Modeling of seafood domain using ontology

Vinu Sherimon, Sherimon P.C., Alaa Ismaeel, Winny Anna Varkey, Naveen B.

***Abstract*— Ensuring food quality has increasingly become an important issue nowadays and is the first step to get attention to countries seafood products. People pay more care to intrinsic quality including nutritional value, fresh degree, and toxic harmful substance content in all the products they consume. Food processing industries employ different quality control systems to check the quality of the seafood. Specific guidelines are also followed as per the country of seafood export. Most of these guidelines are still paper-based and lab technologists often refers these manuals and documents to ensure the standards. This research presents the development of on ontology to represent the concepts of different quality tests used to ensure the quality in seafood domain. It provides taxonomic information on the type of tests, standard values and classify the seafood into accepted and rejected classes. Here, the different steps involved in the development process of this ontology is explained along with classes, its properties and instances. We concentrate on five types of seafood and the case study is conducted in Oman. Protégé which is an open source platform, is the main tool used to implement the ontology. The developed ontology supports the lab technologists in knowledge discovery and information retrieval.**

Keywords— Seafood ontology, quality, Protégé, OWL, microbiological, organoleptic

I. Introduction

Due to the increasing economic and technological developments in our society, lifestyle and food habits have changed considerably. In both developed and developing countries, the diets are low in vitamins, proteins and dietary fiber. Also, the physical activities have reduced. All these have led to an increase in the disorder rates such as obesity and hypertension [1]. Seafood is likely the single most important food one can consume for good health [2]. So, it is necessary to analyze and understand the quality and tests that the seafood undergoes. The global consumption of seafood has been increasing year after year. Hence, research and studies regarding their quality assurance and nutritional benefits are also growing day by day. The environmental risks of seafood include water pollution, metal pollution and other bacterial pollution. So, it is mandatory to ensure the quality of seafood. The seafood is mainly tested in two stages, raw material and the processed one. It is under this consideration that a seafood ontology model is presented in this paper.

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Vinu Sherimon is with Department of Information Technology, University of Technology and Applied Sciences, Muscat, Sultanate of Oman, vinusherimon@yahoo.com

Sherimon P.C. is with Faculty of Computer Studies, Arab Open University, Muscat, Sultanate of Oman (email: sherimon@aou.edu.om)

Alaa Ismaeel is with Faculty of Science, Minia University, Minya, Egypt (email: alaa.ismaeel@aou.edu.om)

Winny Anna Varkey (email: winnyvarkey2000@gmail.com) and Naveen B. (email: naveenb307@gmail.com) are with Saintgits College of Engineering, Kottayam, Kerala, India

Ontology provides a common platform of vocabulary for the researchers to share information in a domain. It provides machine interpretable definitions of the basic concepts in the domain and relations among them [3]. Ontologies are developed to overcome the limitations of keyword-based search and have a crucial role in the processing and sharing of knowledge between programs on the web. Since it is an essential backbone to semantic search, they provide a shared and common understanding of a domain that can be communicated between people and application system. Nowadays, ontologies are being applied in many information retrieval systems to enhance its performance [4].

An ontology is the formal description of knowledge with a set of concepts within a domain and the relationships that holds between them. To enable it we need to specify components that include individuals (instances of objects), classes, attributions, relation as well as constraints and rules. Hence ontology not only introduce a reusable knowledge representation but also add new knowledge about the domain. There are of course other methods that use formal specifications for knowledge representation such as vocabularies, taxonomies and relational database schemas. However, unlike other representations, the upper hand for ontology is that it facilitates the users to link multiple concepts to other concepts in a variety of ways [5]. By having essential relationships among the classes and concepts, it enables automated reasoning of data. That's why ontology gained importance and attention of many researchers all over the world [6].

The use of ontology for the quality assurance has more advantage than taking surveys, integrated reviews or cross-sectional studies. Ontology keeps on growing and can be further refined in the future. More and more modifications can be made in ontology depending on need. It helps in providing a shared and common understanding of domains that can be communicated across people and application systems. Ontology defines relationships and semantics in meaningful ways [7]. Protégé is chosen as the tool because it is one of the best methods of implementing Ontology.

The backbone of our system is ontology build in Protégé software which will assure the seafood quality. Even though many research and related works has been carried out for the quality assurance of seafood, this paper focuses its effectiveness not only in checking the quality of seafood but also on the importance and advantage in building ontology in Protégé software using OWL language. The tests conducted in seafood during different phases of processing (either in company or government approved labs) provide values for various quality parameters that are checked and if these values do not meet with the strict import regulations of any particular country to whom it is exported (either EU or non-EU countries), it would lead to the rejection of seafood [8]. Here comes the importance of this seafood ontology, where the system provides the technologist if there is any variance in the test results. It also verifies the correctness of the data. This paper explains the implementation of ontology in detail.

The objective of this paper is to present the seafood ontology for the quality assurance and to enhance the information on various tests available for certain seafood categories. The different steps in the development process as well as the various classes along with its properties and instances are described in this article.

The rest of the paper is organized as follows: - Section 2 presents the ontology modeling. This section describes the ontology classes, subclasses, relationships, object properties and data properties. Section 3 presents the results followed by Conclusion and Future in Section 4.

II. ONTOLOGY MODELING

In a seafood processing lifecycle, there are many tests done in different stages to ensure its quality. The three main tests performed on the samples are organoleptic, microbiological and chemical test which provide the details of heavy metal content, pesticide content, texture, presence of microorganisms etc. Evaluating the microbial quality of seafood has a vital role in the seafood processing chain. Microbiological quality assessment of the seafood depends on the processing conditions within the seafood chain [4]. As pointed earlier, it is quite easy to formally describe knowledge through an ontology using various concepts. Ontologies ensure a common understanding of information and with it they make explicit domain assumptions.

A. Ontology classes and subclasses

We have used protégé 5.5 to model the Ontology.

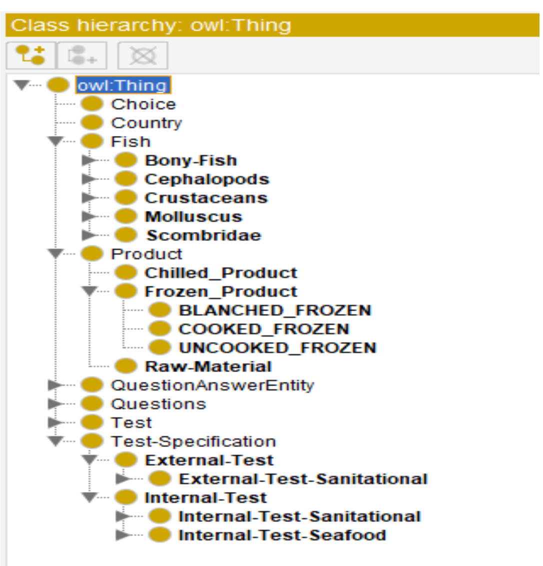

Figure 1. Classes and subclasses of seafood ontology

Protégé is a free, open source software that act as an ontology editor and a knowledge management system. This software helps in the easy creation of ontologies. The domain knowledge is organized with the help of taxonomies. The implementation process has many steps and can be represented in many ways by different tools in Protégé. Figure 1 depicts the implementation of the seafood ontology using Protégé. The domain concepts are explained using the building blocks of ontology called as classes.

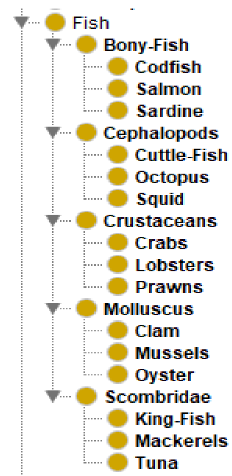

Figure 2. Subclasses of class Fish

Country, Fish, Product, Test, Test specification etc. are the main classes. The product is again classified as chilled, frozen and raw material, where the frozen is again sub divided into Blanched frozen, cooked frozen and uncooked frozen. The test specification is done based on the external and internal test. Fig 2 depicts the subclass of fish category. Three main fishes from each fish families are added under the category. Tests for the fish families are also done separately and their results are hence developed respectively. The subclasses are used so that the concept can be made more specific than using the super class.

Protégé developed in OWL language provides many useful visualization tools to describe the classes, its properties and instances. It includes the pictorial representation in OWL Viz, OntoGraf and DL query.

B. Representation of ontology relationships in OWLVIZ

Figure 3 depicts the basic class hierarchy in OWL Viz that enables the Ontology to be viewed and incrementally navigated. Fig 4 and 5 are also further examples for the seafood ontology where it depicts a detailed class hierarchy representation and subclass representation of microbiological test in OWL Viz. It allows not only the comparison of the asserted and inferred class hierarchy but also in differentiating the primitive and defined classes. The OWL Viz tool of Protégé 5.5 aids to represent the class hierarchy and their relationships in a visualized manner [9]. The OWL Viz tool in Protégé 5.5 requires an open source graph visualization software named Graphviz for the representation of structural information as the diagrams of a graph.

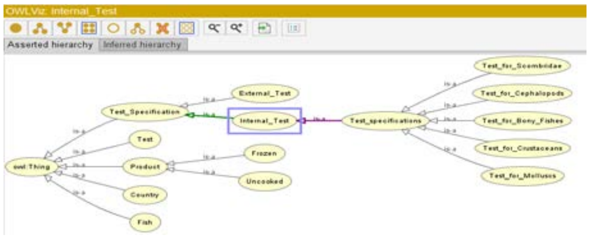

Figure 3. Basic representation of the seafood ontology using OWL Viz

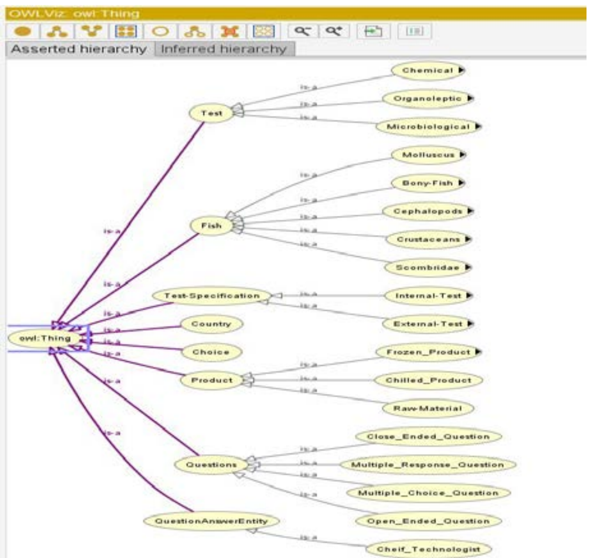

Figure 4. Class hierarchy representation in OWL Viz

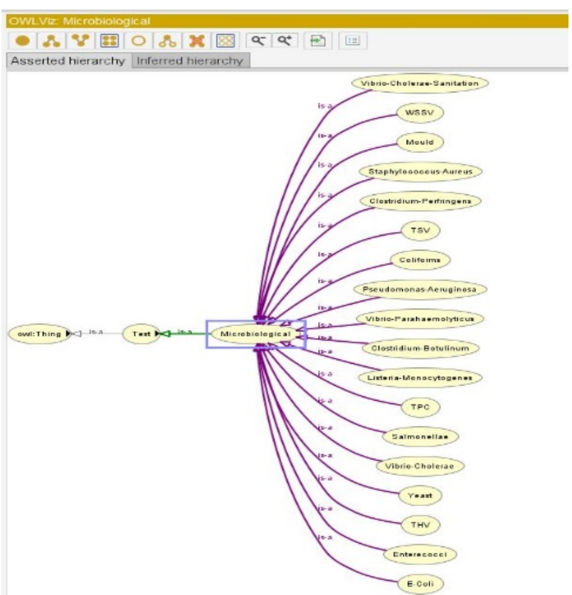

Figure 5. Representation of the subclass of Microbiological test using OWL Viz

C. Representation of ontology relationship in OntoGraf

OntoGraf is a tool designed for Protégé OWL application that supports various layouts for organizing the structure of the seafood ontology automatically [10]. The different relationships supported by OntoGraf includes individual, equivalence, subclass and object properties. Like OWL Viz, it too shows the relationship between classes and subclasses but OntoGraf can only be applied for smaller ontologies and is limited by the RDFS expressiveness [11].

OntoGraf allows to select a concept from the given class hierarchy and view it in a relationship with the neighboring classes. For automatically organizing the structure of seafood ontology, various layouts are supported in OntoGraf. Figure 6 depicts the class hierarchy in OntoGraf, which gives support for interactively navigating the relationship of the seafood ontology.

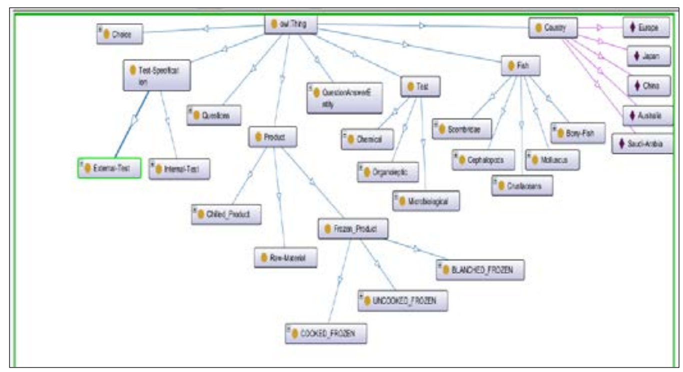

Figure 6. Class hierarchy representation in OntoGraf

D. Object properties, data properties and instances

Object properties describe the binary relationship between two instances. Figure 7 depicts the object properties of seafood ontology.

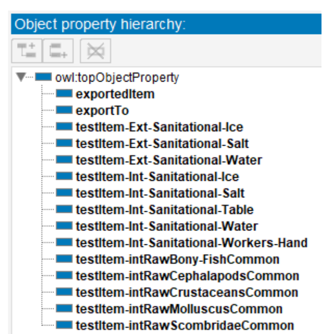

Figure 7. Object property hierarchy

As in Figure 8, tests of fishes (which include Bony fishes, Cephalopods, Crustaceans, Molluscus, and Scombridae) are given as the data property of this ontology. Instances are the 'things' represented by a concept. In our seafood ontology, each classes of fishes have instances.

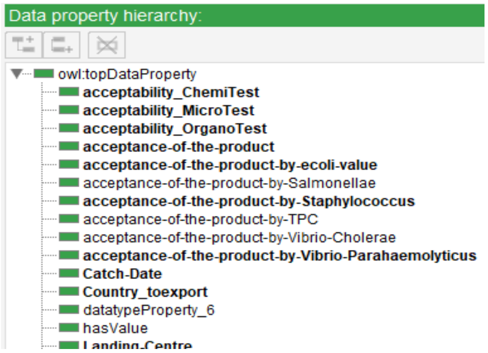

Figure 8. Data property hierarchy

III. RESULTS

A. SPARQL query

SPARQL Query, a tool in Protégé, enables the easy extraction of information from large dataset with a high performance. Figure 9 displays the query to list the different types of tests required for the Crab.

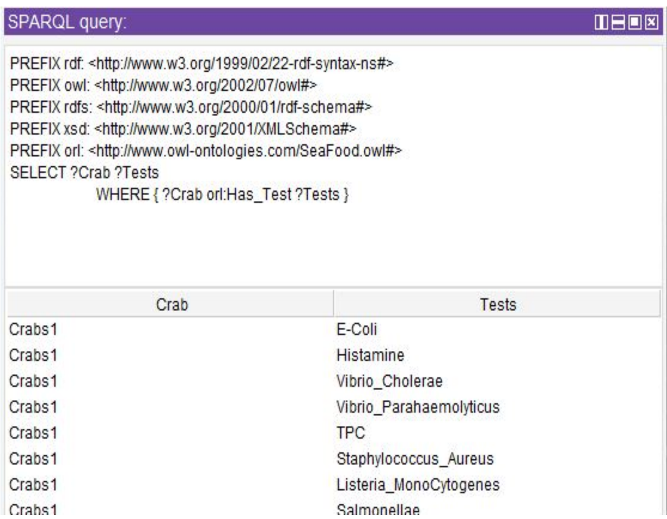

Figure 9. SPARQL Query

B. DL query

Query answering is one of the crucial inference services provided for an ontology-based system [12].

The DL query tab gives a powerful method of searching a classified ontology. Figure 10 shows a basic query to show the instances of a class such as Microbiological. Through this, any class expression could be searched, and its result will be obtained with its subclasses and instances (if any). DL Query tab of Protégé 5.5 provides an interface for querying and searching any class expression with a fraction of time. In the figure, subclasses for the given class expression was obtained as output. This is really a speedy method for searching a classified ontology.

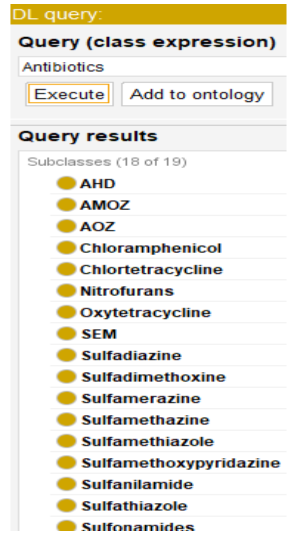

Figure 10. DL query

IV. CONCLUSION & FUTURE

The field of seafood and its quality prediction will have an unending scope in the future. Safety, quality and nutritional benefits must be preserved, and proper handling should be ensured for seafood items. The global seafood market has become a complex system of trade and sustainability issue. The export of seafood must be encouraged as it has satisfied the food security needs of human beings. Numerous studies have proved that the best source of excellent fats, proteins, minerals, and vitamins that promote health can be obtained through the seafood consumption. Thus, the role of seafood in maintaining and enhancing the health of the people may grow stronger as there forms a guaranteed system to ensure its quality.

In this paper, the development of seafood ontology is presented. The classes and subclasses are implemented in Protégé. Moreover, the representation of class hierarchy in OWL Viz, OntoGraf, its data properties, object properties, instances and results obtained using SPARQL and DL Query are also shown. The future scope of this paper includes the ontology rules used to implement various test details of fish families and the implementation of the complete seafood quality assurance system. Further, with the defined ontology, it is possible to update and correct whenever future needs arise such as future advancement in technologies.

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