

A Personalized Diet Recommendation System using Fuzzy Ontology

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ABSTRACT :*In today's hectic world, the importance of diet management has increased exponentially. Due to unhealthy and haphazard eating habits, the spread of diet related diseases is at an all-time high. In India, more than 2 out of every 100 people suffer from diabetes, while 32 out of every 100 people suffer from coronary heart disease. In Urban Areas, the prevalence of these diseases is even more. There are a host of diet related applications and solutions available today. While the importance of balanced diet keeps on increasing, the variety of applications on display today still lack completeness. In this paper, we have reviewed various existing papers and found out the lacunas in the existing systems. In our proposed system, we are using fuzzy ontology, rule-based reasoning, artificial bee colony algorithm and genetic algorithm for suggesting nutrients diet and recipes based on the suggested diet plan. We also take seasonal availability of food available in India and preexisting conditions of the users of the system.*

KEYWORDS-*Diet recommendation, Fuzzy ontology, Rule Based Reasoning, Artificial Bee Colony, Genetic Algorithm.*

I. INTRODUCTION

Balanced nutrition is an important aspect of a healthy lifestyle. Along with regular physical exercise, a balanced diet is extremely crucial for a person's health. However, with the ever-increasing pace of today's professions, nutrition and health is often overlooked. There has been an epidemic of diet related diseases like Diabetes and Coronary Heart Diseases all over the world especially in Urban Areas. According to a report in NFI Bulletin ^[9], in Indian Urban Areas, around 32 out of every 1000 individual suffer from coronary heart disease while more than 2 out of every 100 individuals suffer from Diabetes. These diseases are almost always directly related to unhealthy eating habits. While the advent of technology is often associated with the deteriorating general health of people, it can help people live a healthier lifestyle. Our objective of this project is to build a system that will aim to recommend appropriate nutritional intake to its users based on their diet history and personal preferences. Along with this, our system will consider the user's physical activities throughout the day and suggest appropriate diet plan for the same. Our system will also provide data on the nutrients and seasonal availability of food items to the users. Seasonal availability in India is a major issue and this application aims to provide accurate information about the same. Pre-existing conditions of the user will be taken into consideration and the application will only provide relevant information according to the condition. Our project will also consider the dietary requirements of children and the users can create profiles for their children to keep track of their diet. This application will help users structure their daily diet according to various individual factors which include BMI, physical activity, allergies, etc.

II. LITERATURE SURVEY

Previous studies have proposed systems that offer recommendations and search results based on user preferences, their cooking history, eating lifestyle and food information. Based on that, the following inference has been drawn.

Jong-Hun Kim et al. ^[1] proposed a system which receives the disease management condition and vital sign of the user in real-time and collects user constraints through calculating BMR. Then, it draws the required nutrients using the collected information. Equation (1) represents BMR where h is the number of calories burned (Kcal) in 24 hours, w is weight in (kg), s is height in (cm), and 'a' represents age.

$$h(\text{Male}) = 66.4730 + (13.7516 * \omega) + (5.0033 * s) - (6.7550 * a) \quad h(\text{Female}) = 65.0955 + (9.5634 * \omega) + (1.8496 * s) - (4.6756 * a) \quad (1)$$

The equation that draws the required nutrients is:

$$\text{RN (Required Nutrients)} = \text{BMR} + \text{Activities} \quad (2)$$

Yu-Hsien Ting et al. ^[2] proposes a system that uses of Jena and SPARQL to provide personalized diet recommendations to every user. This is done using an architecture that shows relationship between different ontologies. Wahidah Husain et al. ^[3] proposes Rule Based Reasoning that requires elicitation of an explicit model of the problem domain.

Freyne et al. ^[7] proposed a personalized recipe recommendation system, which is somewhat based on the same process as ours. They derived relations of preferences and the ingredients of the meals from the results of a questionnaire and developed a system to suggest a meal based on the result.

FidelsonTanzil et al. ^[4] uses ABC algorithm that can be used to extract the information from database according to requirements of the user. This algorithm can be used in tandem with Kmean and SOM clustering algorithms. ^[5] The drawback of this system is that it doesn't take the real time information of user dynamically but rather it asks the user to put in that information manually. Chang-Shing Lee et al. ^[6] proposes a T2FO based on T2FSs. This ontology is composed of a type-2 FPPO, a type-2 FFO, and some type-2 FPFOs. Additionally, based on T2FO, this paper further proposes a T2FS-based IDRA to apply to the balanced-diet recommendation for diabetes domain.

III. LACUNAS IN THE EXISTING SYSTEMS

The existing systems do not provide a comprehensive dietary application experience and have one more of the following lacunas:

- a) Does not include and use data from daily activities.
- b) Does not consider any diseases.
- c) Seasonal availability of food is not taken into consideration.
- d) Does not provide recipe info.
- e) Does not provide suggestions for all age groups.

IV. PROPOSED SYSTEM

With our Personalized Diet Recommendation System using Fuzzy Ontology, we aim to recommend appropriate nutritional intake to its users based on their diet history and personal preferences. Our system will consider the user's physical activities throughout the day and suggest appropriate diet plan for the same. We will also provide data on the nutrients and seasonal availability of food items to the users.

The core tasks of our system are as follows:

- a) Use various recipe sources, such as cookpad.com and databases for generating the final menu.
- b) Use a Food & Nutrients database for determining the individual bodily nutritional requirements and the corresponding raw materials that provide those nutrients.
- c) Use a Diseases database to determine the foods relevant to and the foods that need to be avoided for a specific disease that the individual is afflicted with.
- d) Use a Season & Area-wise database to check for the availability of certain foods that will be recommended to the user.

fig 1. shows the block diagram of the system.

BLOCK DIAGRAM

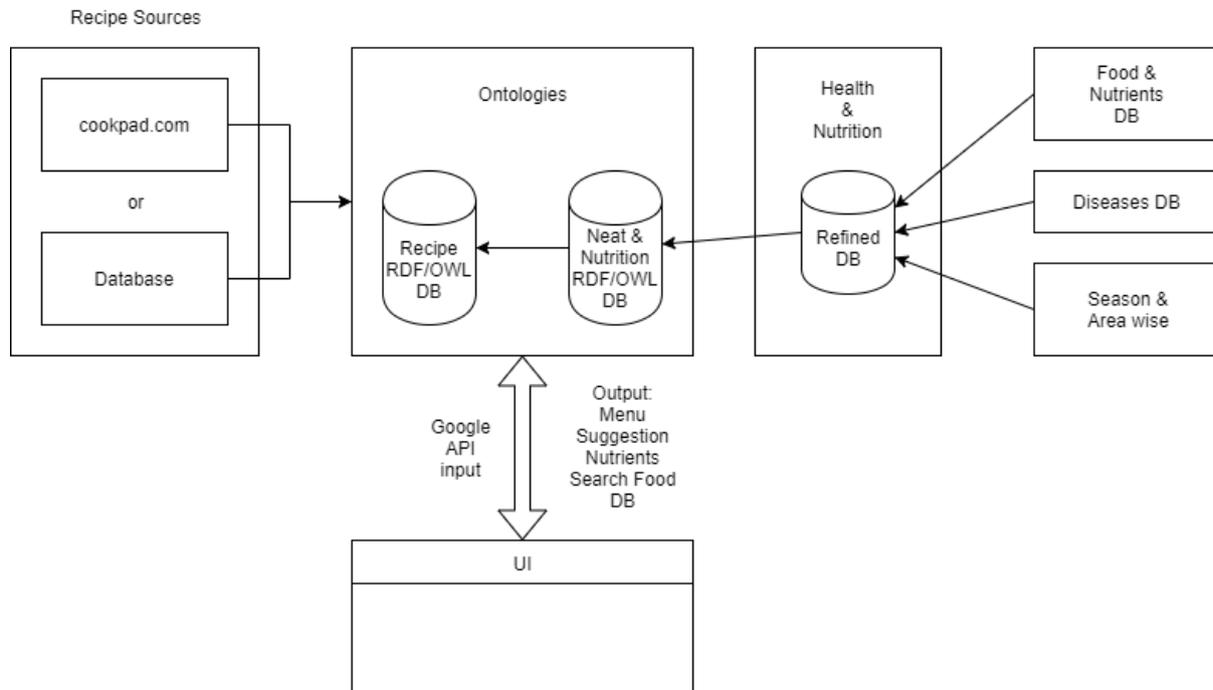


Fig. 1 Block diagram

Using the Food & Nutrients DB, Diseases DB and Season & Area-wise DB, we will be creating a refined database that will serve as a cumulative Health & Nutrition DB.

At the front end, i.e. the User Interface, the input will be in the form of the Google API details collected from the user by tracking their everyday activities, as well as the personal details fed by the user. The output will be in the form of Suggested Nutrient Intake & Raw Materials, as well as the Menu Generated, that incorporates most of the suggested nutrients and raw materials. For being able to use our system, the user will have to register with an email account, preferably their Google account. Our Login module will enable the user to come back to us and/or update their personal details. The User Details will take into consideration essentially the user's personal details and their medical history.

The Update Diet History module will let a user update their everyday diet, for a better diet recommendation. Importing data from Google Fit will save the user their time and effort in putting those details on their own, as the API automatically detects calories burnt and other details. The user also has a provision to search for specific food items, without having to feed details for a short notice reference. The Diet Suggestions module refers to all the previously mentioned databases and ontologies to provide the relevant diet. The Seasonal Availability filter makes sure that the suggested food intake is feasible, the Menu Construction module serves the most important purpose of providing the relevant menu.

V. METHODOLOGY

Datasets will be gathered from various websites like kaggle.com, data.world etc. This data will be cleaned and structured using Pandas library in Python. Disease based data will be extracted from different papers and websites. It will be used to set disease flag in the final database. The final database will be sorted based on types of food. For e.g. sections such as legumes, pulses, cereals, etc. will be made. Once the database is created, the

food and the portions of it is found out using the ABC algorithm. After that, if the user wants recommendations for the recipes, then the recipes are suggested using the K-mean or SOM clustering algorithms. If the user wants to Search of an instance in our database, then that query is resolved using Rule Based Reasoning.

a) Artificial bee colony algorithm:

We use the Artificial bee colony created by DervisKaraboga^[8]; this algorithm was observed from behavior of honey bees to take the process of foraging. The bees are divided into three categories, namely: employee bee (BN), onlooker bee (SN), scout bee.

V.I.Algorithm

1: Initialize food source $X_{ij} \in \{1, \dots, BN\}, j \in \{1, \dots, D\}$

2: Evaluate food source by using equation (12)

3: $t=1$

4: REPEAT

5: Produce innovative solutions V_{ij} for the employed bees by using equation (13) and evaluate them using equation (12)

6: Apply the greedy selection process for the employed bees.

7: Calculate the probability value P_i for the solution X_{ij} by equation (14)

8: Produce the innovative solutions V_{ij} for the onlookers from the solutions X_{ij} depending on P_i by using equation (13) and evaluate them using equation (12).

9: Apply the greedy selection process for the employed bees.

10: Determine the abandoned solution for the scout, if trial have reach limit, then replace it with a new randomly produced solution X_{ij} .

11: Memorize the best solution achieved so far

12: $t = t + 1$

13: UNTIL $t = \text{max iteration}$ where,

V_{ij} is new food source.

X_{ij} is current food source.

X_{kj} is another food source

$i \in \{1, \dots, B\}$.

$k \in \{1, \dots, B\}$ are randomly chosen.

$j \in \{1, \dots, D\}$ are randomly chosen.

D is number of dimension.

In this research have 5 dimensions (MP, LN, LH, SY, BH). \emptyset_{ij} is random number between $[-1, 1]$.

VI. FLOW OF THE PROCESS

With this project, we can provide a user-friendly application that covers aspects like diseases, seasonal availability, menu generation along with providing nutritional information. This research presents artificial bee colony algorithm to get servings and the type of food for the required daily nutrition. The proposed system uses Rule based reasoning and fuzzy ontology to provide food and nutrition suggestions efficiently. In this proposed system, genetic algorithm is used for Menu generation.

fig 2. shows the flow of the food recommendation system. First, we calculate the BMI index of the user. We query the Google fit API of the user to get the information of his daily activities and thus we calculate the energy required for the user in that day. We extract the disease information about the disease the user has. Then according to those details, we either filter the database or we flag the database according to the requirements of the user. Then we cluster the database according to the nutrients present in that item. Then there are two ways to approach:

If the user chooses Nutrition suggestion:

Compile a set of nutrient plans. Display the best $\frac{2}{3}$ nutrient plans. Display the nutrient plan to the user and let him select one according to his preference.

If the user chooses Food suggestion:

Query the food database according to the nutrients needed. Cluster the food items according to the user's liking.

A Personalized Diet Recommendation System using Fuzzy Ontology

Display the list of food items to the user. In the other module, the user searches about the food he wants to know the nutrition content about. The system extracts data from the database and then checks the history of user before displaying.

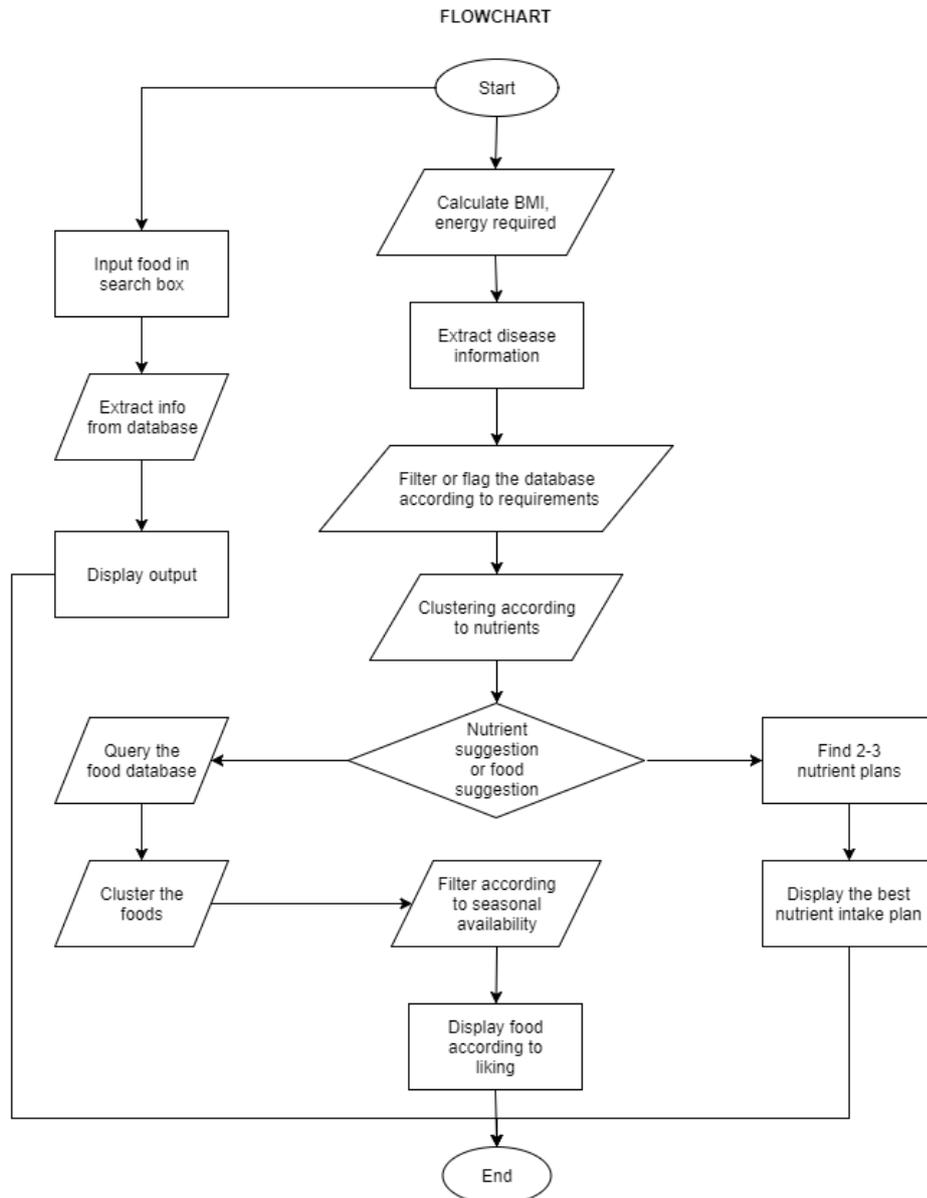


Fig.2 Flowchart of the system

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A Personalized Diet Recommendation System using Fuzzy Ontology

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