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AyurDiet OS: An Intelligent Hybrid Ayurvedic Nutritional Diet Planning and Recommendation System

Vidhi Dattatraya Kamat[1], Dr. K Amuthabala[2], V. Srinath Reddy[3], T. Khatwangadar Reddy[4], V. Allwin Romario Fernando[5]

[1, 3, 4, 5]*Department of Computer, Science Engineering, REVA University, Bengaluru, India*

[2]*Associate Professor, Department of Computer, Science Engineering, REVA University, Bengaluru, India*

Abstract: ***AyurDiet OS is an online diet planning platform that assists in designing a tailored diet one by one, based on Ayurveda and the contemporary nutritional science to inform people on their biological requirements. The majority of diet applications follow only one line of action which is to track calories and count the macronutrients in order to direct diet, however, this does not consider how an individual would respond based on his/her constitution (i.e. body type), his/her digestive capability of certain types of food and how the seasons might influence how we metabolize food in accordance with principles discussed in Ayurveda. In this Platform, an Ayur-Nutri Hybrid Score (ANH-Score) algorithm is suggested, which calculates the compatibility of food products based on the Ayurvedic principles and their nutritional properties. This Platform includes five modules: Prakriti assessment, Food scoring, Meal composition, Detection of food item incompatibility (according to the principles of Viruddha Aahara) and an AI-based diet consultant. The trial analysis demonstrates that the system is able to make balanced meal plans and identify the food combinations that do not have to be taken simultaneously and provide patients and health specialists with instant nutrition information.***

Keywords: Ayurveda, Personalized Nutrition, Diet Recommendation System, Prakriti Analysis, ANH-Score, Knowledge Graph, Food Compatibility, AI Diet Planning.

I. INTRODUCTION

Health maintenance and food habits help us to prevent various diseases. The current research on nutrition is preoccupied with the quantification of foods with the help of their calorie content and macronutrient and micronutrient composition. Traditional medicine like Ayurveda considers nutrition as an aspect that should take into consideration the body constitution (Prakriti) and the digestion capacity (Agni) of an individual, the nature of foods and the impact of the seasonal variations.

Ayurvedic texts classify foods based on properties which include Rasa (taste) and Virya (thermal potency) and Vipaka (post-digestive effect) and their impact on the three doshas of Vata and Pitta and Kapha. The principles establish an all-encompassing dietary framework which modern computational diet assessment tools seldom use.

Digital diet applications available today concentrate on either calorie tracking or meal planning through standard templates which do not consider how people need different dietary approaches based on their individual body types. Ayurvedic dietary knowledge exists in textual format because practitioners have not developed systems which create automatic dietary recommendations through algorithmic methods. AyurDietOS connects Ayurvedic dietary principles with contemporary nutritional assessment methods through computational algorithms. The system examines the Prakriti of a user based on a questionnaire and produces any dietary advice based on a hybrid method of scoring. The platform works based on the algorithmic food scoring and incompatibility recognition and AI-assisted consultation techniques to bridge the gap between traditional knowledge and the modern health technologies.

II. LITERATURE REVIEW

There is interesting research with the title "Heart Disease Diagnosis and Diet Recommendation System Using Ayurvedic Dosha Analysis." From the above research, we can see that the developers have created a system in which you can measure your pulse, and then you can know your dosha. After that, you can know what to eat. Although the developers of the research above have used some machine learning techniques like decision tree and random forest in the above research, the whole system depends on the sensor only, not on the nutritional values of the food [1].

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The article, "Food Recommender: Deep Learning Approach for Predicting Daily Diet Based on Body Prakriti" tells how machine learning is used to suggest the daily meals, based on the prakriti of the individual and the season. The respondents of this study record the food habits and in return, the system suggests foods to the respondents. Nevertheless, we are unable to observe that this study has tried to test the effectiveness of the system in real life [2].

The resource under consideration is named Diet Recommendation Based on Prakriti and Season using Fuzzy ontology and Type-2 Fuzzy logic as it integrates reasons and Ayurvedic theory to propose food on the basis of various body types and seasons. Although it is a good attempt in solving the ambiguities of the Ayurveda dietary instructions, it remains too rule-oriented and is not entirely based on the current nutrition science [3].

The project under discussion is called Smart Diet India: An AI-Based App to manage your Indian diet personally and culturally adaptably, and it is an innovative application that combines the Artificial Intelligence, the natural language processing and Ayurveda to give dietary recommendations, which, in fact, are attractive to the Indian cuisine. The findings reveal that people will tend to be more committed to such plans as compared to traditional diet applications [4].

It is interesting that there is a study named Predicting Ayurveda-Based Constituent Balancing in the Human Body that uses machine learning methods. They apply machine learning to classify prakriti by numerous behavioral characteristics in this study and get a remarkable 95 percent accuracy with their models. This actually brings out the extent to which computers can handle complex analyses [5].

The advantages of using the conventional dietary concepts alongside contemporary nutrition science continue to be mentioned in the recent studies. Consider, as an example, the article by the name An Appraisal on Ayurvedic Diet and Dietary Intake Considerations in View of Nutrition Science. It dwells upon the fact that the Ayurvedic approach to digestion, body type, and food-combination is a wonderful match with the modern concept of nutrition. Such an opinion is capable of strengthening our knowledge [6]. The other fascinating article, "Integrative Approaches to Ayurvedic Nutrition and Personalized Medicine," explains how the integration of Ayurveda and healthcare technology could make nutrition more personal and preventative instead of treatment-oriented [7]. Such results show that the implementation of these frameworks can substantially improve the manner in which we can handle the area of personalized diets.

Recently, scholars who have gone deep into the world of recommender systems have started to use algorithms to prepare customized food recommendations. In a survey called Food Recommender Systems: Important Contributions, Challenges and Future Research Directions, the authors of this article explore the application of different techniques such as filtering and content-based recommendation in dietary recommendation systems [8]. Other papers like Analysis and Optimization of a Novel Efficient Quality Assurance Model in Data Warehousing and Design of Task Scheduling and Fault Tolerance Mechanism Based on GWO Algorithm to Achieve Better QoS in Cloud System also research the role of smart computational models and optimization methods in improving the speed and stability of big data systems. Based on this principle, the AyurDietOS platform utilizes classical knowledge and applies algorithmic food rating, compatibility, and smart meal planning to provide genuinely personalized dieting suggestions [9],[10].

Most of these researches will either focus on the study of your constitution or propose foods along the Ayurvedic principles, but hardly ever both at the same time. Not many of them in fact combine the knowledge of Ayurveda with sound nutritional examination. That is where AyurDietOS strikes in, and both Ayurvedic knowledge and the contemporary nutritional values are combined in one single formula.

III. RESEARCH GAP

The rise of diet planning applications has brought more users to these systems yet their current functionality still faces multiple hurdles.

Digital diet systems depend on contemporary nutritional measurement systems which assess only two elements: calories and macronutrients. The Ayurvedic system of medicine establishes particular digestive traits which these measurements fail to assess along with the individual constitutional differences between different people. Current diet recommendation systems fail to provide sufficient customized solutions for users. The system uses demographic data to create recommendations which depend on age, weight and activity level but it fails to consider essential body constitution traits and thermal requirements and seasonal effects. Ayurvedic dietary knowledge exists in numerous written records but researchers have not yet developed any computational systems which can deliver automated personal dietary advice based on this knowledge.

The existing situation requires a computational system which combines Ayurvedic dietary principles with contemporary nutritional science to produce personalized dietary plans which meet both health requirements and cultural traditions.

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IV. METHODOLOGY

The system called AyurDiet OS functions as a hybrid diet planning platform which combines Ayurvedic dietary principles with contemporary nutritional science through its algorithm-based modeling system.

A. Prakriti Assessment

It is done by identifying your Ayurvedic constitution, or Prakriti, by taking a series of questions. Such questions will cover different subjects like the way you look, how you digest, what you do every day, and even how you think. The three doshas, Vata, Pitta and Kapha have certain weights attached to each answer you give. Imagine that you have a questionnaire where there are N questions, when you answer each one, the question has its own set of values, one of each dosha, so to speak, and this is added to the final total: Wi = (wVi,wPi,wKi)

In order to find total scores of each dosha we will use the equations below:

1. Vtotal=i=1∑NwVi
2. Ptotal=i=1∑NwPi
3. Ktotal=i=1∑NwKi

Where: N = total number of questionnaire questions, wVi = weight contribution of question *i* toward Vata, wPi = weight contribution of question *i* toward Pitta, wKi = weight contribution of question *i* toward Kapha

The normalized percentage distribution of each dosha is:

1. V%= (Vtotal/Vtotal+Ptotal+Ktotal)×100
2. P%=(Ptotal/Vtotal+Ptotal+Ktotal)×100
3. K%=(Ktotal/Vtotal+Ptotal+Ktotal)×100

The highest percentage indicates the primary dosha, while any others that exceed 30% are seen as secondary.

B. Food Property Annotation

All food products have a comprehensive list of its Ayurvedic and nutritional values.

Ayurvedic Attributes

- Rasa (taste): Madhura, Amla, Lavana, Katu, Tikta, Kashaya
- Virya (thermal potency): Ushna (heating) or Sheeta (cooling)
- Vipaka (post-digestive effect)
- Dosha effect values: ED∈[−2,2]
  Where:
  - -2 = strongly pacifying
  - 0 = neutral
  - +2 = strongly aggravating

Nutritional Attributes - Every food product has an easy-to-read breakdown that contains: Calories (kcal), Protein (g), Carbohydrates (g), Fat (g), Fiber (g) and a Micronutrient score.

C. Ayur-Nutri Hybrid Score

The Ayur-Nutri Hybrid Score also known as ANH-Score is a convenient guide that will assist you to know whether a specific food will be a good match or not. It is a blend of ancient wisdom of Ayurvedic practices and the current advances in modern nutrition.

The equation used here is:

ANH = 0.5 × SA + 0.5 × SN

The two aspects are of equal importance. The Ayurvedic score (SA) is a measure of the compatibility of the food to your dosha, whether it heats or cools the body (called virya) or the range of flavors that the food offers to the table (rasa). On the other hand, the nutrition score (SN) is concerned with the basics: is the food you consume adequate, is the protein content adequate, and how nutrient-dense is it?

In this way, you will not need to make a decision between tradition and science. The ANH-Score will make sure that what you eat is not only healthy but also compliant with the Ayurvedic rules.

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D. Meal Composition Algorithm

A greedy constraint satisfaction algorithm is used in meal generation. During this process, foods are arranged by ANH-Score and one is chosen at a time, taking into consideration that important limitations are to be adhered to.

1. Calorie Constraint: Σ Calories$_i \leq$ Cmax
2. Protein Constraint: Σ Protein$_i \geq$ Pmin
3. Taste Diversity: Unique Rasas $\geq$ Tmin
4. Compatibility Constraint: Viruddha(foodi,foodj) = false

When any of the above constraints are not met by a food item then it is disqualified. The system continues making choices that work until it has no more choices that work.

E. Viruddha Aahara Detection

The incompatibility of food can be explained with the help of a graph-based model when each type of food is taken as a node, the incompatibilities between them are the edges. We can denote this as G = (F,E).

When (fi,fj) belongs to E, then it means that the foods do not match.

Each incompatibility is characterized by some degree: mild, moderate, and severe. The total mark is obtained as: VI = Σ Severity(fi,fj).

In case the VI is of higher magnitude, then the meal will be rejected.

F. Recipe Scoring

In determining the properties of the recipes we make use of a technique which is known as weighted averages of the materials. It has the following expression: $P_recipe = \Sigma(qi \times Pi) / \Sigma qi$

The qi in this formula represents the quantity of each ingredient and Pi is the value of property of this ingredient.

The cooking process can even change the use of heat like frying, which increases the level of heat level, and steamed, which keeps the level of temperature relatively neutral. These methods also derive values which further are updated to be incorporated in the end score.

Performance Metrics Used in Evaluation:

The performance measures, which we will be using against our system are the following:

1.Recommendation Accuracy: Accuracy = CorrectRecommendations / TotalRecommendations

2.Constraint Satisfaction Rate (CSR): CSR = Meals Satisfying Constraints / Total Meals Generated

3.Average Response Time (RT): RT = Σ(ResponseTime) / TotalQueries

4. Compatibility Detection Accuracy (CDA): CDA = Correctly Detected Incompatibilities / Total Incompatibility Cases

V. SYSTEM DESIGN AND ARCHITECTURE

AyurDiet OS is a combination of the knowledge of Ayurvedic dietary practices and the knowledge of modern nutritional sciences. It is a modular system, and it is a scalable system. There are several layers in this system, each of which is designed to carry out a particular task. Therefore, it is able to carry out its functions effectively. The presentation layer is that layer in which the user is given a chance to make use of several features, for example, the Prakriti feature, several types of food, etc. The API layer ensures that communication takes place effectively between the frontend and the backend of this system by applying RESTful services. The algorithm layer plays a very significant role in ensuring that all tasks are performed effectively, for example, Prakriti classification, calculation of the Ayur-Nutri hybrid score, etc.

In this section of knowledge processing, several principles, for example, the ancient principle of Ayurvedic dietary practices that states that "Viruddha Aahara" is used to ensure that food that does not go well together is provided, and even better food is provided by applying the substitution method, are used. There are several types of data in this section, for example, food properties, recipes, etc. In this section, several principles, for example, principles of rasa, virya, dosha effects, etc., and knowledge of nutritional sciences are integrated. This is a client-server system. This system is not only scalable, but it is even possible to add several algorithms in the future by applying concepts of artificial intelligence and machine learning.

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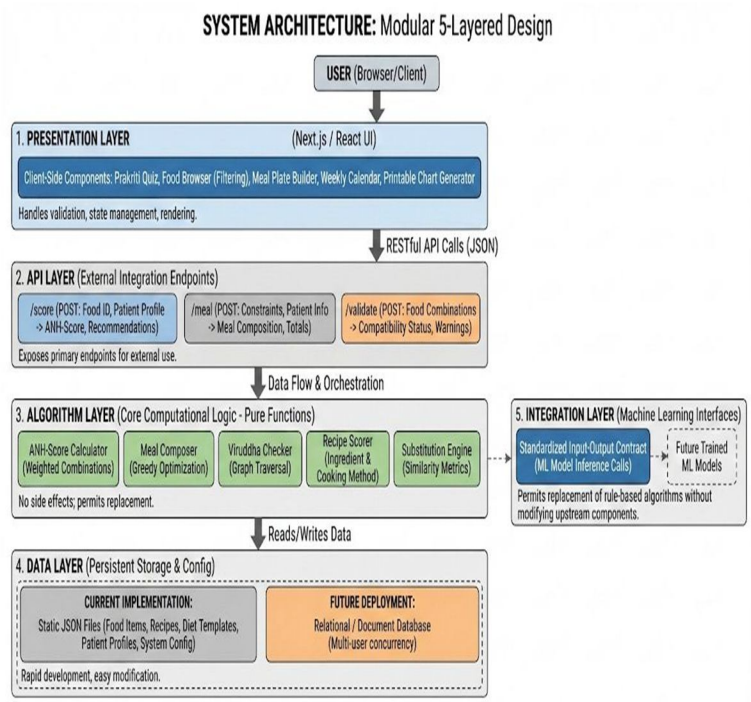


Fig 1. Architecture Diagram

Fig. 1 depicts the modular structure of the proposed AyurDiet OS in the form of the five-layer architecture. The five layers in the modular architecture are the presentation layer, the API layer, the algorithm layer, the data layer, as well as the integration layer.

VI. EXPERIMENTAL SETUP

The AyurDietOS system has also been experimented with to understand the actual efficacy of the hybrid diet recommendation approach used in the system. This application has used different technologies like Next.js for the front-end development, TypeScript for actual development, and SQLite for the actual database management purpose.

To actually perform the task in a smooth manner, a dataset has been created that contains more than 100 different food items along with their corresponding attributes like rasa, virya, vipaka, dosha impact, and nutritional values like calories, protein, carbohydrates, fat, and fiber, etc. Along with that, around 35 different recipes were also included in the dataset to actually perform the scoring of recipes and the composition of the actual meals.

For the actual purpose of testing, different profiles were also created that actually mimic the real profiles of the users. These profiles were created in a manner that different types of prakriti types, dietary habits, and health status were taken into consideration. In that case, the actual Ayur-Nutri Hybrid Score (ANH-Score) has been calculated for every profile. Along with that, the actual meal plan was also generated by making use of a constraint optimization technique.

To actually assess the performance of the system, different parameters were taken into consideration like the accuracy of the recommendations, the constraint satisfaction rate, the accuracy of the compatibility detection, and the actual response time, etc., in a standard Node.js environment.

VII. RESULTS

We performed multiple tests on the ANH-Score calculations, tried out twenty different combinations of food and user profiles, each representing various prakriti types. Our main goal was to see if our algorithms were performing as we expected. When we compared the scores to manual calculations, we noticed the differences were pretty minor, just a bit of rounding here and there. The system did a great job of keeping meals within the calorie limits and hit the protein targets about 92 percent of the time. We also tested the Viruddha Aahara detection module with some well-known incompatible food pairings. It successfully picked up on classic combinations like fish with milk and honey with ghee, showing that the rules we set up worked just as we intended.

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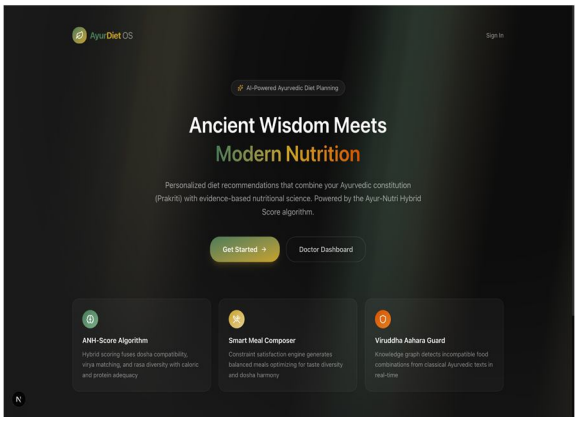


Fig 2. AyurDiet OS Landing Page

Fig. 2 introduces the platform and its core concept of combining Ayurvedic knowledge with modern nutritional science.

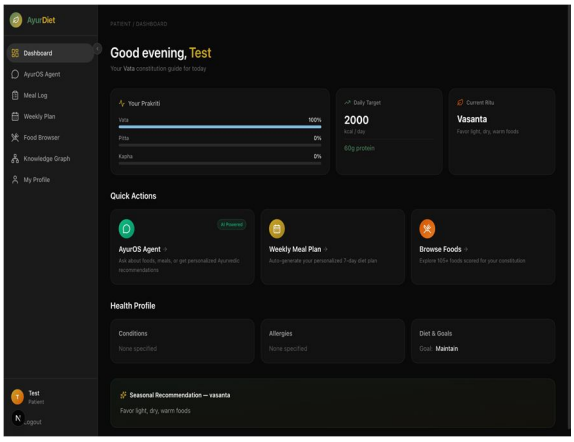


Fig 3. User Dashboard

Fig. 3 displays user's Prakriti distribution, daily nutritional targets and seasonal recommendations. It gives access to modules such as AI diet assistant, weekly meal planning and food browsing.

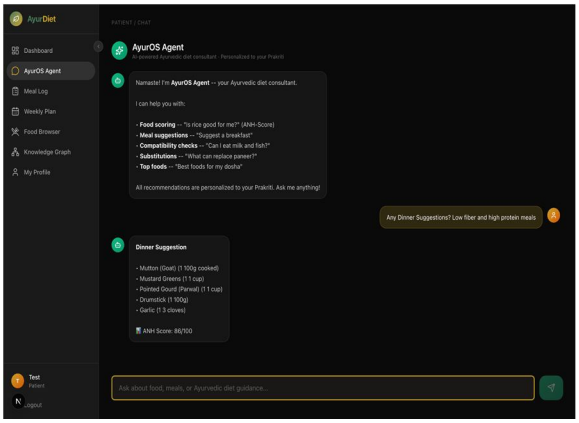


Fig 4. AyurOS Agent interface

Fig. 4 shows an AI-powered Ayurvedic diet consultant which allows users to ask questions related to food scoring, meal suggestions, compatibility checks and substitutions based on their Prakriti.

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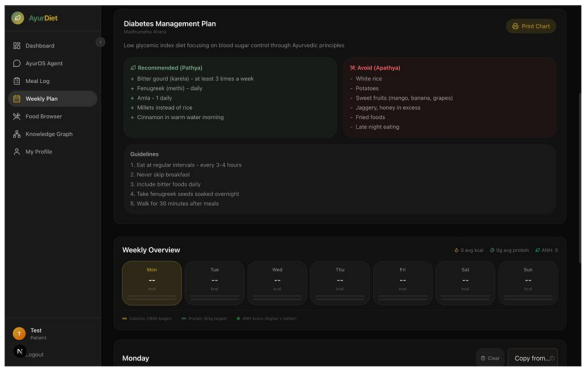


Fig 5. Diet Recommendation Interface

Fig. 5 shows a diet recommendation interface for a specific health condition, such as diabetes management. The system provides recommended foods, foods to avoid and lifestyle guidelines based on Ayurvedic dietary principles.

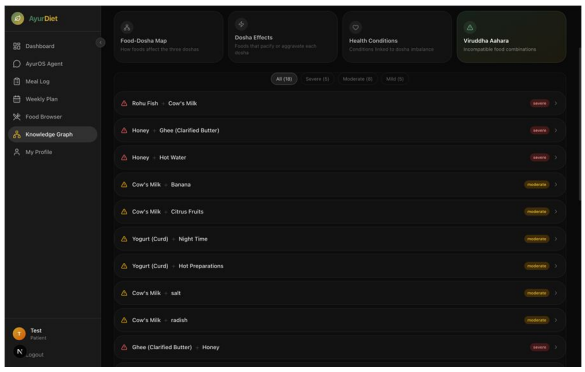


Fig 6. Viruddha Aahara Detection Module

Fig. 6 shows incompatible food combinations based on Ayurvedic dietary rules and classifies incompatibilities into severity levels such as mild, moderate and severe.

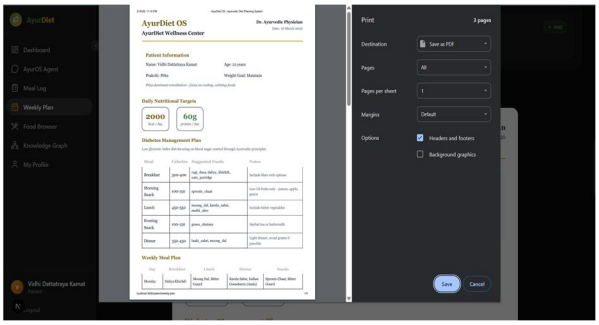


Fig 7. Diet Report

Fig. 7 shows a printable diet report generated by AyurDiet OS, it summarizes the patient's information, Prakriti type, daily nutritional targets and recommended diet plan. It also allows users to export the report as a PDF, enabling easy sharing and clinical documentation.

VIII. CONCLUSION

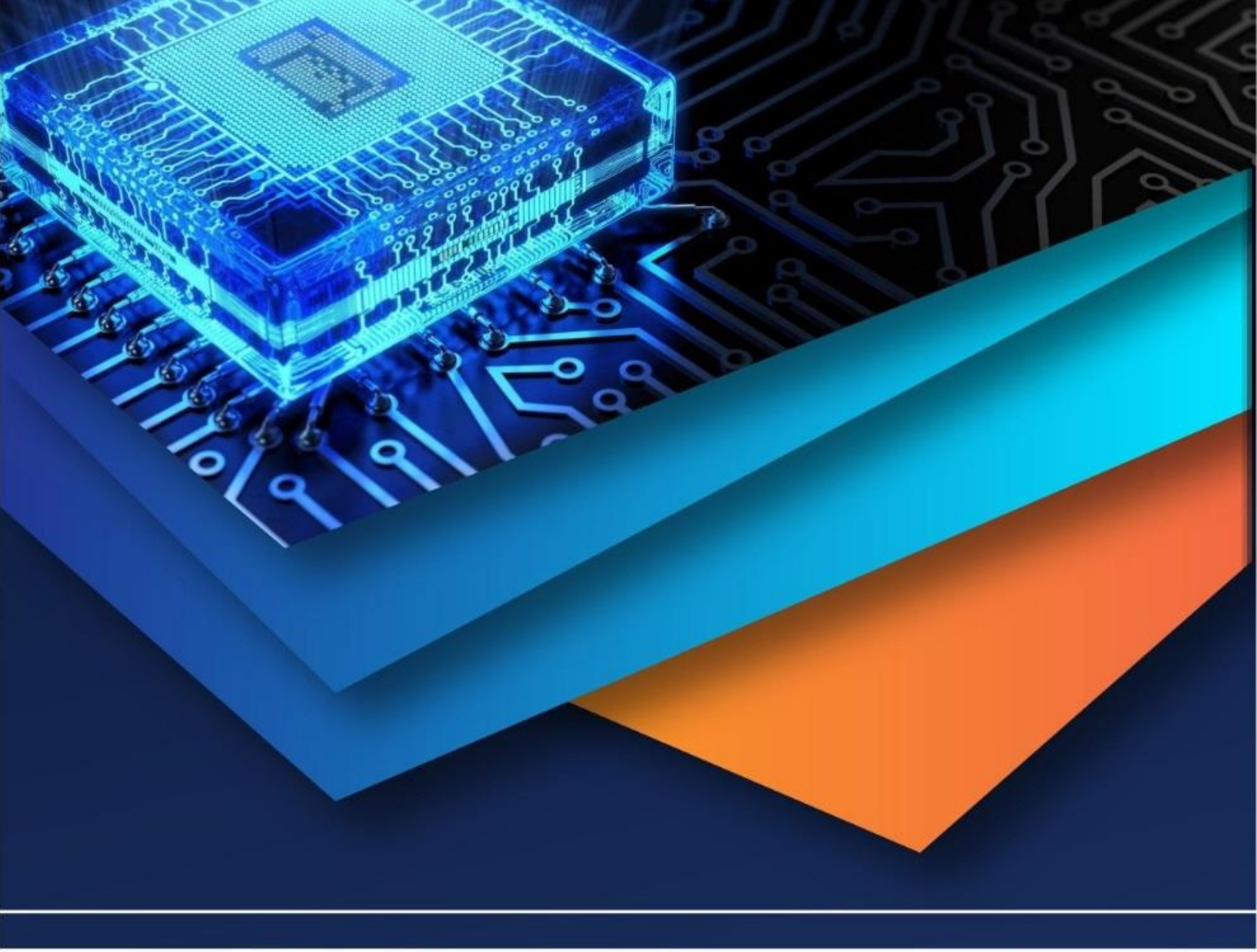
AyurDietOS combines Ayurveda with modern nutrition and allows individuals to create personalized diets using the Ayur-Nutri Hybrid (ANH-Score). This paper outlines how the two systems work together by adding nutritional values (or metrics) to the Ayurvedic compatibility values to create an overall compatibility assessment score.

Therefore, an individual's Prakriti (hereditary constitution) is assessed and the properties of foods are annotated. The system uses the principles of Viruddha-Aahara (Incompatible Foods) to detect incompatible food combinations and construct a diet plan that is balanced, compatible, and ultimately reflects the individual's Prakriti. Therefore, this study shows that computer assistance in dietary planning can help to create a more intelligent and personalized diet plan for individuals. Future directions of the project include expanding the food and recipe database to include more food from regional and international sources, developing machine learning models that can learn from individual user profiles, integrating with current mobile and wearable devices for real-time dietary assessment and creating partnerships with Ayurvedic practitioners and conducting clinical trials to validate and assess the ANH-Score as a reliable and useful tool for healthcare.

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