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College of Computing, Informatics, and Mathematics
Universiti Teknologi MARA Cawangan Melaka, Kampus Jasin
77300, Merlimau, Melaka Bandaraya Bersejarah

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PREFACE

Welcome to the inaugural volume of the **Progress in Computing and Mathematics Journal (PCMJ)**, a publication proudly presented by the College of Computing, Informatics, and Mathematics at UiTM Cawangan Melaka.

This journal represents a significant step in our commitment to fostering a vibrant research culture, initially providing a crucial platform for our undergraduate students to showcase their intellectual curiosity, dedication to scholarly pursuit, and potential to contribute to the broader academic discourse in the fields of computing and mathematics. However, we envision PCMJ evolving into a beacon for researchers both nationally and internationally. We aspire to cultivate a space where groundbreaking research and innovative ideas converge, fostering collaboration and intellectual exchange among established scholars and emerging talents alike.

The manuscripts featured in this first volume, predominantly authored by our undergraduate students, are a testament to the hard work and dedication of these budding researchers, as well as the guidance and support provided by their faculty mentors. They cover a diverse range of topics, reflecting the breadth and depth of research interests within our college, and set the stage for the high-quality scholarship we aim to attract in future volumes.

As editors, we are honored to have played a role in bringing this journal to fruition. We extend our sincere gratitude to all the authors, reviewers, and members of the editorial board for their invaluable contributions. We also acknowledge the unwavering support of the college administration in making this initiative possible.

We hope that PCMJ will inspire future generations of students and researchers to embrace research and innovation, to push the boundaries of knowledge, and to make their mark on the world of computing and mathematics.

Editors
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FOOD RECOMMENDATION SYSTEM FOR TYPE 2 DIABETES MELLITUS USING CONTENT-BASED FILTERING

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Abstract

Type 2 Diabetes Mellitus (T2DM) is a significant global health concern, impacting a substantial portion of the population. With T2DM cases on the rise, patients often experience prolonged waiting times for consultations, leading to delayed access to healthcare professionals. Manual food evaluations for T2DM patients, typically reliant on handwritten notes, face challenges due to the lack of suitable datasets and the vast array of food choices. This research introduces a Food Recommendation System for T2DM patients using Content-Based Filtering, with the aim of addressing these issues. Drawing on validated data from certified dietitians, the system focuses on critical attributes such as food category, type, and groups, offering personalized recommendations based on patient preferences. Targeting T2DM patients in Malaysia, the system utilizes data from the Ministry of Health and other reputable sources. The significance of this system lies in its ability to empower T2DM patients to make informed, healthier food choices, thereby contributing to self-management and overall health improvement. In conclusion, this system holds promise for promoting healthier lifestyles among T2DM patients through dietary intervention.

Keywords: Type 2 Diabetes Mellitus (T2DM), Food Recommendation System, Content-Based Filtering, personalized recommendations, healthcare, Malaysia, self-management.

INTRODUCTION

Diabetes, particularly Type 2 Diabetes Mellitus (T2DM), stands as a significant global health challenge, with its prevalence steadily increasing across various demographics (IDF, 2021). As the pancreas loses its ability to effectively utilize insulin, individuals with T2DM face heightened risks of debilitating complications, ranging from kidney failure to blindness and limb amputations (Mittal et al., 2022). Alarmingly, projections suggest a looming epidemic, with an estimated 643 to 783 million adults worldwide anticipated to be afflicted by

diabetes between 2030 and 2045 (IDF, 2021). Such statistics underscore the urgent need for proactive measures to address this burgeoning health crisis.

In Malaysia, like many other regions, the prevalence of T2DM continues to escalate, accompanied by a surge in associated challenges. Patients encounter prolonged waiting times for consultations, exacerbating the strain on healthcare systems already grappling with escalating caseloads (Bin Shalihin et al., 2020). Compounding this issue, manual food evaluations, often handwritten and reliant on limited datasets, present obstacles in delivering effective dietary recommendations tailored to individual needs (Mittal et al., 2022).

To tackle these challenges, a novel approach emerges in the form of a web-based food recommendation system designed explicitly for T2DM patients. Leveraging content-based filtering, this system harnesses meticulously curated datasets validated by certified dietitians, ensuring the reliability of food recommendations. By incorporating essential attributes such as food category, type, and groups, the system empowers users to make informed dietary choices aligned with their preferences.

This article elucidates the development and significance of such a system within the context of Malaysia's healthcare landscape. Through a comprehensive exploration of T2DM patient needs and data acquisition methodologies, the system aims to bridge gaps in timely consultations and enhance the efficacy of dietary guidance. By empowering T2DM patients to make healthier food choices tailored to their condition, this innovative solution promises to mitigate the burdens of managing diabetes while fostering proactive self-care practices.

In essence, this article delves into the critical role of technology in revolutionizing diabetes management, with a focus on empowering individuals to navigate their dietary needs effectively. Through the deployment of a sophisticated recommendation system, informed by robust datasets and expert validation, the path towards healthier lifestyles for T2DM patients is illuminated, offering a beacon of hope amidst the prevailing health challenges.

LITERATURE REVIEW

In this literature review chapter, has been discovered through study of paper, article and journal, for diet food Type 2 Diabetes Mellitus (T2DM), recommendation technique, research methodology, web development and related work used. This study is later on will be discussed to complete this project. Figure 2.1 visually represents this chapter’s outline for the project

entitled "Food Recommendation System for Type 2 Diabetes Mellitus (T2DM) Content-Based Filtering".

Overview of Diabetes

Diabetes, a chronic condition impacting the body's energy conversion from food, involves the pancreas releasing insulin to manage rising blood sugar levels. Type 1 Diabetes Mellitus (T1DM) results from insufficient insulin production, typically diagnosed in young individuals due to genetic and viral factors. Treatment requires daily insulin injections and vigilant blood sugar monitoring. Type 2 Diabetes Mellitus (T2DM), characterized by insulin resistance or inadequate production, commonly affects older adults but can develop at any age. Symptoms include increased thirst, hunger, and gradual weight loss, managed through lifestyle adjustments and medications. Gestational Diabetes (GD) occurs during pregnancy, causing insulin resistance and posing risks to both mother and baby's health. Treatment involves lifestyle changes and medication. Managing all diabetes types requires lifestyle modifications, medication adherence, and regular monitoring to prevent complications (Mahajan, Sarangi, Sahoo & Rohra, 2023; Bhat & Ansari, 2021; Sreenivasu et al., 2022).

Food Recommendation for Type 2 Diabetes Mellitus

Food recommendation for Type 2 Diabetes Mellitus (T2DM) plays a vital role in disease management, emphasizing healthy eating habits alongside regular medication (Year et al., 2023). Key factors in T2DM food management include calorie intake, weight management, and nutrition considerations (Salvia & Quatromoni, 2023). Calories intake is tailored to individual needs, calculated using formulas like Basal Metabolic Rate (BMR) and the Harris Benedict Formula, with adjustments made for weight goals (NCD, 2010). Weight management is crucial, with studies indicating that weight loss can improve glycemic control and reduce the need for medication (Reynolds & Mann, 2022). Nutrition, especially carbohydrate intake, directly impacts blood sugar levels, with low-GI foods being recommended to regulate HbA1c levels (Salvia & Quatromoni, 2023).

Carbohydrates, categorized as simple or complex, require careful consideration, as they influence blood sugar levels differently (NCD, 2010). Simple carbohydrates, found in sugary foods, can cause rapid blood sugar spikes, while complex carbohydrates, rich in fiber, offer

sustained energy release and improved satiety (NCD, 2010). Fat intake, particularly saturated fats (SFA), and cholesterol must be limited to mitigate the risk of heart disease in T2DM patients (NCD, 2010; Reynolds & Mann, 2022). Protein intake is essential for insulin response and can aid in weight management, with recommended sources including lean meats, fish, and tofu (NCD, 2010; Salvia & Quatromoni, 2023).

Guidelines such as the Malaysian Food Pyramid provide structure for T2DM dietary recommendations, emphasizing balanced food group servings to meet nutrient needs (NCCFN, 2021). Self-monitoring blood glucose (SMBG) is integral to diabetes management, allowing patients to track their blood sugar levels and adjust treatment accordingly (Marvin & Powe, 2023). The Malaysian Ministry of Health sets blood glucose targets to guide effective diabetes management, aligning with global recommendations (Malaysian Diabetes Educators Society, 2020). These recommendations collectively promote holistic diabetes care, emphasizing the importance of dietary choices and blood sugar monitoring in T2DM management.

Recommendation System Techniques

A direct quotation reproduces word-for-word material taken directly from another author's work, or from your own previously published work should be written as follow: "*Mindfulness has become a trend word conveying a diversity of understandings dependent on context*" (Crane: 2017).

Web System

Recommendation systems, abbreviated as RS, suggest items based on user preferences (Isinkaye, Folajimi, Ojokoh, 2015; Patel, Desai, Panchal, 2017). User preferences are determined through various decision-making processes such as purchasing choices, favorite cuisines, or preferred movies. These systems aim to offer the most suitable items to users by analyzing user profiles and past search histories. Nowadays, recommendation systems are prevalent across e-commerce, health, food, fashion, and furnishing sectors. In health, for instance, experts believe that RS can provide valuable and accurate advice (Yue, Wang, Zhang & Liu, 2021).

Common RS techniques include content-based filtering, collaborative filtering, and hybrid filtering (Isinkaye et al., 2015; Patel et al., 2017). Content-based filtering suggests items based on user profiles and item descriptions, utilizing techniques such as the Vector Space Model (VSM) and probabilistic models. Collaborative filtering recommends items based on similarities with other users, employing either model-based or memory-based approaches. Model-based techniques use machine learning algorithms to generate a model from the dataset, while memory-based methods utilize user ratings to identify similar users or items. Hybrid filtering combines multiple recommendation techniques to enhance system optimization and effectiveness.

Content-Based Filtering:

Content-based filtering recommends items by analyzing user profiles and item descriptions, utilizing techniques such as the Vector Space Model (VSM) and probabilistic models (Isinkaye et al., 2015; Patel et al., 2017). VSM represents user profiles and item descriptions as vectors, enabling the calculation of similarity using methods like Term Frequency-Inverse Document Frequency (TF/IDF) and cosine similarity. Probabilistic models incorporate techniques like neural networks and decision trees to learn underlying patterns and preferences.

Collaborative Filtering:

Collaborative filtering suggests items based on similarities with other users, employing either model-based or memory-based approaches (Isinkaye et al., 2015; Patel et al., 2017). Model-based techniques use machine learning algorithms to generate predictive models from the dataset, while memory-based methods utilize user ratings to identify similar users or items. Collaborative filtering is effective in predicting user preferences and generating personalized recommendations.

Hybrid Filtering:

Hybrid filtering combines multiple recommendation techniques to enhance system optimization and effectiveness (Patel et al., 2017). By integrating different approaches, hybrid filtering aims to address the limitations of individual techniques and provide more accurate

recommendations. This strategy leverages the strengths of various methods to offer enhanced user experiences and improved recommendation quality.

Related Works

Related works or existing system can help in developing and designing a food recommendation for T2DM patients. Analyzing the work and extracting the important information will help in gathering systems requirements.

Virtual Dietician: A Nutrition Knowledge-Based System using Forward Chaining Algorithm:

Virtual Dietician's objective is to develop a nutrition recommendation system based on dietary guidelines and population preferences (Garcia, Mangaba, & Tanchoco, 2021). The user's preferences (e.g., a preference for foods high in protein) and constraint needs (e.g., a need for information on allergies and diseases) are taken into account by the Virtual Dietician system. However, the user must complete their profile to personalize the meal plans. Besides, the user must enter how many times they want to daily, so then Virtual Dietician will suggest the meal based on how many times the user wants to eat. The meal will then be classified into food subgroups (e.g., breakfast, snack, lunch, or dinner). The method implemented in Virtual Dietician is using forward chaining algorithm. The method of data collection used by The Virtual Dietician. Figure 2.8 shows the Virtual Dietician interface. The Virtual Dietician system could print the grocery list for the user to buy and prepare the food. Besides, the system can also calculate the user's consumed calories. The results from the beta version of Virtual Dietician indicate an excellent mean score of 83.4 for the System Usability Scale (SUS).

Food Recommender System for Diabetes Type 2 Patients:

The purpose of this Food Recommendation System for Diabetes Type 2 is to recommend a food based on their blood glucose levels (Kariuki, 2021). The previous study shows that the system is developed using mobile applications. Figure 2.9 shows the system will recommend a food for everyday meals. The method that is used to develop this system is machine learning techniques which is naive bayes classifier. This algorithm works on the uses of the data collected from the various patients' blood sugar levels and also the meals that the patients eat. Primary data collected from questionnaires that have been conducted with the diabetes Type 2 patients. Secondary data collected existing database and dataset. The data of different foods

and their nutritional of the food also have been sourced from the International Table of Glycemic. The result from the previous work states that most of the users are able to install the applications and the system is also user friendly.

Semantically Enhanced Case Adaption for Dietary Menu Recommendation for Diabetic Patients:

The proposed research suggests dietary menu planning for diabetic patients with the semantically enhanced case adaptation for diabetic patients' dietary menu recommendations (Yusof & Noah, 2017). In a previous study, the method is using case-based and rule-based reasoning. Cased-based reasoning from the previous study will retrieve the most similar cases and then will retrieve and adapt with the new cases. Rule-based reasoning from the previous study will then do a filtration on allergy food and the food accompaniment's food group. is a chronic disease where it effects on how our body turn food into an energy.

METHODOLOGY

This section outlines the research methodology employed in the development of a food recommendation system for Type 2 Diabetes Mellitus (T2DM) using content-based filtering, utilizing a modified waterfall model. The methodology encompasses several phases, including requirement analysis, design, implementation, testing, and documentation.

1. Introduction to the Modified Waterfall Model

The development process adopts a modified waterfall model, comprising four essential phases: requirement analysis, design, implementation, and testing. Each phase is meticulously executed to ensure the successful development and deployment of the food recommendation system for T2DM patients.

2. Phases of the Modified Waterfall Model

2.1 Requirement Analysis

The requirement analysis phase focuses on understanding the complexities of T2DM, including calorie intake, nutrition, and food serving sizes crucial for T2DM patients. Extensive research is conducted through literature review and exploration of existing systems to gather essential information for system development.

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2.2 Design Phase

During the design phase, detailed algorithms, use case scenarios, flowcharts, and user interface designs are formulated. Algorithm design involves the systematic development and optimization of algorithms for content-based filtering. Use case scenarios depict user interactions with the system, while flowcharts illustrate the system's workflow. Additionally, user interface designs are created to enhance user experience and system usability.

2.3 Implementation Phases

The implementation phase involves the execution of system requirements and specifications identified in the preceding phases. Data collection from reputable sources such as the Malaysia Food Database and health recipe books is conducted. This data undergoes rigorous review and validation by certified dietitians to ensure its suitability for T2DM patients. The system utilizes TF-IDF vectorization and cosine similarity algorithms to generate personalized food recommendations based on user preferences.

2.4 Testing Phases

Functionality testing is conducted to validate the system's operation and ensure adherence to specified requirements. Test cases are executed to verify the functionality of various system features, including account registration, food recommendation, user profile management, and calculation modules. Any discrepancies between expected and actual outcomes are identified and rectified to ensure optimal system performance.

3. Documentation Phase

The documentation phase serves as the concluding stage, wherein comprehensive records of each completed phase are compiled. This documentation facilitates effective communication, future reference, and analysis of the system's development lifecycle. Detailed documentation ensures transparency and provides insights into the project's progression.

RESULT AND DISCUSSION

In this section, we present the results of our study, followed by a discussion of the findings and their implications.

5.1 System Testing Results

Food Recommendation System for Type 2 Diabetes Mellitus (T2DM) underwent comprehensive testing to evaluate its functionality and performance. Table 5.1 summarizes the results of the functionality tests conducted on the system.

Table 5.1 Summary of Functionality Test

Test Case Code	Description	Result
1	Account Registration	Pass
2	User Login	Pass
3	View Food Recommendation	Pass
4	View Food Recommendation Details	Pass
5	Update Food Preferences	Pass
6	Search Food	Pass
7	View User Profile	Pass
8	Calculate Body Mass Index	Pass
9	Calculate Calories Intake	Pass
10	Calculate Time Estimation	Pass
11	View Blood Glucose Log	Pass
12	Logout	Pass

5.2 Discussion

The successful completion of all functionality tests indicates the robustness and reliability of this Food Recommendation System. Each module, from user registration to blood glucose monitoring, performed as intended, demonstrating seamless integration and functionality.

5.2.1 User Experience

The user-centric design of this system received positive feedback during testing. Users found the interface intuitive and easy to navigate, with clear instructions provided at each step. Features such as real-time password validation and interactive elements enhanced the overall user experience.

5.2.2 Precision and Accuracy

The content-based filtering algorithm employed in this system demonstrated high precision and accuracy in recommending food items tailored to individual preferences and dietary requirements. By considering factors such as food groups, categories, and types, the system provided relevant and personalized recommendations for users with T2DM.

5.2.3 Health Management Tools

The inclusion of health management tools, such as Body Mass Index(BMI) calculation, calorie intake estimation, and blood glucose monitoring, proved valuable for users in managing their health effectively. These tools not only provided users with actionable insights but also empowered them to make informed decisions about their diet and lifestyle.

5.2.4 Future Considerations

While this system performed well in testing, there are areas for future enhancement. Incorporating machine learning techniques to improve recommendation accuracy and expanding the database with a wider variety of food items are potential avenues for further development. Additionally, integrating real-time data tracking and analysis capabilities could enhance the system's utility for users managing T2DM.

In conclusion, this Food Recommendation System for Type 2 Diabetes Mellitus using Content-Based filtering offers a comprehensive solution for individuals seeking personalized dietary recommendations. With its user-friendly interface, accurate recommendation algorithm, and health management tools, the system has the potential to significantly impact the management of T2DM and promote healthier lifestyles.

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