

**Ontology Driven Diet Advisory System For Health Monitoring****Omotosho, O. I.<sup>1\*</sup>, Adeosun, O. O.<sup>1\*</sup>**<sup>1</sup>Department of Computer Science and Engineering, Ladake Akintola University of Technology, Ogbomoso, Oyo State 210214, Nigeria.Corresponding author: <sup>1\*</sup>{oiomotosho|ooadeosun}@lautech.edu.ng**ABSTRACT**

For a healthy lifestyle, foods are not just expected to be taken but taken as required by the body system (that is balanced nutrition and diets). Cardiovascular diseases (CVD) has been identified as number one cause of death worldwide and twice as many deaths due to CVD can be attributed to risk factors such as hypertension and obesity. It is of a vital importance to monitor the dietary need of hypertensive, obese and diabetic patients, major cause of morbidity and mortality, in relation to various foods in order to recommend healthy diets. In this paper, a diet advisory system was developed using ontological approach, a form of knowledge representation. The system serves as a platform to assist users to proffer appropriate dietary solution through provision of advice as to whether a particular food is good enough after the health condition of such user has been considered.

**Key words:** Diet advisory, Health monitoring, cardiovascular diseases, Ontology

**1. INTRODUCTION**

Hypertension, diabetes and obesity are major ailments that are on the high side in the whole world. These three have contributed greatly to increased mortality rate in most countries [1]. A lot of those affected don't even consume the appropriate diet because they don't know what their diet should consist of. By so doing their situation is aggravated and they move close to death faster than they should. Hence, a food advisory system, as such developed in this paper, will be able to suggest the right diet to such patients at the right time and at the appropriate proportion is of very good benefit. It is obvious that some diseases have no permanent cure but studies revealed that some diseases or ailments can be exterminated through correct intake of appropriate diet in correct proportion.

Nevertheless, the effect of the drugs might be negligible if the correct diet is not taken into consideration. As much as it is important to eat the right quantity of food in correct proportion required by the body, it is discovered that people are ignorant of quantity of individual nutrient required by their body [2]. There are people who think life is enjoyed by consumption of costly food items that has great value attached to them such as juices, fast foods, etc.

Most of these food items have lost needed nutrient during processing and high consumption of them leads to the

detriment of human health. Some of these foods have high cholesterol content which is harmful to someone who is hypertensive [4]. This work provides maintainable health care solution for patients with only diabetes, obesity and high blood pressure through proper diet combination using ontology approach. It does not however cater for patients with other ailments. Section 2 discusses related works while section 3 explains the system design. We give details of our implementation in section 4. Section 5 concludes the paper with recommendation for future work.

**2. RELATED WORK**

A food advisory system is a framework or platform for assisting users through counseling or provision of advice as to whether a particular food is good enough after the health condition of such user has been considered. It is best developed as a form of knowledge representation. The American nutrition advisory panel [3] has urged people to cut back on added sugars, too much salt, and saturated fat. They are urged to include enough food that fit a "healthy dietary pattern," like fruits, vegetables, nuts, whole grain, fish and moderate level of alcohol. Americans are to focus less on individual nutrients and more on overall patterns of eating that is associated with lower rates of heart diseases and stroke. Unfortunately, many do not consider themselves at risk from consuming poor diets consisting of food and snacks with high salt, saturated fat content and refined carbohydrate content, as well as cigarette smoking and alcohol consumption. Also, the diversion of scarce societal resources to the treatment of these disorders dangerously compromises the 'unfinished agenda' of infectious and nutritional disorders that almost exclusively afflict the poor. It is against this backdrop that this paper examines the dietary need of hypertensive, obese and diabetic patients, major cause of morbidity and mortality, to recommend healthy diets and using ontological approach that proffers solution through appropriate diet.

Nowadays, several applications have been developed to help dietary and healthy food seekers. Fooducate [5] alerts its users to high amounts of sugar, controversial additives such as artificial food colorings, and misleading claims. Locavore [6] serves as a directory of healthy food stores. It determines the user location and guides him to the nearest stores. FoodFacts [7] provides user with nutritional information on thousands of different products with their ingredients, food label information, nutrient content information, protein, fat and carb information. This paper project specifically relates to ontologies, a formal type of knowledge representation, which define a vocabulary intended for sharing knowledge of

a domain. Ontology is an "explicit specification of a conceptualization,"[8]. Very few ontological resources exist that describe the dietary food details. A food related ontology is the renowned Wine and Food Ontology [9], which was designed to match recipes with the most suitable wine. However, It does not model any information regarding dietary or nutritional facts, which is a major issues that this work addresses.

### 3. DESIGN ARCHITECTURE

Our architecture consists mainly of ontology as discussed in subsection 3.1, which supplies food nutritional facts. Other components include a user interface for accessing this information and the OWL API/RDF that gives a high-level implementation of ontology concepts for integration into a web accessible format. The overall architectural design of the diet advisory system is shown in figure 1.

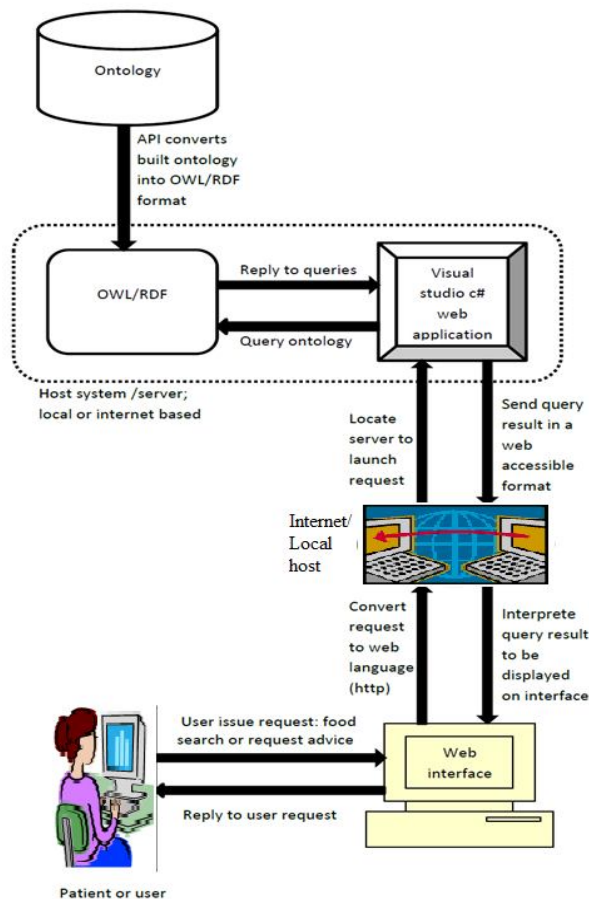


Figure 1: Architectural Design

#### 3.1 Ontology Diet Advisory

The architecture uses ontology [8], which integrates Food Advisory component, which include patient, disease, foods and meals by defining all possible relationships that can exist between the components. All food advisory concepts and entities are captured in a hierarchy as well as the relationships between such entities. The classes and object properties are also arranged into subsumption relationship

with the classes instantiated. This definition encodes essential background knowledge into the ontology that enables consistent and correct inferences to be made at the point of advisory. Figure 2 gives a snapshot of the ontology. The diagram shows how the components are logically and functionally related. The design is such that an appropriate food constituent and advisory could be obtained in a concise and automated manner. Here, different entities are shown with arrows linking them to show relationships. For example diabetes, hypertension and obesity sub entities are linked through meals consisting of foods as well as the disease entity. When an enquiry is made by a patient by entering a food combination, a health condition has to be selected for related nutrient constituents required in individual food as relate d to selected diseases.

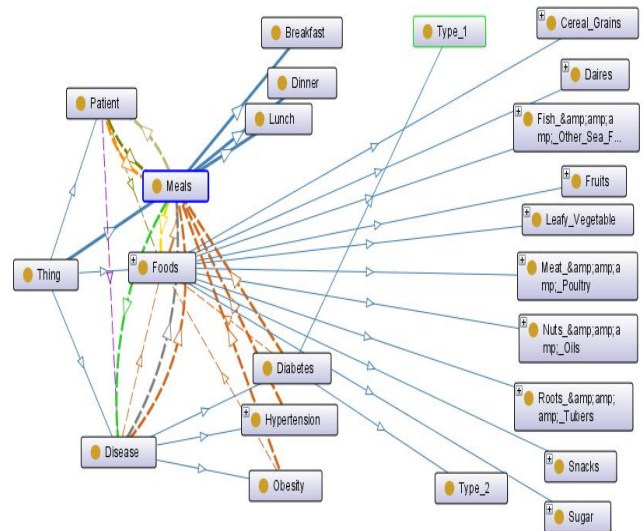


Figure 2: Ontology graph diagram showing relationships between food advisory entities

#### 3.2 Web interface design

The developed ontology requires an interface, being a web based in this work, to access the knowledge represented in it. Hence a web based application was developed. The application captures user requests which are limited to asking for the nutritional constituent of a known food and entry of intended food combination of patients for a day thereby giving advice with reference to their request. If a food that is not represented in the system is being searched for, the system reports a message that “food not found”, rather than generating a server error which will not be understood by an ordinary user.

##### 3.2.1 Software specification

Software specification deals with what the software should be able to do. Whether accessed through desktop or mobile devices. Its feature includes the following:

1. It provides basic information about obesity, diabetes and hypertension.
2. It accepts food name as input from user and displays the nutritive content of such food.

3. It allows users to supply daily food combinations and then verify if the combination is medically advice able.
4. It advises about diet intake in the absence of a nutritive expert.
5. It reports a message that “food not found” if a food is not represented in the system.

### 3.2.2 Software Requirements

In developing the application, the following software was used:

- IDE (Integrated Development Environment) – Visual Studio 2012.
- Programming Language – Visual C#.
- Embedded Framework – .NET Framework 4.0
- Operating System - Windows 8.1

### 3.2.3 Flowchart for Diet Advisory Interface

The flow chart in figure 3 shows the processing steps diet advisory interface. The first step is to click a choice link to either search food page of advisory center page. Click to either of the pages gives access to the diet advisory interface functionalities as listed in section 3.2.1.

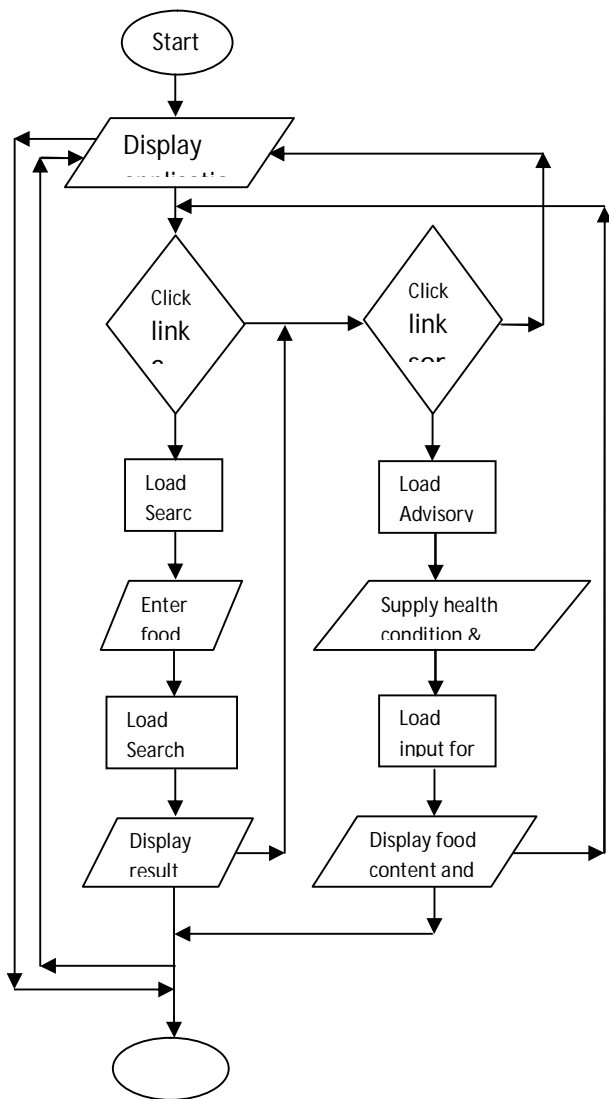


Figure 3: Flow Chart for Diet Advisory Application

## 4. IMPLEMENTATION

The user interface are highlighted and discussed in this section of the work.

### 4.1 Home Page

This page serves as an introductory page that briefly introduces its user to what the application is all about. The most important component on this page is the MENU tab, which enable users navigate from one page to another. The diet advisory homepage can be seen in Figure 4.



Figure 4: The diet advisory homepage

### 4.2 Search Foods Page

Figure 5 shows the page meant to search for foods. On this page, user can enter a food name to search for its nutritive content as represented in the ontology.

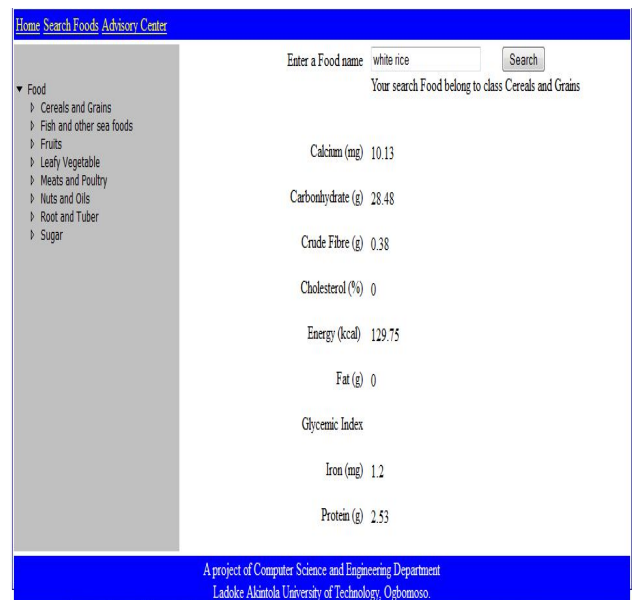


Figure 5: Search foods page

### 4.3 Advisory Centre page

Figure 6 shows the actual page where users can obtain advice as regards their selected food combinations. The user is expected to select combinations of his/her intended meal for a day each in the provided combo boxes and input the intended quantity (size or weight) in gram(g) in each of the textboxes provided in front of each combo box. On doing this, the user clicks his/her medical condition (obesity, hypertension and diabetes) on the upper part of the page and proceed to click the button calculate. This calculates the total nutrients in all the combinations, displaying them on the right side of the page and also compares the calculated value to the standard maximum expected nutrient intake of each health condition as provided in the program to display an advice of whether such combination is ok or not for the health of that user.

The screenshot shows a web interface for a dietary advisory system. On the left, there is a 'Food' category menu with sub-items: Cereals and Grains, Fish and other sea foods, Fruits, Leafy Vegetable, Meats and Poultry, Nuts and Oils, Root and Tuber, and Sugar. The main area contains a warning: 'You are not encourage to take this combination' in red text. Below this, there are several 'select' dropdown menus followed by input fields for quantity in grams (g). The selected items are: white rice (0150 g), egg (010 g), goat meat (020 g), banana (030 g), soya beans (0150 g), spinach (0100 g), orange (020 g), potato (0100 g), chicken (030 g), and multiple instances of soya beans (0 g). At the top right, there is a section 'Choose your medical condition' with radio buttons for Obesity, Diabetes (selected), and Hypertension. A 'Calculate' button is located at the bottom center. On the right side, a list of nutrients and their values is displayed: Calcium (mg) 495.895, Carbohydrate (g) 109.91, Crude Fibre (g) 7.3, Cholesterol 0, Energy (kcal) 1100.625, Fat (g) 32.41, Glycemic Index 0, Iron (mg) 20.032, and Protein (g) 86.075.

Figure 6: Advisory centre page

### 5. PROPOSED EVALUATION

The developed Diet advisory system will be evaluated based on users' assessment in terms of system reliability and effectiveness, system ease of usage and efficiency of the system. We intend to evaluate the system based on users' assessment with procedure and guideline properly mapped out. The evaluation will entail the of Questionnaires with Likert rating scale [11] for each question and would be administered to individual users. We intend to formulate the three quantitative parameters; System Reliability Index (SRI), System Ease of Use (SEU) and System Degree of Relevance (SDR) from user responses during the evaluation. Appropriate Statistical test of significance will also be carried out to on the user responses as part of the data analysis.

### 6. CONCLUSION

This study has looked vividly into our environment, found some bottlenecks in dietary management of many individuals and has therefore created a medium where proper diet management is enhanced. This was achieved by classifying foods, represent knowledge and make the represented knowledge available for exploration with several advantages of it being expressed. . It can be concluded that this project has established and proven it functions in assisting people with obesity, diabetes and hypertension in regulating their diet intake for improving their health condition and minimize the effect of these diseases on them.

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