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DEVELOPMENT OF A SEMANTIC ONTOLOGY FOR MALARIA DISEASE USING PROTÉGÉ-OWL SOFTWARE

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Abstract- Ontology which focuses entirely on malaria diseases or on any of the diseases that affect the tropical region of the world is hard to come by due to the economic condition of the countries in this region. Furthermore, the type of access provided by some of the existing medical ontology is a somewhat cumbersome process and the data that might be provided at the end is often not comprehensive and concise enough to be understood by a non-professional seeking knowledge, may be on a specific concept or aspect and how they are linked to other concepts. Hence, the need for a semantic medical ontology that addresses the issues raised.

The methodology used for this project work involve the gathering of adequate and correct information on malaria from recognized bodies i.e. the parasites, the mode of treatment, Malaria type, symptoms, etc., developing an ontology model from the information given and providing a means of remote or online access for individuals or groups that require information that is well represented.

In this work, an ontology model that is completely devoted to the malaria parasite along with the establishment of a semantic website that enables a less cumbersome mode of access to relevant information gathered on malaria was developed.

Keywords – *Ontology, Protégé OWL, Malaria*

I. INTRODUCTION

Giving the nature of tropical diseases (Malaria for instance) and their area of occurrence, it was found out that very little or insufficient ontology materials can be gotten on them. The tropical countries (mainly in sub-Saharan African) are then left to fend for themselves and this can lead to lack of an adequate intelligent information gathering system on the prevalence, incidence, nature of infection, how it spread, curative measures that can be taken, when and how they can be taken etc. Of a special concern are those from the poorest parts of the already poor state in the federation that have no reliable means for efficient information dissemination i.e. the hinterlands (villages).

In order to provide a lasting solution to ailments of any kind, malaria in this case, there is the need of constant and accurate flow of information on such diseases particularly to those parts where there are no easy accesses to data. Hence, the development of a semantic ontology (model) for Malaria Infection in the tropical region the world using Protégé-OWL.

II. MALARIA

Among the list of diseases predominant in this part of the world, Malaria ranks as one of the most prevalent not just in this region but the world at large. The World Health Organization in its report titled 10 Facts about Malaria remarks that about 3.3 billion people around the world (about half the world's population) are at risk of being infected by the Malaria virus. (WHO Reports, 2013).

Malaria disease has been with the Humans since the very beginning, in fact it predates the entire Human race. This widespread and potentially lethal infectious disease has been known to have afflicted people throughout the history of mankind and has also affected patterns of settlement over time. The treatment and prevention of this disease has been a focus of investigation in science.

Figure 1: A female anopheles mosquito (Source: http://www.malariasite.com)

Malaria is caused by the Plasmodium parasite. This occurs when an infected female anopheles mosquito (Figure 1 above) called "malaria vectors", bites a person usually between dusk and dawn. This process injects the Plasmodium parasites into the blood stream of the individual in form of Sporozoites. These sporozoites multiply and overtime cause malaria with the host showing signs of fever and some other symptoms.

III. ONTOLOGY

Ontology is a formal framework for representing knowledge. This framework names and defines the types, properties and inter-relationships of the entities in a domain of discourse. It compartmentalized the variables needed for some set of computations and establishes the relationships between them (Gruber, 1993).

Ontology is generally classified into 4 categories namely:

1. Upper Level Ontology – Used to facilitate the sematic integration of domain ontologies and guide the development of new ones. (Ontogenesis, 2010)
2. Interface Ontology – Describes those concepts that are relevant to the juncture of disciplines.
3. Process Ontology – It is a description of the components and the relationships that make up a process.
4. Domain Ontology – Deals with concepts that are relevant to a specific field of study, area of interest or a particular branch of science.

IV. NEED FOR MEDICAL ONTOLOGY

Medical ontology is defined as a model of the knowledge base from the clinical domain such as the malaria parasite syndrome. It contains all of the relevant concepts related to the diagnostics, treatment, clinical procedures and patient data (Jovic et al, 2007). Ontologies are designed in a way that allows knowledge inference and reasoning.

Medical ontologies describe the concepts and structures that exist in the field of medicine. They also describe the relationships and or similarities between those concepts and structures in a way that provides for easy access by the viewer to provide a pool of resources from which information can be extracted and decisions taken.

In modern times, the need for ontology that a takes a broad topic and then breaks it down into smaller relevant bits while also establishing relationships between those smaller bits that make up the whole, is always a welcome idea. True, a layman might not be able to fully understand the jargons being used in such ontology; but its use especially, by professionals in the field or even policy makers cannot be over-emphasized.

To a medical professional, such models could serve as a constant remainder on the parts that make the system being studied. Take for instance, suppose a there is a model for the human circulatory system and which has been published and is constantly being updated with newer information, such a model can serve as a source of information on the advances and new discoveries to the professional.

To the policy makers, use of medical ontology can provide them the enabling environment to formulate such policies that will encourage growth in the sector. Ontology on malaria control and prevention can provide a policy maker with the tools needed to make informed decision on the steps needed to be taken at the various stages of the development life cycle of the parasite to eradicate or at least minimize the spread of the infection.

A medical ontology can also be used by a researcher to provide first hand information on terms and concepts that will be used to enhance his/her research work like those used by this researcher.

V. METHODOLOGY

The approach adopted for the development of the project was quantitative and manually-driven given that the data needed for the development of the ontology was written as it was being developed. Though this project seeks a modification of an existing model to incorporate a new model of result delivery and viewing, it was realized that the entire system had to be implemented and not just the modification being considered, this necessitated the development of the system from scratch.

For the purpose of this research, the research strategy or method adopted was Case Study Research as it (the research project) sought to examine in great depth and detail, the extent of the Malaria infection as it applies to ontology development. The other research methods outlined above were not able to effectively capture the type of data being envisaged by this research.

The model adopted consisted of an ontology created using the Protégé-OWL software, a database created for the project using the appropriate tool (XAMP), a procedure for accessing the data contained in the database and an interface for interaction with the system.

The interaction with the system is in form of queries, after the user has successfully logged on.

The framework represents a modification of the existing model, necessitated by the inclusion of a comprehensive ontology that focuses entirely on malaria and other factors believed to be important such as detailed delivery of the requested information on the web page rather than providing links to where such information might be found.

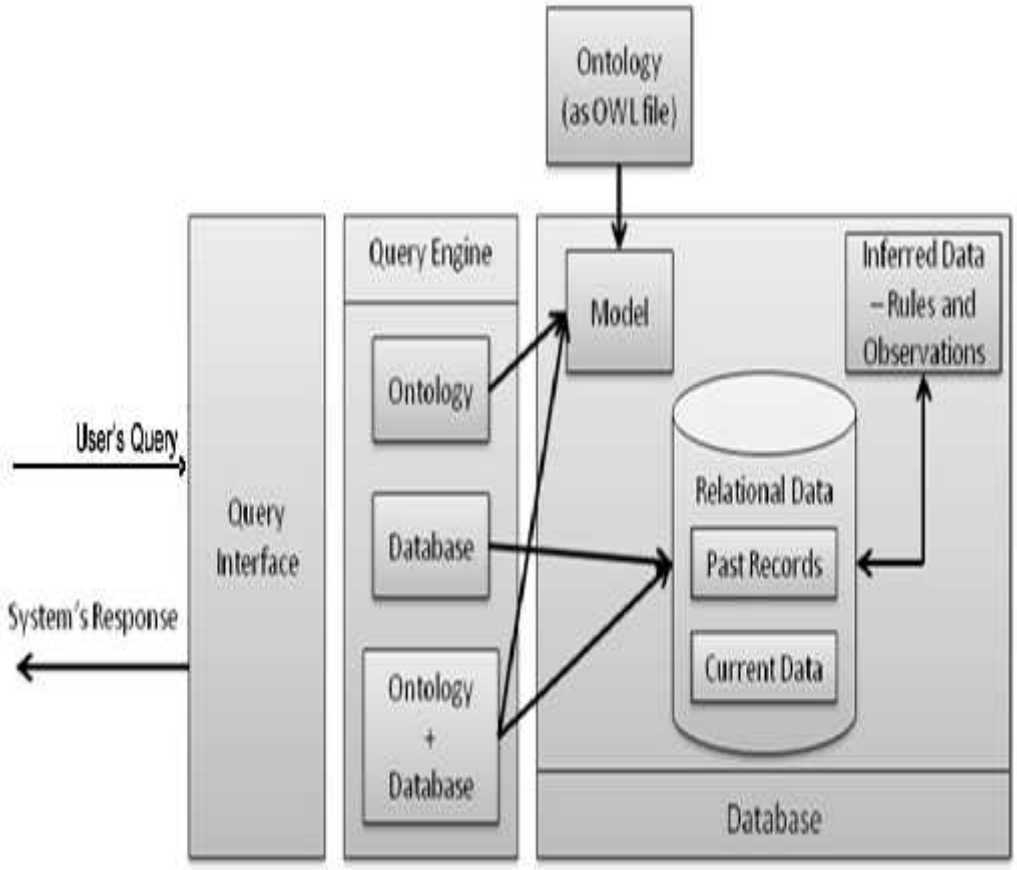

Figure 2: System architecture framework

The research framework posited in figure 2 above guides us in the development and as an instrument for the implementation of the prototype. The system was built such that the result of searched information will be made available in a comprehensive format on the web site. This will reduce the amount of time it will take to navigate to the different websites that have the information being sought for.

The tools chosen to perform the processes outlined above include Protégé-OWL 3.4.2, Hypertext Markup Language (HTML), PHP (Hypertext Preprocessor) and JavaScript to develop the website while MySQL provided the Database Management System (DBMS) for the database.

VI. RESULTS

In developing the malaria ontology, Protégé-OWL was used. Since Ontology is used to represent to represent shared concepts in a hierarchy (Gruber, 1993), the concept (or class) malaria was generally divided, after the research, into seven (7) main subclasses namely: Endemic Countries, Malaria type, Parasite, Symptoms, Treatment, Vector control and Vectors.

Figure 3 below shows the ontology interface with the various sub-classes and the sub-classes of these subclasses

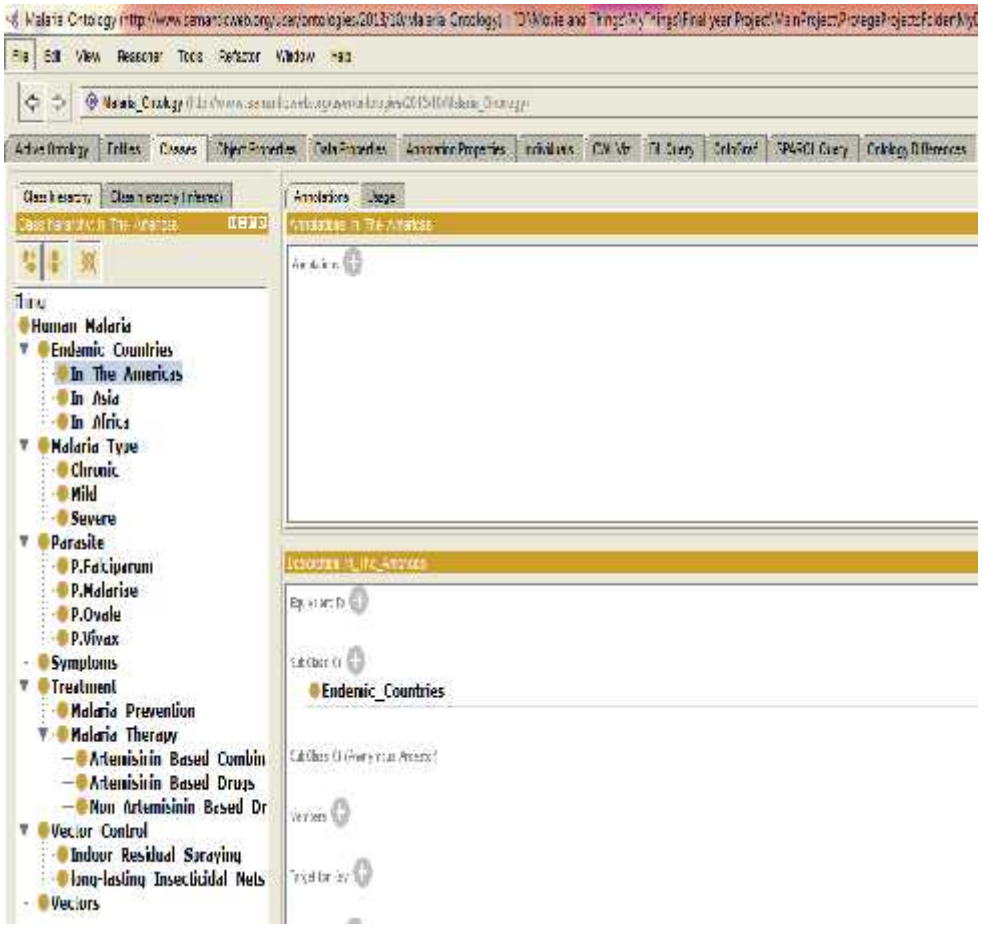

Figure 3: The protégé-OWL interface showing the classes and subclasses for malaria.

After our research had being concluded and for better organization we presented additional data in a series of subclasses or instances for each class created, for instance for the subclass parasite, we divided this class into four different subclasses (types of parasite) for four main parasites that are known to cause malaria in humans, *P.falciparum, P.vivax, P.ovale, P.malariae.* Individual members (or instances) of the class were also added at the end of the chain. Figure 4 below gives a demonstration of this.

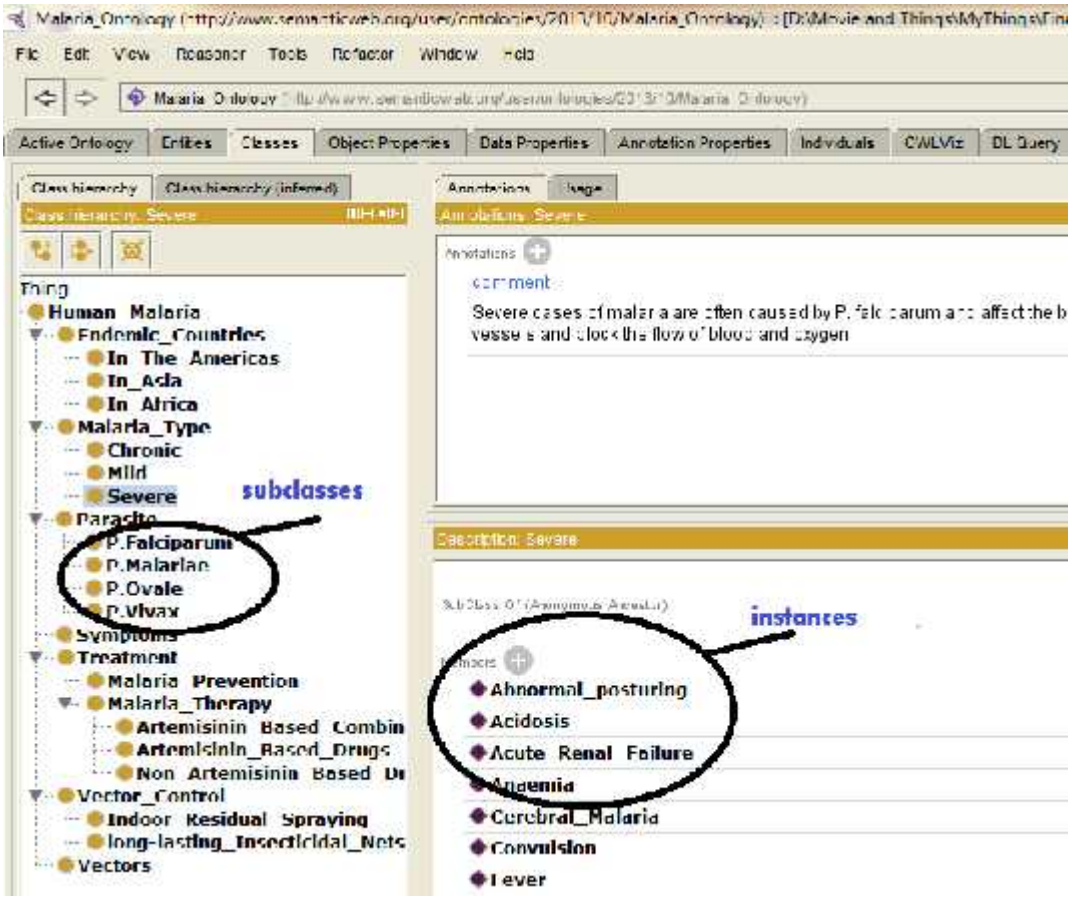

Figure 4: Example of subclasses and instances

One of the objectives of this project was to present the developed ontology in a format that is understandable by even the novice; this was achieved by the addition of comments (and annotation properties) for each of the data in the ontology. This feature is particularly useful for the researcher or non-medical personnel. Figure 5 below gives a demonstration of this.

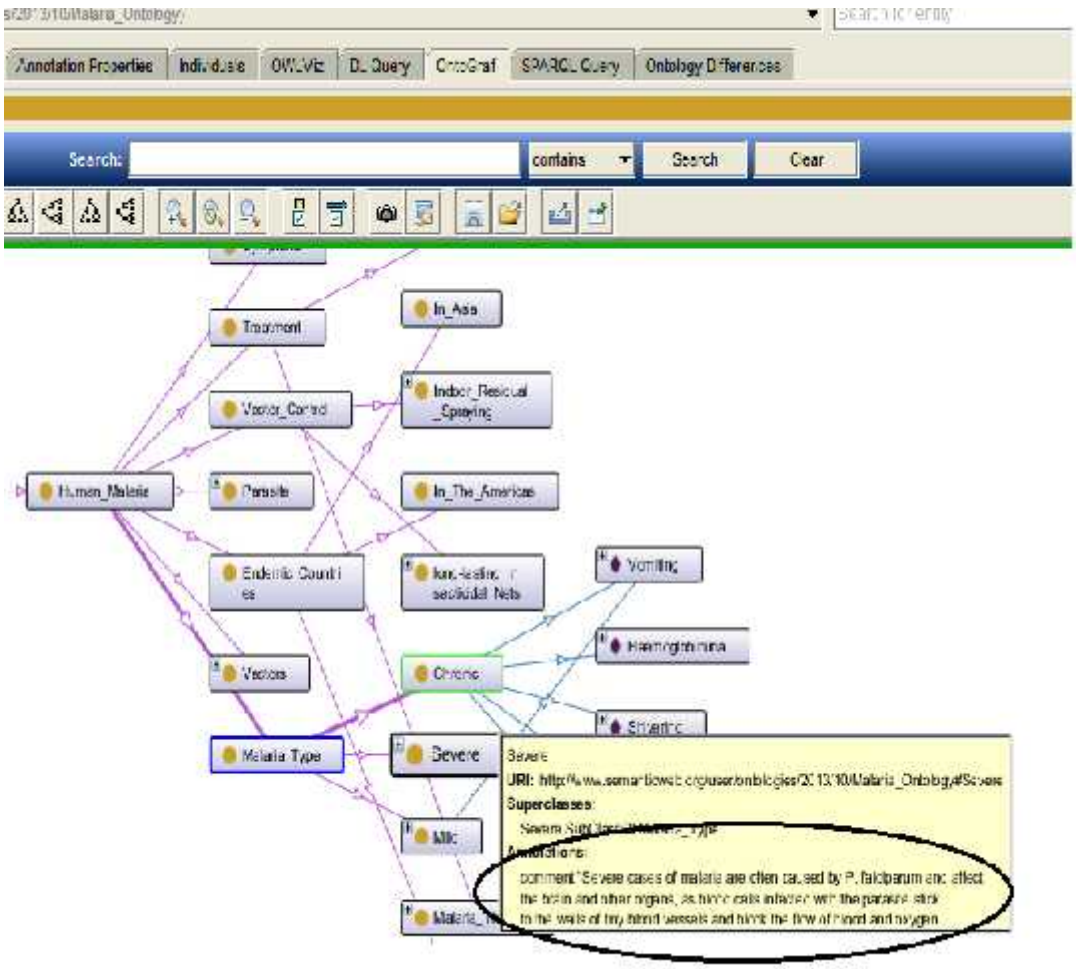

Figure 5: OntoGraf image showing the comment for severe malaria.

To view the OWL file created, the user has to install Protégé-OWL, with all the plugins onto his or her system. One particular plugin of Protégé-OWL is the OntoGraf. This plugin enables the user to view a graphical representation (or a hierarchical tree format) of the ontology model created. The OntoGraf representation of the Malaria is given below.

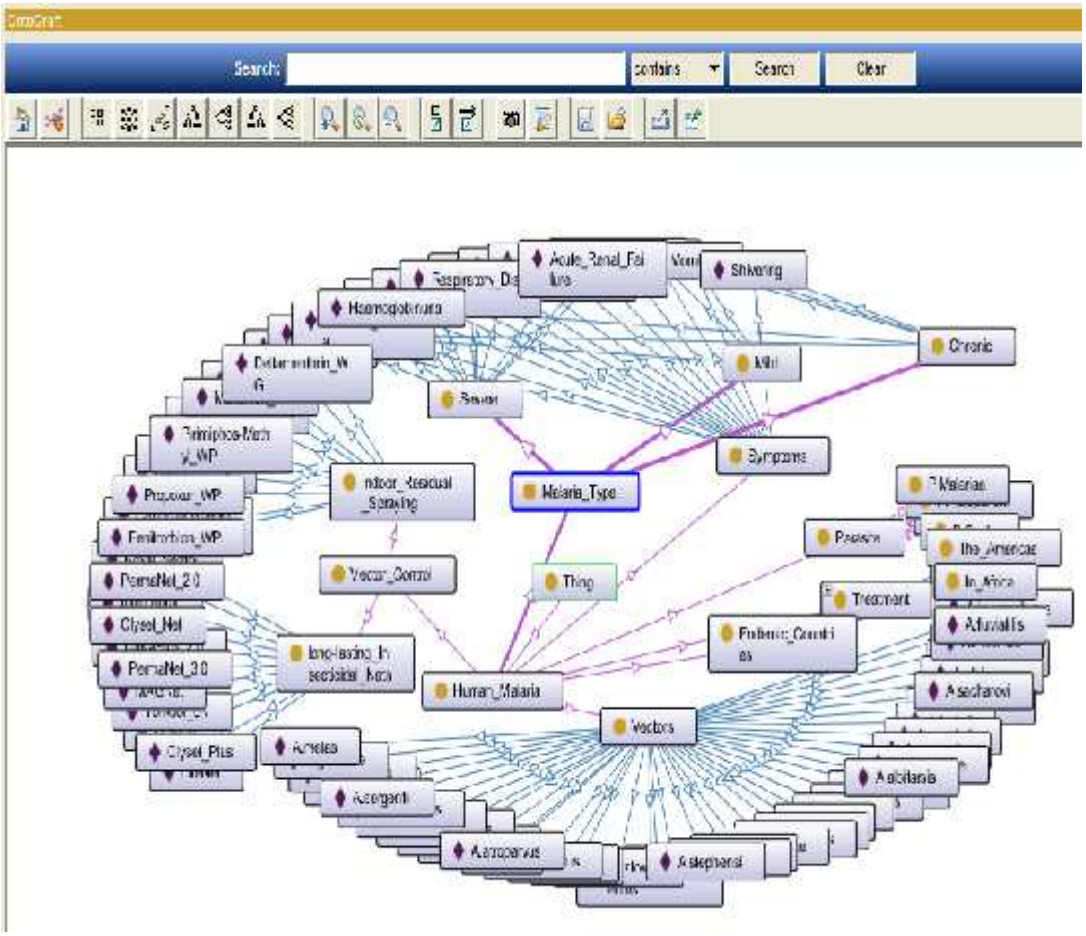

Figure 6: OntoGraf for the malaria ontology

VII. CONCLUSION

Various techniques were involved in order to construct Malaria Ontology. Protégé-OWL was used in order to get maximum expression and consistency of the concepts. We used Protégé to capture conceptual and relational domain knowledge as ontologies.

A new medical ontology for malaria disease management has been built with reuse of existing ontology tools and medical data. Taxonomical hierarchy and medical data interrelationship were formulated in this work and implemented in the ontology created. A comprehensive malaria disease database has been implemented to provide useful structured information for user. Performance test result shows that the built ontology system is user friendly, has enough concise information, and recommended to be used as reference for malaria disease management.

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