Two techniques Neuro-Fuzzy and dimensionality reduction are used to reduce scalability problems. The experiments performed on dataset of yahoo and trip advisor and get accurate results.

Restaurant recommender using Psychographic and Demographic factors is used by Nilashi, Bin, Ithnin, Zakaria [16]. This is new recommender system consist of three factors. First factor is one in which lifestyle, interest and personality of an individual is observed by mobile usage pattern which is called Psychographic. Second factors are attributes like age, gender is observed in Demographic. Third one is location and the results observed by these are through means and square root. Also author of OWA book recommender technique designed a book recommender system in Katarya [17] integrated with fuzzy logic is developed. This book recommender system gives user top ranked books assigned by universities.

New methodologies have been designed by Sohail [18] rather than using collaborative technique, relative technique is used in this paper. This technique is based on single individual for whom we are presenting data, fuzzy sets methods are used in this paper. Recommender systems are best for recommending things to user according to their requirements. In this book Yager [19] author use different methods and techniques of designing a recommender system , algorithms are use

collaborative and content filtering techniques also described for recommending different types of things to user. A restaurant recommender is developed by the authors of Adaptive Food Suggestion Engine in Jannach [20]. System allows users to give feedback and according to this feedback system will calculate the user taste and prepare menu list according to their choice. Fuzzy controller is developed and used in this paper for taking input from users user interface is developed in PHP.

3. THEORY

Our objective is to design a system by expanding fuzzy logic; Fuzzy system takes parameters as input and gives them preference level according to rules defined in fuzzy controller and user reviews, this results in menu called as fuzzy output menu. The components on which system consist of are described below in detail:

i) **Input Variables:**

a) **Taste:**

Taste is the first thing to be considered whenever we talk about food because every person has different taste some like spicy food some like sweet and so on. User can give any kind of taste sweet, sour, spicy, crispy even can give combination of two tastes like sweet-spicy, sweet-sour. Fuzzy system can take one variable at one time we can give N variables but because of N variables system design would become difficult so first fuzzy controller take one variable as input and set preference level then take another variable and set preference level then by combining these two variable fuzzy controller will give one output.

TABLE I
RULES OF CALCULATING PREFERENCE LEVEL FOR TASTE

Taste	Preference Level		
	High	Medium	Low
1~3	1	0	0
3~6	0	1	0
>6	0	0	1

Each taste variable has 3 fuzzy levels low, medium and high with their membership functions. For example if a user search for something spicy and crispy then first system will fetch data from database and find all records having taste spicy and crispy then assign fuzzy values to these records. As fuzzy controller take one value at a time that's why first we give the score of value then other

and then fuzzy controller will give output as single value.

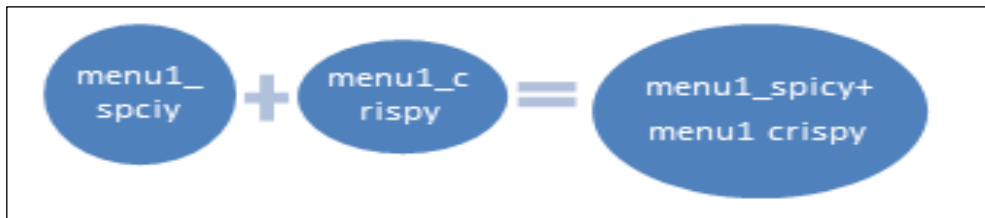


Fig. 1 Combining two tastes giving one result.

b) Budget:

Budget value will be taken as integer. Database will have budget value for each menu. Price will be checked according to following equation:

$$\mathbf{Budget} = 0.05 * \$\mathbf{budget} \quad (\mathbf{i})$$

Where \$budget is value given by user, if user give price 200 then the following rule will be used to search the food from the database:

- its exact value
- value 5% less than this
- 5% greater than this

According to this the preferences of the user budget will be set as follow:

TABLE 2

RULES OF CALCULATING PREFERENCE LEVEL FOR BUDGET

Budget	Preference Level		
	High	Medium	Low
Exact Price	1	0	0
<max price	0	1	0
>max price	0	0	1

c) Location:

Distance is calculated by using Geo measurement function. If distance is less than 2 km than preference level is 3 and if distance is greater than 2 km and less than 6 km then preference levels will be 2 otherwise preference level will be 1. According to distance longitude and latitude have been calculated.

TABLE 3

RULES OF CALCULATING PREFERENCE LEVEL FOR LOCATION

Distance	Preference Level		
	High	Medium	Low
0~2(Closer)	1	0	0
2~6(Near)	0	1	0
>6(Far)	0	0	1

d) Environment

Environment can be casual, formal and informal. Environments will be saved in database with restaurant. Like taste, restaurant will be selected according to environment too but environment will be only one entry it will be either formal or informal or casual not two like taste.

e) User Review:

User will give reviews and search according to reviews too. 5 preference levels most preferred, more preferred, preferred, lesser preferred and less preferred are added with each food item so that user can also search with preference levels.

f) Input membership Functions:

Membership functions are used for mapping input values equal to the value in between 0 and 1. For example in our work if we take taste as input and taste intensity is 10 then the membership function will indicate low preference level. We have used Gauss method for calculating membership function and membership function of each input is shown separately.

TABLE 4

RULES OF CALCULATING PREFERENCE LEVEL FOR USER REVIEW

User Review	Preference Level		
	High	Medium	Low
1~3	1	0	0
3~6	0	1	0
>6	0	0	1

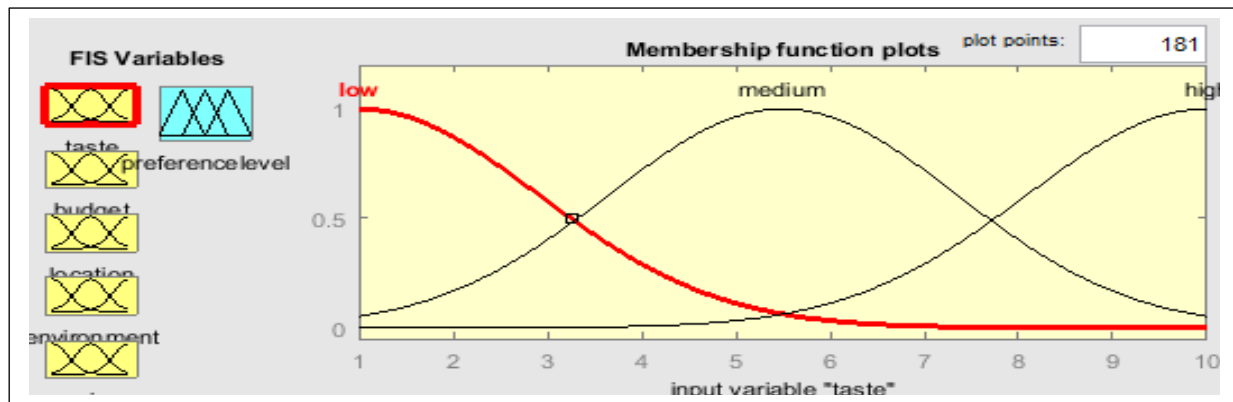


Fig. 2 Membership function for input taste

This figure is showing the same results as we have discussed in table 1. In the same way we have calculated the membership function of all the inputs we have defined above.

j) Output Variables:

Output variables will be calculated by adding the variables. Suppose budget, environment, taste, location and user reviews are a_1, a_2, a_3, a_4 & a_5 values of all variables if have high preference level 3 when added will be;

$$\sum a_i = 3 + 3 + 3 + 3 + 3 = 15 \quad (ii)$$

k) Output Curves:

Output curve showing the preference levels according to input variables given. Output curves are showing values from 1 -10.

l) Fuzzy Condition Rules:

If taste = low

Budget = high

Environment = Casual

Location= Far

And user review = low

Then restaurant is lesser Preferred

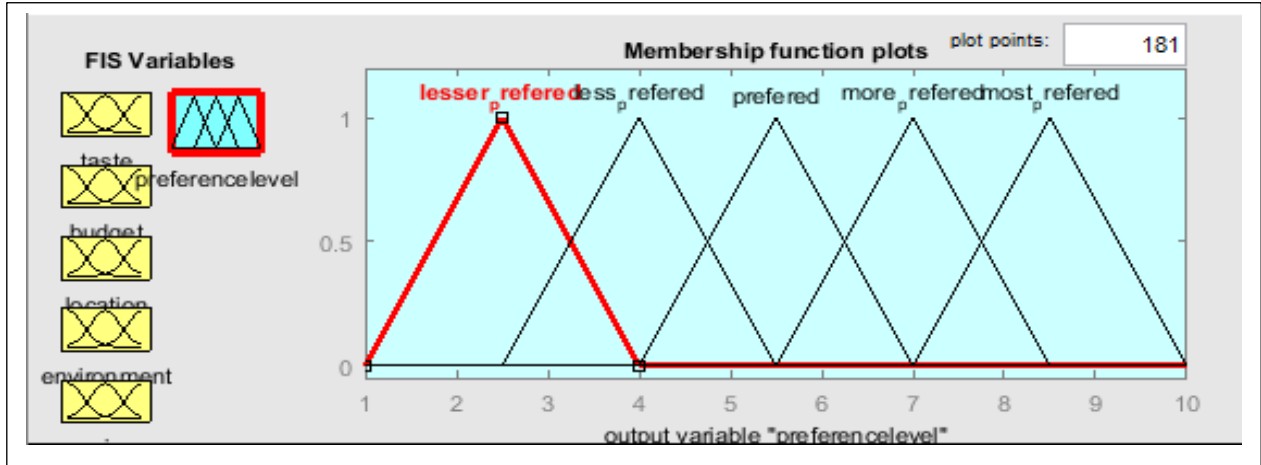


Fig. 3 Output Curve

Depending on these rules all the preference levels have been calculated. We have defined all these rules in MATLAB as shown in fig. 4. Figure 5 is showing the result taken from MATLAB Rule Viewer.

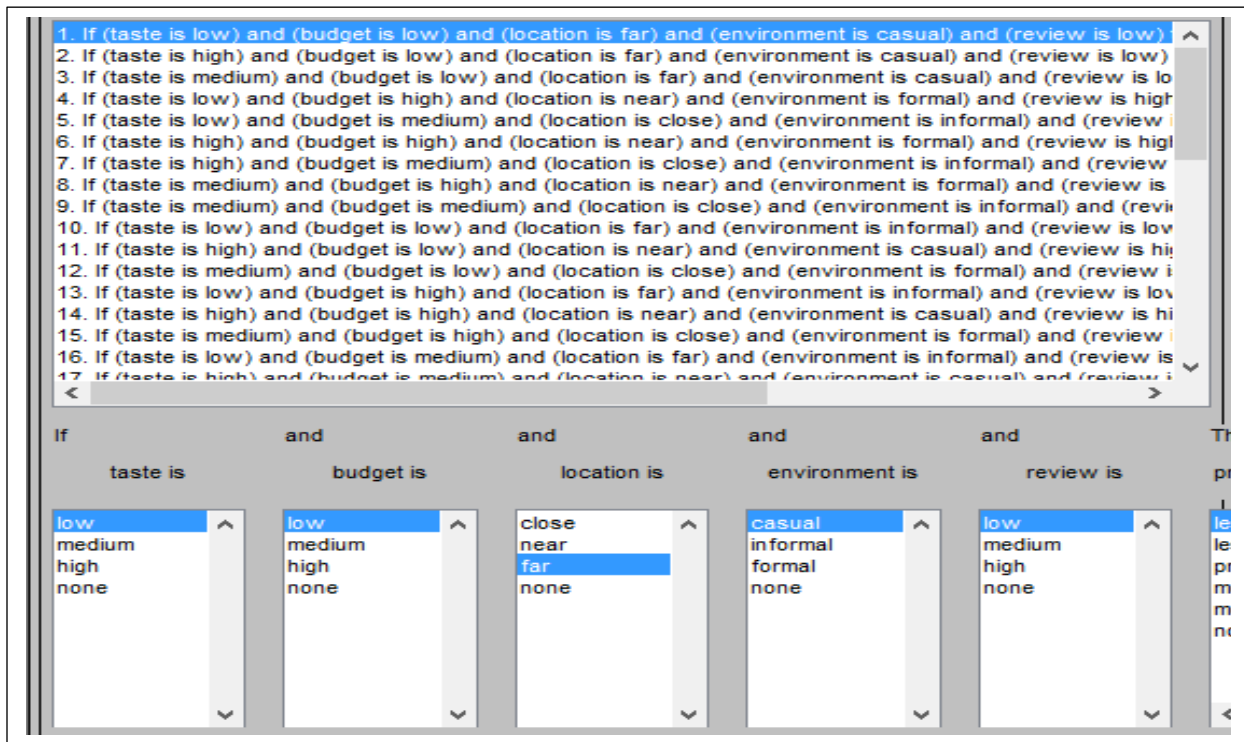


Fig. 4 Fuzzy rules defined in MATLAB

We have given taste and budget as input and the preference level we get is shown in following surface viewer.

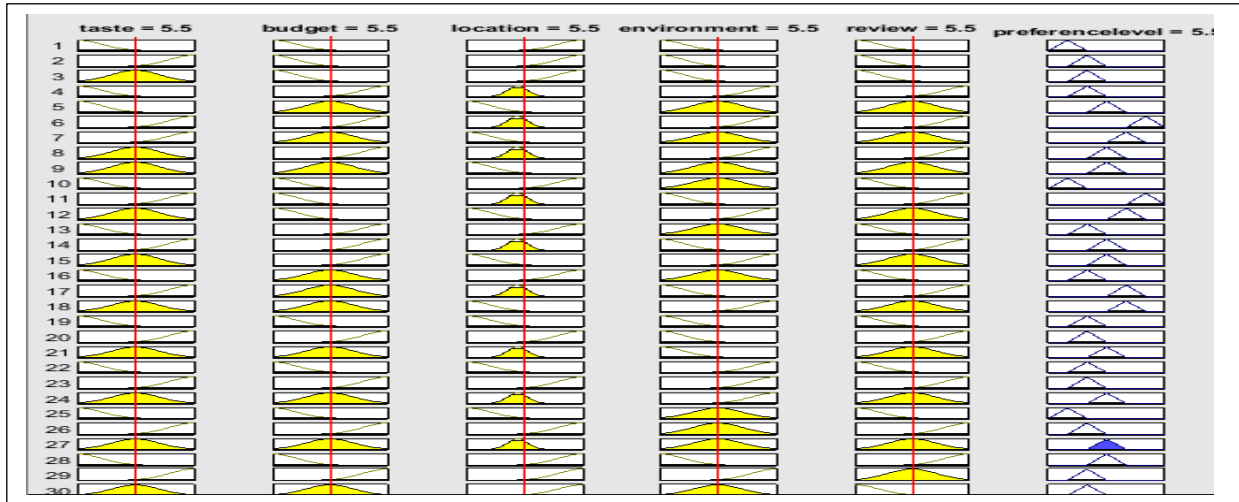


Fig. 5 Rule Viewer

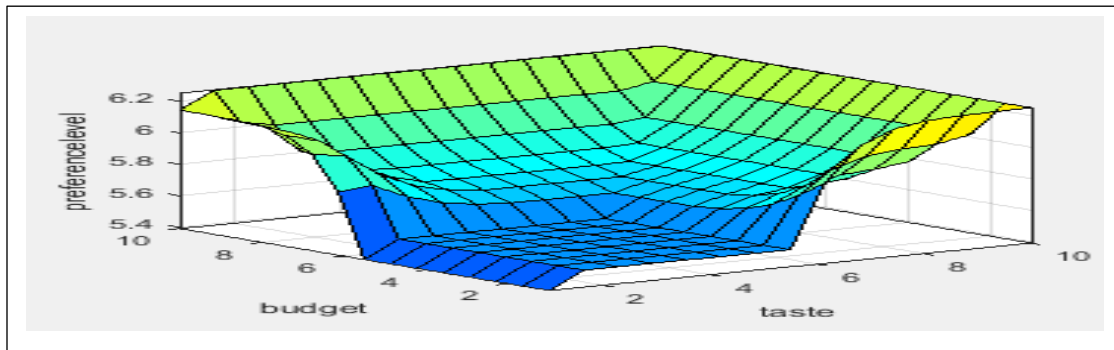


Fig. 6 Surface viewer of Input Taste and Budget

4. PROPOSED ALGORITHM

1	Start
2	Declare Variables location, budget, taste, review, environment
3	Read Value budget
4	Get 5% of budget greater or less than user given value
5	Assign Fuzzy membership function
6	If budget is according to user given value Preference level= 3 && if given price < max price Preference Level=2 otherwise 1
7	Read Value Location
8	Distance measured through Geo measurement Function
9	Assign Fuzzy membership function
10	if (distance <= 2) Preference Level= 3 else if (distance > 2 && distance <= 6) Preference Level = 2 else Preference Level= 1
11	Read Value Taste
12	Assign Fuzzy membership function
13	If taste_intensity < =3 Preference Level =1 Else if(taste_intensity<=6) Preference Level=2 Else if(taste_intensity<=10) Preference Level =3
14	Read Value Environment
15	Assign Fuzzy membership function
16	If environment casual Preference Level=1 Else if(environment informal) Preference Level=2 Else if(Environment Formal) Preference Level=3
17	Read Value User Review
18	Assign Fuzzy membership functions
19	Output menu according to user preferences and search
20	Stop

5. IMPLEMENTATION OF PROPOSED ALGORITHM

Websites are the best source for getting information of any kind. Now a day when internet is accessible nearly every place one can check whatever they want or need just by browsing from their laptop or mobile phones. That's why we have also developed a user friendly web interface in PHP for our users so that they can check restaurants and food of their own choice by simply entering the food taste they like , location near to their home or office, budget they want to enter and most of all environment in which they can make themselves calm. We have also added user reviews so that people can check the user reviews of people eaten the food from restaurants. It is also easy person because by clicking on website new restaurants and the new menu will also be given to them.

All the data of restaurants and types of food is stored in database already. When the user go on website and enter the data like taste environment or location etc of their, this entry will be sent to database where database will search the food of this type an sent this to fuzzy controller now the fuzzy controller will assign parameters according to the rules defined in MATLAB and send data back to user interface in the form of new designed menu with preference levels.

As this is the era of mobile phones so we have also developed an android version you can get the same data from android phone as given in website.

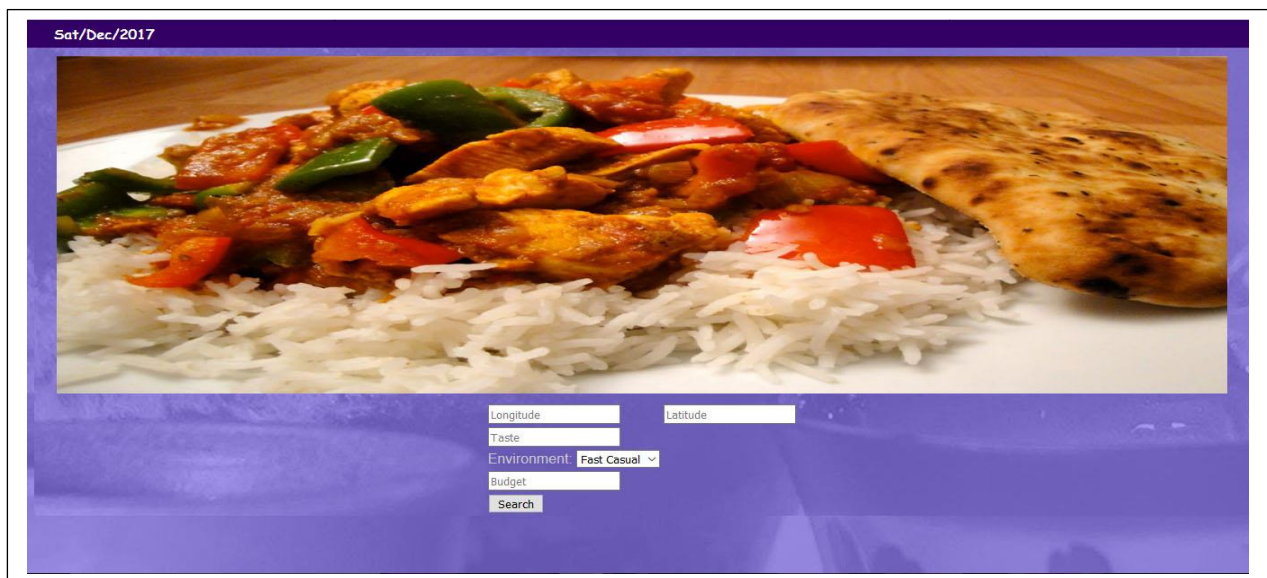


Fig. 7. User Interface.

Preferred Menu					
Food	Hotel	Price	Budget Rating	Distance Rating	Taste Rating
Chicken Cheese Sandwich	Bundu Khan	370	1	1	Bitter 1
Prawn With Green Chilli Dry	Bundu Khan	760	1	1	Spicy 1
Chicken Masala Rice	Bundu Khan	420	1	1	Spicy 1
Plain Rice	Bundu Khan	250	1	1	Salty 1
Hot and Sour Soup	Bundu Khan	550	1	1	Spicy 1
Chicken Corn Soup	Bundu Khan	510	1	1	Salty 1
Raita	Bundu Khan	120	1	1	Salty 1
ColeSlaw	Bundu Khan	330	1	1	Salty 1
Roti	Bundu Khan	10	1	1	Salty 1
Ginger Naan	Bundu Khan	100	1	1	Salty 1
Mughlai Hari Mirch Chicken Curry	Bundu Khan	1280	1	1	Spicy 1
Cheese Naan	Bundu Khan	200	1	1	Salty 1
Arabic Chicken Gyora	Almaida Pizza Garden	220	1	1	Salty 1
Soup Of the Day	Almaida Pizza Garden	100	1	1	Salty 1
Bar B Q Platter	Almaida Pizza Garden	460	1	1	Spicy 1
Malai Wings	Almaida Pizza Garden	210	1	1	Salty 1
Bonfire Pizza	Almaida Pizza Garden	790	1	1	Spicy 1
Shahi Pizza	Almaida Pizza Garden	790	1	1	Sweet 1
Cheese Lover Pizza	Almaida Pizza Garden	740	1	1	Salty 1
Chicken Sweet Corn	Almaida Pizza Garden	760	1	1	Salty 1
Fajita Sicilian	Almaida Pizza Garden	740	1	1	Spicy 1

Fig. 8 Preferred menus with Fuzzy Parameters.

6. METHODOLOGIES

Fuzzy Logic is used to control complicated things and in decision making process. For example, it can be used to design thermostat through which temperature can set as high, low medium and cold. In this paper different factors like environment (casual, formal, informal) budget (low, medium, high) taste (spicy, crispy) user reviews (lesser preferred, less preferred, more preferred. Most preferred and preferred) and location (close, far, near) will be added in RDBMS according to user requirements.

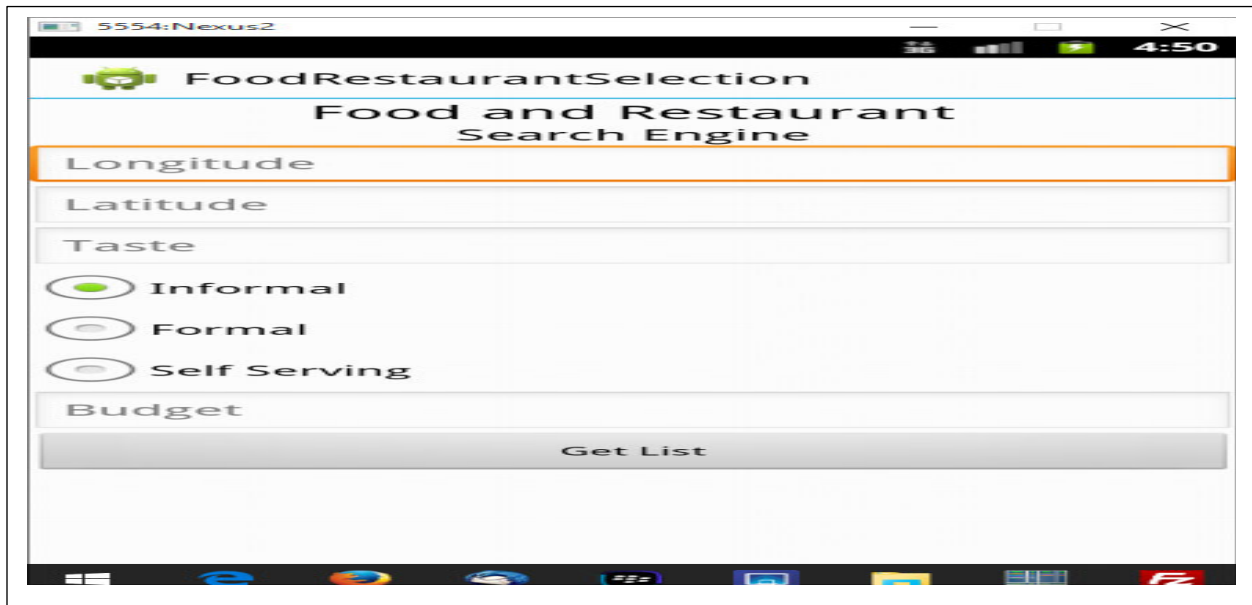


Fig. 9. Android app implementation.

Then by using PHP (Hypertext preprocessor) a user interface will be developed, server will receive data from user interface and fetch relevant data from database, calculate parameters and then send this to fuzzy system. Fuzzy system will check preference level and sort out a menu as output. This menu can be on website and on your android phone.

Methodologies we used while doing implementation of our work are:

- i) Server
- ii) RDBMS (Relational Database Management System)
- iii) Fuzzy Controller System
- iv) Android

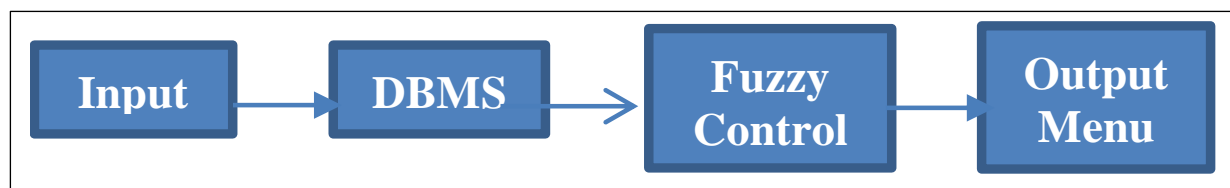


Fig. 10 Block Diagram of methodology

i) Server:

We have used PHP (Hypertext Preprocessor) language for developing web based user friendly interface. PHP is open source and is widely used for developing website. Apache Server is used with PHP. Server fetches data from website, check it with already stored data in database and send to fuzzy controller. There are two forms on website one for taking data from user and other one for keeping record of user reviews.

Table	Action	Rows	Type	Collation	Size	Overhead
<input type="checkbox"/> admins	Browse Structure Search Insert Empty Drop	1	MyISAM	ascii_general_ci	2.0 K	-
<input type="checkbox"/> environment	Browse Structure Search Insert Empty Drop	3	MyISAM	ascii_general_ci	2.2 K	-
<input type="checkbox"/> menus	Browse Structure Search Insert Empty Drop	660	MyISAM	ascii_general_ci	41.8 K	-
<input type="checkbox"/> menutastemap	Browse Structure Search Insert Empty Drop	510	InnoDB	ascii_general_ci	48.0 K	-
<input type="checkbox"/> restaurants	Browse Structure Search Insert Empty Drop	14	MyISAM	armscii8_general_ci	3.5 K	-
<input type="checkbox"/> reviews	Browse Structure Search Insert Empty Drop	0	InnoDB	ascii_general_ci	16.0 K	-
<input type="checkbox"/> tastes	Browse Structure Search Insert Empty Drop	7	MyISAM	ascii_general_ci	2.3 K	-
<input type="checkbox"/> users	Browse Structure Search Insert Empty Drop	0	MyISAM	ascii_general_ci	1.0 K	-
8 tables	Sum	1,195	InnoDB	ascii_general_ci	116.8 K	0 B

Fig. 11 Database of System.

ii) RDBMS:

Data of all the restaurants is taken and stored in DBMS, then after fetching from server records will be matched with the data of database and passed to fuzzy controller. Eight tables are created in database i) admins add, delete and edit the record of restaurant ii) environment holds the type of environment iii) menus hold the data of all type of menus of all restaurant iv) menu taste map mapped the taste and menu together v) restaurants hold the data of all the restaurants vi) reviews hold the data of user review vii) taste hold all the taste Data of all the restaurants is taken and stored in DBMS, then types viii) users hold the data of users.

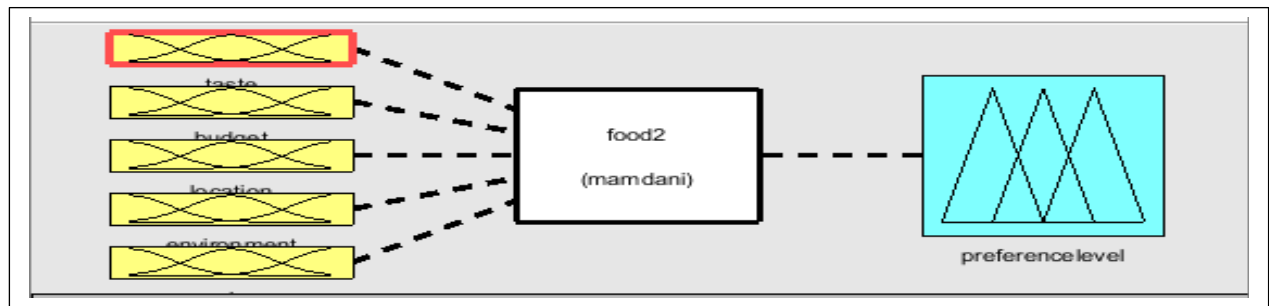


Fig. 12 Through Mamdani System Showing Output

iii) Fuzzy Controller System:

Fuzzy Logic System is designed for taking set of values as input and provides preference level to given input. We have used MATLAB for fuzzy controller design and given below diagram show the preference level of given input when we gave taste, environment, budget and location as input. By using Mamdani System, we have calculated the preference level.

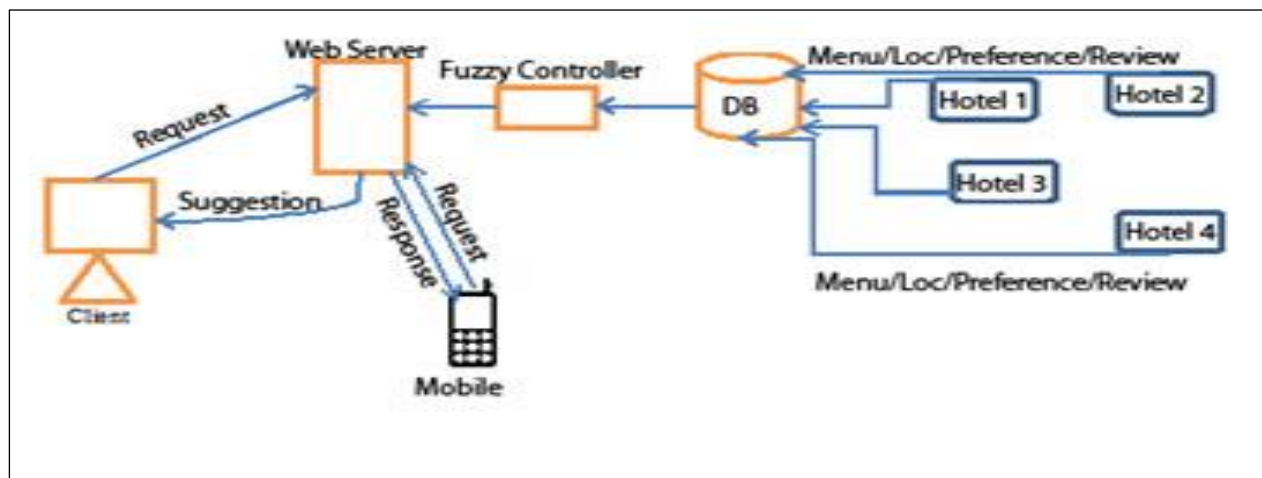


Fig. 13 Architectural Diagram.

iv) Android:

Android technology is used for making application so that user can install app in mobile phone and just by entering data of their choice they can see the restaurant and food of their own choice.

7. COMPARISON RESULTS OF ANDROID USERS

We have taken three categorize of people who use android phone.

- i. Beginner Level Android Users
- ii. Medium Level Android Users
- iii. Low Level Android Users

Twenty users were selected each time for checking the android application. When we did experiment on beginner level user 5 users like the app because they did not know how to use the android phones. Then we did experiment on medium level android users 16 liked the app and when we went towards higher level users result was 100% because everyone liked to tour the restaurant just by using app.

TABLE 6
COMPARISON OF ANDROID USERS

Total Number of Users	Sample Space	Percentage of Users
Beginner Level Android Users	5	40%
Medium Level Android Users	16	80%
High Level Android Users	20	100%

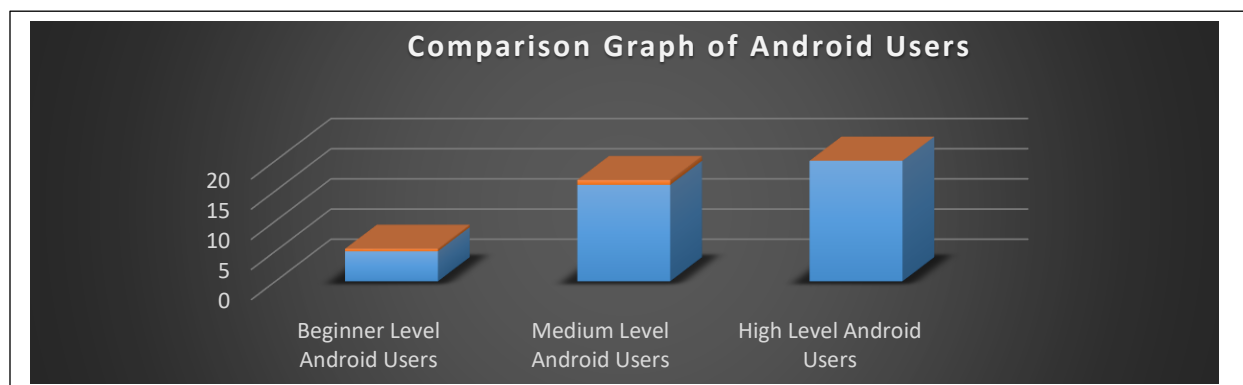


Fig. 14 Comparison Graph of Android Users.

8. DISCUSSION

Restaurant recommender system is for recommending people the restaurant of their own choice. We have used fuzzy logic for making a restaurant recommender instead of artificial intelligence system because fuzzy logic is basically natural intelligence and artificial thinking while artificial intelligence is for making expert systems. We continued the work of Adaptive suggestion engine using fuzzy logic in which the data set of Yelp have been used. The authors used the variable taste, budget, location, environment and user reviews as input and after applying the fuzzy logic the results had been given. They used the web interface and PHP (hypertext preprocessor) language for designing their web application but they did not use the android interface.

In our system we have used the different frameworks for developing the android app and converting the web interface in to android application. Our system has not taken data set from any website we have taken the data of 15 restaurants of our city and add the menu items, restaurants and all the required information in to the database. When the user visits the android app he would choose the parameters according to his choice like if he/she wanted to choose taste user could select one taste or many tastes at a time.

TABLE 7

COMPARISON WITH PREVIOUS SYSTEM

Features	Adaptive Food Suggestion Engine	Our System
Search by taste	Test based search was available but not multiple tastes selected	Multiple taste selection available.
Search by location	Location service available but according to distance no GPS.	GPS service enabled so that distance can be automatically detected
Search by environment	Used the keywords casual, formal and informal.	Virtual Environment like music yes/no, play area yes/no, wall decorated or not, location inside or outside.
Search by budget	Available	Available
Search by user reviews	Use keywords good, bad excellent.	Use the ratings of people who have already visited the restaurant.

When coming to environment we have given a little touch of virtual environment in our system which was not given in previous work. We have added factors like music, wall, play area, sitting

area, casual environment, formal environment so that user can select any of these and when he visits the restaurant environment would be of his choice.

Deal variable is new variable added in our system for example if a person wants to go alone he would select single deal and all the restaurants supported single deals would be in front of users list and if one wanted to go with family multiple deals option would be selected from user and all the restaurants supported multiple deals would be displayed.

Location would be calculated through GPS system. We have used a plugin of GPS which would automatically detect user location by turning on the location service from mobile phone this option was also not available in previous work. User Reviews would be selected by users one can choose user review from the rating button these are the reviews given by user who had already visited he restaurants.

Budget textbox was also given for entering the amount one would enter according to his budget.

After taking data from user our system would check fuzzy rules, fetch results from database and show the results after calculating all parameters. When results would be displayed you could also select start button and google map would display you the direction to follow for your desired restaurant. Android app has also been published on play store.

9. CONCLUSION AND FUTURE WORK

Now a day there is restaurant at everyplace. People love to eat food in restaurant because in affordable money one can get many products of eating with drinks also. Choosing a restaurant without going in it and know about its environment is very difficult task. When first time people go in restaurant it might be possible they may not like the food quality, or service of food, staff of restaurant, location of restaurant, budget may exceed then they might expect. So these can be bad experiences one can face while going first time in restaurant.

We have developed our restaurant recommender system keeping all these things in mind so that our valuable users not get panic, angry and their money not get waste while they visit the restaurant. We have taken the five variables as input for getting user's data and recommend them the restaurant of their choice according to their taste, budget, location and environment. We have also

added the videos of each restaurant it's like virtual tour where one can see the environment and location of restaurant by sitting at their home

Fuzzy controller is designed and integrated with android and website. Through different simulations in MATLAB and testing it is seen that customized restaurants are referred to people according to their requirements and using android app people can check restaurant of their choice anywhere while moving. We have taken many restaurants and implemented the data in our database and after checking our app we have seen that recommender system is working good and recommending the restaurant keeping in view all the parameters.

We have developed a fuzzy system which suggest customer the food of their own choice. By using android app and web applications we have shown our implementation. We want to add virtual reality feature in future so that this system can be more feasible to the people who use it. Virtual reality is the 3D video of any location by taking images of location you can make a 3D view of that location and use them in restaurant or any other project you like.

One more technique beside fuzzy logic can also be used. Artificial Neural Network (ANN) techniques is also good to be used in recommendation system. Artificial intelligence and fuzzy logic can also work in collaboration with each other because both use if-else rule. Adaptive technique of artificial intelligence can be used for this purpose.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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