Nutria: An AI-Driven Personalized Meal and Exercise Recommender System for Diabetes Management

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Abstract **- The prevalence of diabetes has led to a growing demand for personalized dietary management tools, leading to the development of Nutria, a web-based food recommendation system tailored for individuals with diabetes. Nutria application is leveraging artificial intelligence, machine learning, and image processing. Nutria analyzes individual health data to provide real-time meal suggestions. The system also features predicting blood glucose level, feature of a chatbot that supports user engagement by offering dietary advice, tracking user progress and exercise recommendation for control their disease condition. The inclusion of a chatbot serves as a vital component of Nutria, facilitating ongoing user engagement and support. Users can interact with the chatbot to receive personalized dietary advice, track their progress over time. This interactive feature not only helps users stay motivated but also fosters a sense of accountability in their dietary choices. Findings from the system evaluation revealed a high level of user satisfaction, with over 85% of participants reporting improved dietary awareness and adherence.**

Keywords **- artificial intelligence, machine learning, blood glucose, chatbot**

I. INTRODUCTION

The Nutria is an innovative web application designed to support
individuals with diabetes by offering personalized food and exercise recommendations tailored to their unique health needs. At its core, Nutria uses advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), and image processing to provide real-time, intelligent suggestions. These include personalized meal planning, predictions of blood glucose levels, and customized exercise routines—all aimed at helping users manage their condition more effectively in day-to-day life.

One of Nutria's standout features is its AI-powered chatbot, which acts like a virtual health companion. Available 24/7, the chatbot allows users to ask questions, upload lab reports such as blood glucose readings, and receive instant, relevant feedback. Whether someone wants advice on what to eat for dinner or how to adjust their exercise routine based on their latest health data, Nutria is there to help. What sets Nutria apart from many existing health apps is its seamless integration of multiple modules—meal planning, exercise guidance, image-based food recognition, and interactive chat—all within one cohesive and user-friendly platform.

The development process followed the Agile methodology, enabling the team to build the system iteratively while incorporating continuous feedback from potential users. This ensured that Nutria remained practical, intuitive, and aligned with real-world needs. On the technical side, the system makes use of tools like Tesseract OCR for converting images (e.g., reports or handwritten notes) into text, Python and NodeJS for back-end logic, MongoDB for flexible data storage, and TensorFlow-powered convolutional neural networks (CNNs) for accurate food identification.

II. LITERATURE REVIEW

Existing digital health applications for diabetes typically focus on logging data such as glucose levels, food intake, or physical activities. Applications like Dario Health, MySugr, and Health2Sync provide data entry interfaces but lack real-time, AI-driven feedback mechanisms. MySugr, for example, includes features for logging meals and estimating HbA1c, but does not deliver personalized meal suggestions or track user engagement.

According to recent studies, conversational agents, like chatbots have a significant impact on how patients comprehend and manage their health especially diabetes [1] and [2]. Chatbots can act as intelligent assistants capable of behavioral coaching, especially when integrated with health monitoring systems to support proactive decision making and lifestyle interventions like [2]. For example, [3]

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proposed a machine learning based food recommendation system that dynamically adjusts to glucose levels, while [4] developed a deep learning model to recognize food items through image processing. Despite these advancements, a major limitation of existing systems is the lack of full integration and real-time personalization, which are crucial in managing complex conditions such as diabetes [3] and [4].

Existing Systems	AI chatbot	Meal plans	Special meal plans(diabetics)	Progression analyzing diet planning guide	Exercise guidance	Analyzing & tracking blood glucose level	Track Activity	Rating and Report
Dario health	✗	✗	✗	✗	✗	✓	✓	✓
mysugr.	✗	✓	✗	✗	✗	✓	✗	✓
h2sync app	✗	✗	✗	✗	✓	✓	✗	✓
Glycemic index tracker	✗	✓	✓	✗	✗	✓	✗	✗
Diabetic diet	✗	✓	✓	✓	✓	✓	✓	✗
Healthy diabetic recipes	✗	✓	✓	✓	✗	✗	✗	✗
Diabetic Recipes(offline)	✗	✓	✓	✗	✗	✗	✗	✗
7 Day Meal Plan	✗	✓	✓	✗	✗	✗	✗	✗
Nutria	✓	✓	✓	✓	✓	✓	✓	✓

Fig.1 Comparison existing systems with Nutria

Fig.1shows the illustrations of a comparison of existing food recommendation systems identified during the literature review. To bridge the identified gaps, the Nutria platform is introduced as a comprehensive solution combining multiple technologies into a unified framework. Nutria leverages conversational AI, food image recognition, and real-time personalized dietary recommendations through machine learning models. It features a modular design that supports functionalities such as the interpretation of lab reports, chatbot-based interactions, and intelligent decision-making, offering an innovative and user-centric approach to diabetic care.

Several researchers have explored the incorporation of machine learning and clustering algorithms within dietary recommendation systems. For instance, [5] proposed a system utilizing Food Ontology (FO) in conjunction with K-Means clustering and Self-Organizing Maps (SOM) to structure modules for data preprocessing, noise elimination, weight adjustment, and meal planning. Similarly, [6] employed K-Means clustering to develop a dual-purpose recommendation engine for both food and exercise, comparing it with BIRCH and DBSCAN algorithms and concluding that K-Means produced the most consistent results. In parallel, various studies have emphasized the importance of personalized chatbot interactions that consider user preferences, behavioral patterns, and even psychological factors such as meal skipping or emotional eating [7]. Furthermore, [8] highlighted the need to integrate physical activity planning with nutritional guidance, while [9] explored AI-based recipe customization to match individual dietary restrictions. Additionally, [10] demonstrated that AI-powered chatbots can effectively guide users in making healthier meal and lifestyle choices.

III. METHODOLOGY

The Nutria application was developed using the Agile software development methodology. Agile was selected due to its iterative approach, adaptability, and emphasis on customer feedback. Development was organized into bi-weekly sprints, each consisting of planning, designing, coding, testing, and reviewing. This enabled the team to build core features incrementally, gather early user feedback, and make timely adjustments to meet user needs. Each sprint included tasks such as chatbot training, UI prototyping, algorithm implementation, and database integration. At the end of every sprint, feedback was collected from a small user group comprising diabetic patients and nutritionists to guide further refinements. In Nutria the system has several models like calorie recommendation model, general question model and diabetic model.

A. Actual vs Predicted Calorie intake model

Goals of the model; Age, gender, weight, height Activity level, Job industry, Family history of diabetes, Diabetic status. Interpretation: “Most dots fall near the line, indicating strong prediction accuracy.” Calorie’s calculations work:

The basal metabolic rate (BMR) =

10 * weight (kg) + 6.25 * height(cm) - 5 * age(y) + 5 for (man) /

10 * weight(kg) + 6.25 * height(cm) - 5 * age(y) - 161 for (woman)

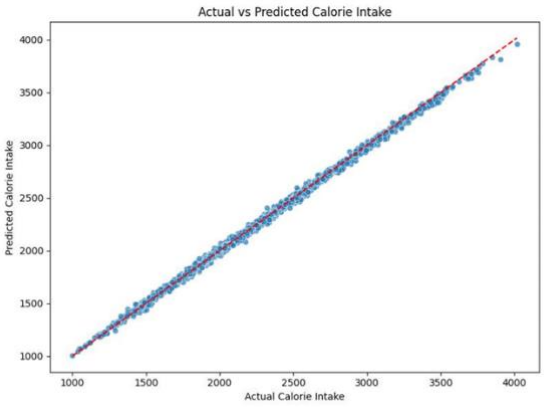

Fig.2 Illustration of Actual calorie intake vs Predicted calorie intakes of Nutria application

B. Chatbot Design

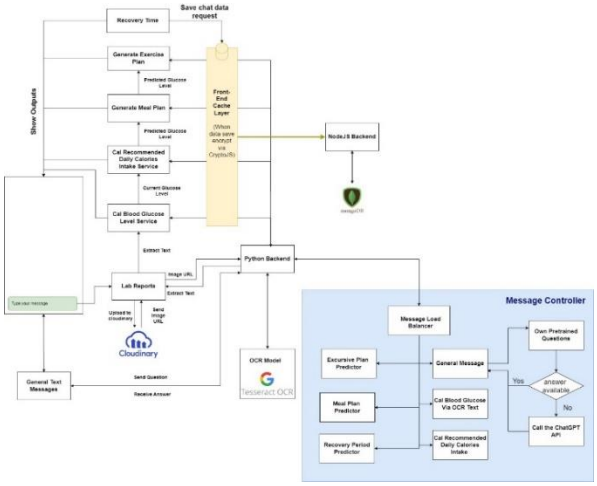

Fig.3 Illustration of the design of the chatbot development for the Nutria application

The design of chatbot illustrates a complete system architecture for a chatbot as health assistant like; Communicate with users, Processes lab report analyze, generates meal plan and exercise plan, interacts with backend and database.
Includes a messages controller with various services. The chatbot was created with a structured flow of intents and training
phrases to support natural conversation; "What does NUTRIA mean?", “Can you suggest a low-carb meal plan?", "What should I eat to lose weight?", "Can you recommend a meal plan for someone with diabetes?", “What are some healthy breakfast ideas?"

C. Architecture system design of Nutria

Nutria is built on a scalable, modular client-server architecture that ensures fast performance and user-friendly interaction, and Fig.4 shows the illustration of system architecture diagram of Nutria application. The frontend uses React.js for dynamic and responsive user interfaces, while the backend, developed with Node.js and Express.js, handles business logic and communication with the MongoDB database, which stores user bio data, glucose reports, and historical data in a flexible NoSQL format. The system leverages AI through TensorFlow for food image recognition and OCR for personalized meal suggestions based on individual health data. A trained natural language chatbot offers real-time advice and guidance, enhancing user interaction. All components communicate via RESTful APIs, with the frontend deployed on MongoDB and the backend hosted on Render, ensuring a robust and easily upgradable platform.

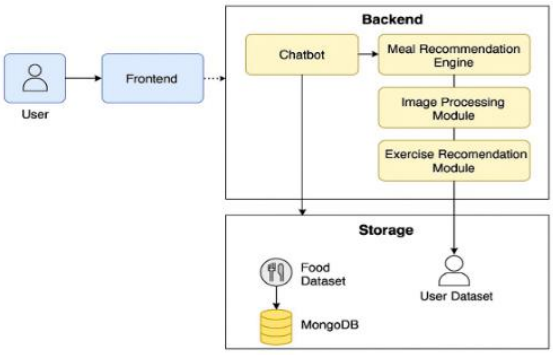

Fig.4 Illustration of System Architecture diagram of Nutria Application.

Nutria application test and evaluation with several testing methods:

1. Unit testing - Conducted on individual modules such as the recommendation engine, chatbot response handler and image recognition algorithms to ensure logical accuracy.
2. Integration testing - verified well different modules interact within the application like user input, AI responses, Database
3. System testing– Evaluated the complete application in a simulated real – world environment to validated system flow and functionality.
4. Usability testing – Focused on the user-friendly application, ensuring that the interfaces are accessible.
5. Performance testing – Monitored response times, especially for meal plan generation and exercise plan.

IV. RESULTS

A. Nutria Q&A Geral Question model

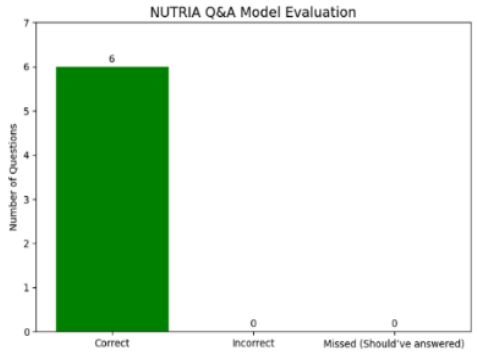

Fig.5 Illustration of Q&A Model Evaluation of Nutria application

Fig.1shows the illustration of Q&A model evaluation of developed Nutria application and it reads predefined question-answer pairs from a dataset. Convert the questions into semantic embeddings using a pre-trained language model. Save these embeddings and answers into a. pkl model file. Load the model and match new user questions with the most similar stored question using cosine similarity. Return the best-matching answer or "no_answer" if confidence is too low.

B. Evaluation of system

The researcher evaluated the user feedback with three main categories, like user details, system usability and experience and satisfaction of the system. The survey of user feedback got 30 responses. Below the answers to questions will be reviewed. 30 users participated in usability testing. 90% found the recommendations useful and easy to follow and it shows in Fig.6.
Overall, both testing and evaluation confirmed that Nutria delivers on its core objectives. The personalized approach to dietary and fitness planning was well received, and the system's intelligent features provided value to diabetic users. Feedback highlighted strengths in usability and customization, while also pointing out avenues for future enhancement such as gamified user engagement and integration with wearable devices.

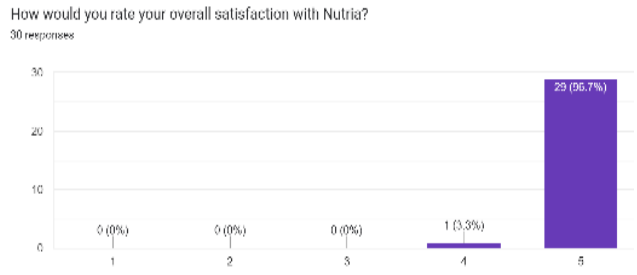

Fig.6 Illustration of overall user satisfaction of Nutria application.

V. CONCLUSION

The Nutria application demonstrates the effectiveness of an AI-powered, personalized dietary planning system for diabetic patients. It integrates features such as a user-friendly interface, chatbot support, calorie prediction using machine learning, and tailored meal and exercise recommendations. Trained on a realistic dataset, the system accurately estimates calorie needs based on user health data. Evaluation through performance metrics and user feedback confirmed high usability and precision. The chatbot enhances interaction by providing personalized responses, while image processing aids in food recognition. Nutria addresses the need for real-time, customized nutritional guidance, helping diabetic users manage their health and prevent complications effectively.

Future development of the Nutria system includes expanding datasets with diverse, real-world data to improve calorie prediction accuracy. Integrating wearable devices can enable real-time monitoring and personalized feedback. Enhancing accessibility through multilingual support and text-to-speech features is recommended. Upgrading the chatbot with advanced NLU will improve user interaction. Clinical validation with experts and diabetic patients can refine system effectiveness. Finally, incorporating gamification and habit-tracking features can boost user engagement and adherence to healthy dietary and exercise routines.

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