Prenatal Nutrition Diet Generator Utilizing Modified Genetic Algorithm for Smartphone

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***Abstract*—The paper promotes a Prenatal Nutrition Diet Generator which utilizes modified genetic algorithm for smart phones. It is a mobile application designed to generate optimum diet suggestions for pregnant women to assist the user on improving prenatal health. The said application adopts modified genetic algorithm in order to generate a nutritional diet consists of 1) breakfast, 2) fruits, 3) lunch, 4) drinks, 5) snacks and 6) dinner which is a suitable algorithm for the optimization of suggestions. To evaluate the developed tool, the proponents used descriptive research method. The prototype was tested and evaluated based on the following criteria: correctness of the output, reliability of the system, accuracy of computations, functionality of the system, user-friendliness of the interface and speed of the system.**

***Index Terms*—diet generator, genetic algorithm, mobile application development**

I. Introduction

Ref. [1] Nowadays, mobile application development is considered to be a boom in the Information Technology world. [2] For instance, there are some medical mobile applications (apps) which were developed to help people manage their own health and wellness, promote healthy living, and gain access to useful information when and where they need it. [3] In the study of Quesada et. al. they developed a Sana Mobile Telemedicine System which is a standard-focused open-source system that allows for the creation of highly customizable workflows that are loaded onto the phone (Android based application), connects to a back-end electronic Medical Record System (OpenMRS), and allows for reliable operation on unreliable networks through its synchronization, packetization and multi-modal transfer abilities.

Ref. [4] According to the Bellagio eHealth evaluation group, the greatest impact on eHealth implementations should focus on improving quality and access to care, increasing accountability, governance and client participation within health systems, and delivering health gains for the most disadvantaged populations.

Ref. [5] In our previous study, we developed an m-health tool called CERES: Conjuring Emergency Relieving Expert System. It provides assistance to people experiencing different physical injuries by using the modern pattern matching algorithm. The said algorithm helps the system to generate outputs in a more convenient and efficient way. Apparently, CERES just focuses on physical injuries issues which commonly occur on athletes and students who were enrolled in physical education courses. However, the said study does not cover any prenatal diet issues.

Thus, in this study the authors developed a mobile application that can be used for prenatal care. [6] Prenatal care, also known as antenatal care, is the medical care recommended for women during pregnancy. Its goal is to provide regular check-ups which allow the attending physician to treat and prevent potential health risks and problems during the course of pregnancy; and to promote healthy lifestyles which benefits not just the mother, but also the child.

Ref. [7] It is composed of screening for health conditions that are likely to increase the possibility of adverse pregnancy outcomes, providing therapeutic interventions and educating pregnant women about planning for safe child birth. Its importance on maternal and infant health is ascertained by different medical literature. This study helps inform women on what nutrients they need and what foods they should avoid.

According to research, [8] the NICHD and other organizations led the U.S. Public Health Service to recommend that women of childbearing age get at least 400 micrograms of folic acid, through food and/or supplements, for three months before pregnancy and for at least the first three months of pregnancy to prevent certain types of birth defects. As such eating a healthy diet during pregnancy is important in preventing birth defects, or, even miscarriage. The baby needs nutrients to grow and develop organs and for those organs to begin to function properly. Moreover, a healthy pregnancy diet will promote the baby's growth and development. [9]

The type of a mother’s pregnancy diet depends on her condition throughout her pregnancy (Fetal Age of Gestation). [10] Pregnancy is the most important and delicate period in a woman’s life and therefore she must make sure that she gets the right diet that can keep her and her baby safe throughout the nine months. Table I summarizes the necessary nutrients per trimester:

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TABLE I. WEEKLY PREGNANCY DIET [10]

Weeks	Suggested Foods
First – Twelfth	Green vegetables like broccoli, green peas, cabbage, cauliflowers, spinach, fenugreek, beetroot, Etc. Fruits like oranges, muskmelon, sweet lime and lemon. Milk products and dry fruits
Thirteenth – Twenty Fourth	Green vegetables, radish, beetroot, beans, capsicum. Fruits like banana, peaches, apricot, pomegranate, mango, and pears. Important: Drink plenty of water along with coconut water and vegetable soup for hydration.
Twenty Fifth – Thirty Sixth	Low sugar snacks to avoid gestational diabetes. Continue with oranges, broccoli, and green vegetables.

In this study, the proponents aim to provide users with a healthy nutrition diet generated appropriately based on the fetal Age of Gestation (AOG), medical conditions, foods allergies and vitamin deficiencies of the mother, by utilizing a modified genetic algorithm. Once the user input the first day of her Last Menstrual Period (LMP), her medical conditions, her food allergies which may affect the diet suggestion, and the vitamin deficiencies of the mother; the system will compute for the AOG. [10] Naegele's Rule is a standard way of calculating the due date for a pregnancy. The rule computes for the estimated due date based on the woman's last menstrual period. The formula is as follows:

- Add one year; (e.g. LMP = May 8, 2009 EDD = May 8, 2010)
- Subtract three months (e.g. EDD = February 8, 2010)
- Add seven days (e.g. EDD = February 15, 2010)

After determining the AOG, the system will then determine the appropriate nutrients. [8] During pregnancy, the basic principles of healthy eating remain the same – get plenty of fruits, vegetables, whole grains and lean protein. Table II shows a few nutrients which deserve special attention during pregnancy.

TABLE II. NUTRIENTS SUMMARY [10]

Nutrients	Benefits	Amount Required	Good Sources
Folate Folic Acid	Prevent birth defects	800 micrograms a day before conception and throughout pregnancy	Fortified cereals, leafy green vegetables, citrus fruits, dried beans and peas
Calcium	Strengthen bones	1000 milligrams a day 1300 milligrams a day for pregnant teenagers	Dairy products
Vitamin D	Promote bone strength	600 IU a day	Fortified milk, orange juice and fatty fish such as salmon and tuna

Once the nutrients required, vitamins deficiencies and prohibited food have been determined, it will be used as the basis for the selection in the modified genetic algorithm, which will then generate the output diet.

The basic methodology in a typical genetic algorithm involves: 1) Initialization, 2) Selection, 3) Cross-Over & Mutation and 4) Termination. However, in this paper, the proponents modified this methodology into: 1) Initialization, 2) Breeding, 3) Selection and 4) Termination.

II. THE DEVELOPED SYSTEM

The developed tool is designed to generate a healthy nutrition diet for pregnant women. The user inputs her LMP in number format MM/DD/YYYY (e.g. 01/01/2013). Then the system provides checkboxes for the user to input her medical conditions, food allergies and vitamin deficiencies. Then the system calculates the AOG and the EDD. After determining the AOG, the system will determine what nutrients are appropriate (e.g. the foods should be rich in this or that). Then the system will analyze the nutrients needed, vitamin deficiencies and prohibited foods as basis for selection in the modified genetic algorithm.

The system can display the AOG, the EDD, the nutrition needed appropriately, and the diet for the required nutrition. The initial output will be the AOG, in the format of N number of weeks and N number of days, and the EDD, in the format MM/DD/YYYY (e.g. 01/01/2013). Once the user clicks the PROCEEDS button the system will display the needed nutrients. The final output will be the generated diet. This includes 1) recommended foods for the expectant mother which are essential for the mother and her baby (in format Breakfast, Fruits, Lunch, Drinks, Snacks and Dinner); and 2) foods that the mother should avoid which may cause negative side effects for her and the baby. However, if the user inputs data in the wrong data format, the system will not accept it and it will prompt the user with error message. Furthermore, the developed tool can only display recommended diet for the expectant mother but it cannot generate a recipe of the said diet.

A. System Architecture

Fig. 1 depicts the System Architecture. The system initially requires the user to input the date of her last menstrual period, medical conditions, food allergies and vitamin deficiencies. The system then computes for the age of gestation and estimated due date. The AOG, medical conditions, food allergies and vitamin deficiencies are used to determine what foods to filter and what nutrient requirements will be used as the basis for selection in the modified genetic algorithm to generate the output diet. The user may regenerate another diet if she wants a different suggestion. The user may also store the diet in the database if she wants to.

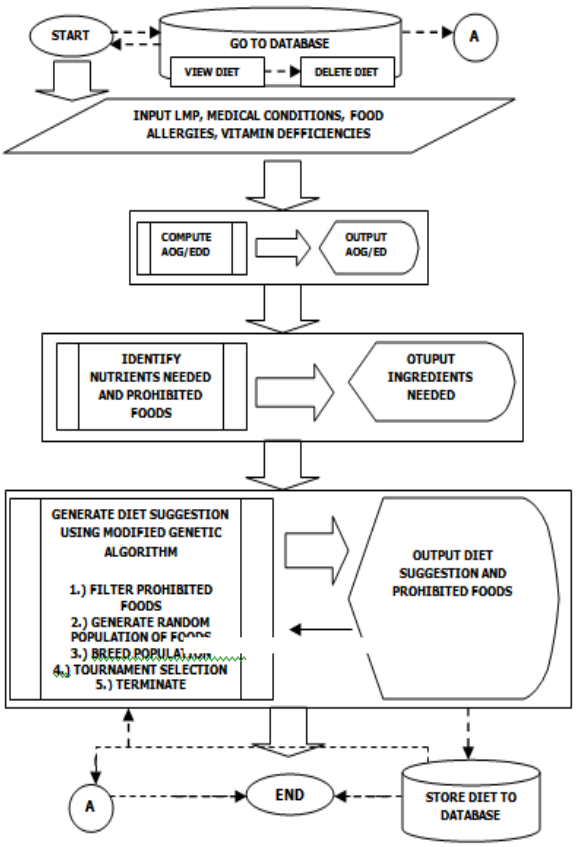

Figure 1. System architecture

B. Software

The proponents provide several graphical user interfaces which can help the user to easily utilize the system. Fig. 2 shows the layout of the Start Up screen.

Figure 2. Start up screen

The Start Up Screen is the initial screen that pops up when the system is used. A Welcome note can be seen, as well as a button which allows the user to proceed (YES Button). Fig. 3 shows the layout of the Help Screen which explains to the users the required data format. After the user has read the information provided, she may proceed to the input screen by clicking the OK Button.

Figure 3. Help screen

Fig. 4 shows the layout of the Input Screen where the user inputs her last menstrual period (LMP) in the format MM/DD/YYYY. Three text fields are provided for the user to type her input then afterwards she must click the Submit Button to enter her input to the system. The next three screens provide check boxes for the user to input her medical conditions and food allergies.

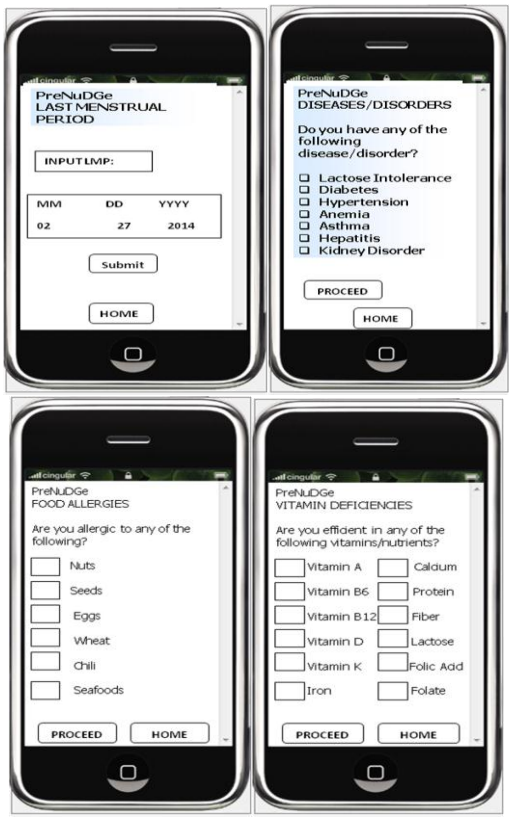

Figure 4. Input screens

Fig. 5 shows the different layout of the Output Screens which contains the AOG/EDD Output Screen which shows the computed age of gestation and estimated due date of the user. Once the user clicks the PROCEED BUTTON it will generate the diet suggestion. The next

phase is the Nutrients Output Screen which provides the nutrients needed by the user based on her age of gestation. After the user has read the given information, she must click the PROCEED BUTTON in order to proceed to the Diet Output Screen. The Diet Output Screen provides the user with a Diet Suggestion generated by the system based on the nutrients needed by the user. After the user has read the given information, she can either generate a new diet (Regenerate button), store the diet to the database (Save button), or return to initial screen (Home button).

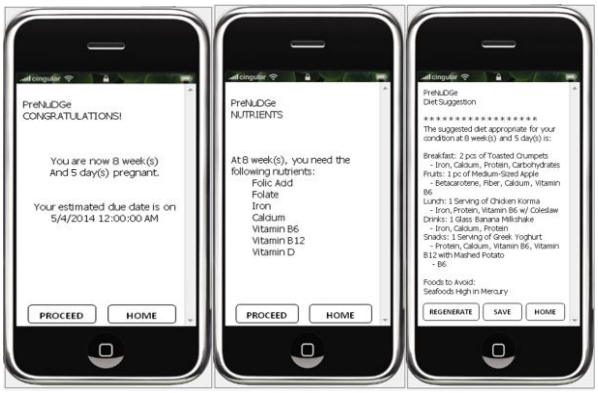

Figure 5. Output Screens

III. Research Methods and Techniques

The proponents used descriptive research to evaluate the proposed tool. The respondents of the study came from the out-patient department (total of 70 patients per day) of the Quirino Memorial Medical Center Department of Obstetrics, whilst the experts were obstetricians (total of 10) of the same hospital. The proposed system's level of acceptability was evaluated by the said respondents. The researchers used Slovin's Formula to compute for the total number of patients and obstetricians who will be the respondents using a margin of error of 8%:

No. of Patients = 70 / (1 + (70 * 0.08^2)) ---> = 48.34 thus, 48 patients

No. of Obstetricians = 10 / (1 + (10 * 0.08^2)) ---> = 9.39 thus, 9 obstetricians

IV. Results and Discussion

After conducting the survey, the proponents used the formula for average weighted mean to evaluate each item under consideration. The Likert-Scale was used in the study in order to present interpretation of the computed data. The prototype was tested and evaluated based on the following criteria: correctness of the output, reliability of the system, accuracy of computations, functionality of the system, user-friendliness of the interface and speed of the system.

Table III shows the summary of findings for performance of the system. According to the assessment of the experts the criterion on accuracy got the highest weighted mean followed by reliability with the verbal interpretation of Strongly Agree. However, criterion on correctness got the lowest score which means that the application developed need to improve in this area. The application is acceptable because its over-all performance got an average weighted mean of 4.52 with the verbal interpretation of Strongly Agree.

TABLE III. Summary of Findings for Performance of The System

Criteria	Average Weighted Mean	Verbal Interpretation
Correctness	4.11	AGREE
Reliability	4.58	STRONGLY AGREE
Accuracy	4.88	STRONGLY AGREE
Over-All Performance	4.52	STRONGLY AGREE

Consequently, Table IV illustrates the summary of findings for usability of the system. According to the evaluation of the respondents the over-all usability rating got an average weighted mean of 4.08 with the verbal interpretation of Agree.

TABLE IV. Summary of Findings for Usability of the System

Criteria	Average Weighted Mean	Verbal Interpretation
Functionality	4.29	AGREE
User-Friendliness	4.12	AGREE
Speed	3.83	AGREE
Over-All Usability	4.08	AGREE

V. Conclusion and Future Works

Based on the evaluation made by the obstetricians and the respondents they recommend the developed mobile application.

In the future, the proponents would extend their work by developing a subsystem that will allow the users to submit feedback, comments and suggestions or ratings of the system. The new version will use more graphics and animations which may encourage the users to keep on exploring the application. Furthermore, it will enhance the speed of the system by using another algorithm that will produce the optimum diet suggestion with the least possible number of iterations.

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