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(RESEARCH ARTICLE)

Development of framework to support software requirement elicitation using a domain ontology

Abdalmoneim Mohamed Mohamed Khair * and Farid Meziane

[1] *Sudan University of Science & Technology College of Graduate Study PhD (Computer science) program Khartoum, Sudan.*
[2] *University of Salford School of Computing Salford, M5 4WT United Kingdom.*

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Abstract

One of the main goals of Software Requirements Engineering is to understand customers' needs and to put their customer needs in requirement. The requirement engineering has several processes one of them are requirement elicitation the requirement elicitation considered as one process of requirement engineering and also considered as important process so the process of elicit the requirement has difficult, due to the incompleteness problem, ontology has player important rule to helps the requirement elicitation by adding more information about the words. in this paper implementing framework by using domain ontology, the frame work implement using java and ontology using protégé, the framework evaluated using requirement in in banking domain, and show the results helps the software developer to choose the requirement.

Keywords: Requirement elicitation; Ontology; Framework; Protégé.

1. Introduction

1.1. Requirement Gathering and Analysis

The process of requirement gathering and analysis as the activity that considered one of the most critical activities during the software development life cycle (SDLC) because the problems of requirement related issues can have a great impact and even cause the failure of the software project and it includes the tasks of eliciting, analyzing, and specifying the functional and behavioral properties of a software intensive system (Castro-Herrera et al. 2009).

1.2. Requirements elicitation and analysis

After an initial feasibility study, the next stage of the requirements engineering process is requirements elicitation and analysis. In this activity, software engineers work with customers and system end-users to find out about the application domain ,what services the system should provide, the required performance of the system, hardware constraints, and so on.

1.3. Ontology

In the context of computer and information sciences, ontology defines a set of representational primitives with which to model a domain of knowledge or discourse. The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members). Ontologies are typically specified in languages

* Corresponding author: Abdalmoneim Mohamed Mohamed Khair
Sudan University of Science & Technology College of Graduate Study PhD (Computer science) program Khartoum, Sudan.

that allow abstraction away from data structures and implementation strategies; in practice, the languages of ontology's are closer in expressive power to first-order logic than languages used to model databases. For this reason, ontologies are said to be at the "semantic" level, whereas database schema are models of data at the "logical" or "physical" level. Due to their independence from lower level data models, ontologies are used for integrating heterogeneous databases, enabling interoperability among disparate systems, and specifying interfaces to independent, know ledge-based services Gruber [55] from 2009

1.4. Problem Statement and its significance

The problem is incompleteness of requirement in software elicitation, which causes ambiguity in some concepts of words , this is due to the lack of information and semantic of the words that used to elicit requirements.

1.5. Research Question

- How ontology support the requirement elicitation?
- How frameworks help the software developer ?
- How frameworks remove the ambiguity of terms in requirement elicitation?

2. Related works

Alshehri et al. [1] proposed a novel framework for semantic processing of software requirements based on ontology. The aim of their work is to enable software developers to elicit software requirements and implement structures that suit particular requirements. The proposed ontology has two components: requirement elicitation and reusable parts. The solution aims to incorporate an intermediate step involving conceptual design work. The additional step is actually a new method for mapping unified modeling languages (UML) to Ontology Web Language (OWL). This approach provides an opportunity for formal representation of domain knowledge. The challenge is that conventional engineering approaches do not rely on ontology representations using Semantic Web Languages. Therefore, the proposed solution will seek to adapt Protégé to support the addition of ontology languages.

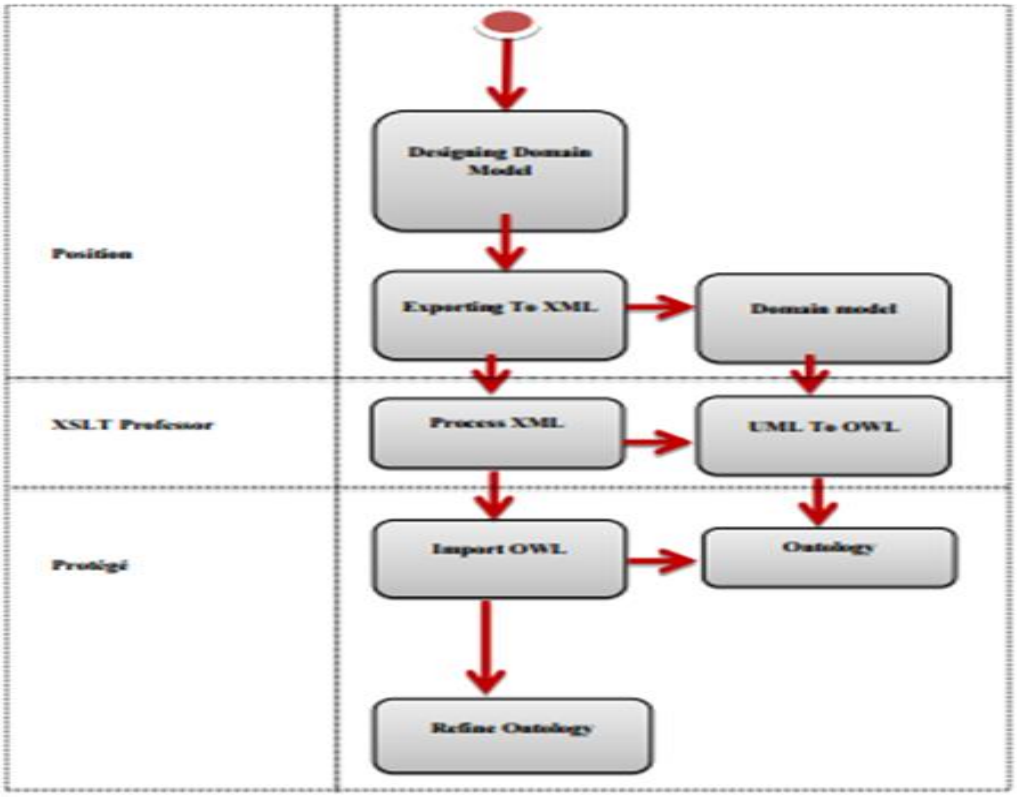


Figure 1 Methodology of the framework proposed by AlShehri et al. [1]

The solution involves two major steps. The first step is analyzing extensible stylesheet language Transformation (XSLT) processors, that is the.NET Framework Class Library and extensible markup language (XML) Spy to generate OWL files

by using XSLT file as the input to enhance the mapping rules generated using (Ontology UML Profile) OUP. The strengths of this methodology is to refine and validate the requirement elicitation by XML. And convert requirement by XSLT processor to UML and then to OWL. The weakness of this methodology is harder to write the requirement elicitation and incompleteness. The validation of the proposed solution relies on public survey that is targeting experts in software engineering and professionals in system design and development. The selection of participants has followed purposive sampling approach in which the researcher relies on personal acquaintances and professional contacts. Overall, 31professionals participated in the survey. Each of the three goals is evaluated using five questions. The evaluation of the survey questionnaire responses relies on ranging from (1)Very High (2) High (3) Nominal (4) Low(5) Very Low. Figure 1 illustrate the proposed framework.

Putla and Mohan [2] presented an approach to capturing and validating a set of project requirements performed an evaluation using an extant set of project requirements. This approach considered an ontology as a semantic domain so as to provide the meaning for requirements, and discuss the potentials of the RE techniques using an ontology as a semantic basis. Provide the semantics for goal descriptions written in natural language using a mapping from them to ontology and focuses on semantic processing of requirements by re-usable parts using ontology techniques and developing techniques that enable us to elicit semantically correct requirements and to select the implementation structures that are semantically suitable for those requirements. This approach has an ontology system that concrete structure is the thesaurus of domain-specific words for each problem domain. In our methodology requirements are elicited based on the ontology or more concretely the ontology system guides the analysts' activities to elicit requirements. As a result the meaning of the elicited requirements can be represented with a set of relevant words included in the ontology system. reusable parts also semantically related to words in ontology system that is the meaning of each reusable part is provided by the ontology system consequently our ontology system has two layers (one for requirements elicitation) two (for re-usable parts) by establishing relationships between the two layers.

Hagal and Kandemili [3] Proposed a systematic approach for eliciting user requirements in a simplified manner that will encourage software developers not only to elicit user requirements but also to improve the capturing and understanding of the potential requirements. the users would not be able to articulate will be helpful especially for the non-expert developers to elicit excellent requirement with little effort this approaches considered as empirical studies in software development lifecycle and show that one of the most important reasons for systems failures and result from the misunderstandings of the systems requirements and the late correction of these requirements that would be expensive. Figure 2 illustrate the approach.

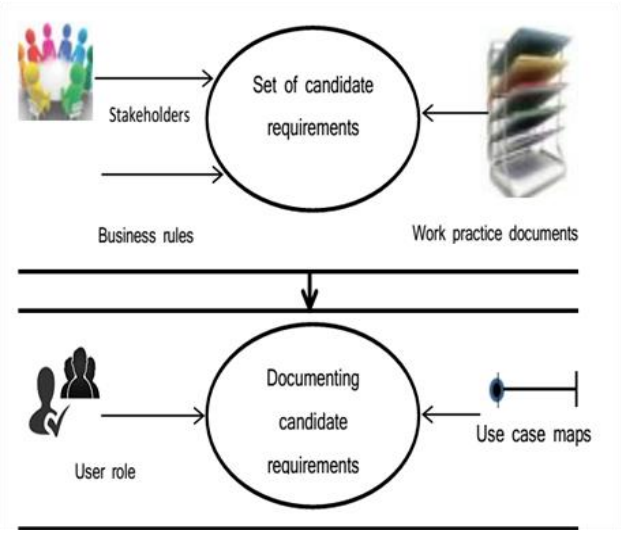


Figure 2 Approach for eliciting user requirements proposed by Hagal and Kandemili [3]

Stefan Farfeleder et al [4] Developed a prototype implemented using semantic guidance used to assist requirements engineers and capturing requirement using semi-formal representation and a semantic guidance system that uses concepts , relations , and axioms of domain ontology to provide a list of suggestions. Requirements engineer can build on to define requirements and semantic guidance system is evaluated.studies from the aerospace domain. The results show that the semantic guidance system effectively supports requirements engineers in defining well-structured requirements and is also intended to be the foundation for further analyses by facilitating. Figure 3 illustrate the prototype.

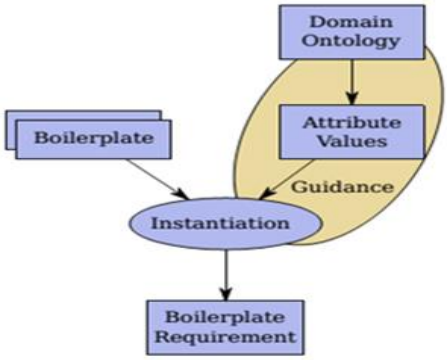


Figure 3 Prototype by Stefan Farfeleder et al [4]

Singh et al [5] Presents the main issues in requirement engineering about the sources and reasons for of ambiguity. They then present approaches used to avoid, detect, or measure ambiguity in any Requirement Engineering text then define the types of ambiguity in text and develop approach to detect ambiguity by using the following steps

- Use of formal specification language (formal mathematical method) for stating requirement specification
- Inspection technique (Based on checklist and scenario based reading)
- Using Natural language tools (NLP tools) for measuring and detecting ambiguity.

and use of formal specification language (formal mathematical method) for stating requirement specification. The formal methods techniques can be divided into two main categories , Model based methods and property based methods.

Mahmoud Abd Ellatif et al [6] provided a framework for reducing requirements errors during earlier requirement engineering activities and achieving software project's success with high quality. Furthermore, the framework represented the software project requirements in double layer presentation the first layer is the ontology layer that is constructed from textual requirements by using natural language processing software integrated with a java tool and protégé, an ontology modeling tool the second layer is the concept maps layer concept maps are generated. The first layer that contains ontology is a formal layer constructed based on a form of textual requirements to provide an explicit specification.

Yousef and Almarabeh [7] proposed a requirement elicitation framework starting with business organization process and build the a CRUD matrix which need possible relationships between entities , functions of the system and generated relationship between entities and functions. and evaluated using real case study the cancer care and registration in Jordan. Figure (2-1) illustrated the proposed framework.

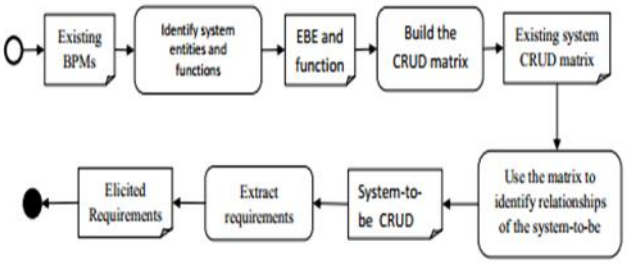


Figure 3 Framework proposed by Yousef and Almarabeh [7]

Elliott and Allen [8] Developed automated methodology with support for producing software requirements specification that includes requirements engineering data elements and presented as seven use cases and an ontological framework it also presents three empirical retrospective case studies. The case studies also demonstrated ontology is readily customized for various application domains. they conclude the ontological support is a promising way to enhance processes that produce a software requirements specification. and also ontology encoded data elements in the software requirements knowledge area of the to extract software requirements from Ontology Web Language

/Resource Description Framework OWL/RDF ontology and format them in simple text files. they then automatically create a software requirements specification document.

Vadim Ermolayev [9] Developed a methodology for evaluating the requirement engineering in elicitation fitness and completeness using existing ontology. The approach used in the reported research is based on the use of Onto Elect consider the methodology for ontology and refinement through workflow of ontology and contains three phases are elicitation, requirements conceptualization, and ontology and evaluation elicits the set of terms extracted from a collection of documents in the domain and using term significance in the form of numerical scores and the mappings between the elements in the requirements and ontology elements.

Nguyen et al [10] Developed a framework has a method of detecting inconsistencies of requirements engineering , Knowledge base Requirements Engineering (KBRE) in domain knowledge and semantics of requirements in elaboration, structuring, and management of captured requirements and present how they facilitate the identification of requirements inconsistencies and other related problems in KBRE model and description logic applied of Ontology Web Language Syntax.

Graaf et al [11] Approach that involves the typical questions for eliciting and constructing an ontology. depend on eight contextual factors especially in complex software projects, with diverse Architectural Knowledge (AK) tested by case study and report can be used for acquiring and modeling (AK) needs. The resulted shows can improve (AK) descriptions and retrieval by typical question ,this approach is based on the involvement of different roles to resolves the conflicting and interpretations between role and supports different forms.

Amel Mammar et al [12] method are a goal-based approach building of an initial formal model (in Event-B) is driven by goal-oriented requirements engineering model. to enhance the goal model in order to obtain more complete formal specification of domain of ontology in order to share common understanding of the structure of different applications this propose useful for complex systems and describe how ontology and the structural model are translated into Event-B this propose illustrated through a landing gear system.

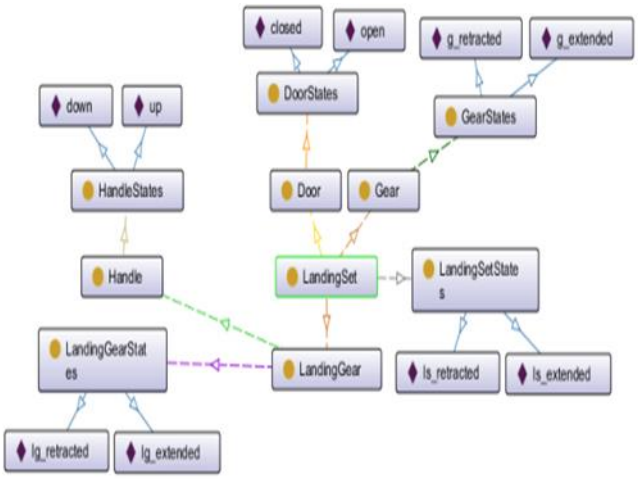


Figure 4 landing gear ontology [12]

Guizzardi et al [13] Work is based on the definitions of the foundational ontology. Furthermore, based on these ontological definitions and it provides guidelines for distinguishing between non-functional requirements and functional and sketch syntax of specification language that can be used for capturing (NFRs) it discusses how these interpretations differ from existing RE approaches to non-functional the distinction between NFR and FR is hard goals and soft goals. Traditionally, hard goals and soft goals a hard goal is a proposition that is objectively satisfied by a given set of situations. In contrast, a soft goal is an initial and temporary vague expression of intention before the goal at hand is properly refined.

Rashwan et al [14] Develop novel method by manually annotated for sentence and classification of requirements. And focuses on non-functional requirements and can be used for many automated analysis tasks. also worked to improve semantic tool and support for the domain of requirements engineering. Furthermore they developed a new classification algorithm for the automatic categorization of requirements in software specifications the results of this

work will be of interest to researchers as well as practitioners from industry who are interested in estimating the effort for building requirements in general and improving software quality in particular and use measurement data in requirements engineering. In addition used the ontology to transform software requirements documents into a semantic representation automatically and to estimate the cost of the software system.

Morales-Ramirez et al [15] develop novel (user feedback ontology) describe in Onto-UML and focuses on online feedback given by users experience in using a software service or application from different customer. The evaluation that is expressed in terms of quality price and comparison of similar products. To check people to buy (or not) the product as the summary of product and user feedback usually concerns questions on technical details about the software experience. Ontology applies to online user feedback in general added specific entities that are needed when we consider user feedback in software application domain. Ontology has been used to give a full account of the concepts needed to describe user feedback and its analysis in several application scenarios. These scenarios consider as the different presentation formats of user feedback. Namely and unstructured semi-structured and structured text as well as manual and semi-automated analysis of user feedback. as performed in requirements engineering tasks and then described how we evolved the ontology through an iterative validation process with the goal of improving its modeling quality by eliminating possible anti-patterns in OntoUML models. Moreover used the analyzer for generating instances of the concepts of the user feedback ontology and validate a true correspondence of the concepts and their relations against the real world.

Rastgoo et al [16] developed approach for automated generation of requirements ontology using unified modeling language (UML) diagrams in service oriented architecture (SOA). The goal of this paper is to converted progress of software engineering processes like software design and software reuse and service discovery to (SOA) and the proposed method is based on four conceptual layers The first layer (includes requirements achieved by the stakeholders like functional requirement and non-functional requirement) the second layer (design service-oriented diagrams from the data in the first layer) and extracts Extensible Markup Interchange codes from them. The third layer (includes requirement ontology and protocol ontology) to describe the behavior of services and relationships between them semantically. The forth layer (makes standard the concepts that exists in the ontology of the previous layer) also this method can extended to other design diagrams such as sequence diagrams and activity diagrams.

Sanya and Shehab [17] develop a knowledge-based engineering framework (KBE) that enabled product design systems. within the aerospace industry, the aim of this paper is to strengthen the structure reuse and portability of knowledge consumed within (KBE). The proposed framework uses an ontology based approach for semantic knowledge management and adopts a model driven architecture and uses the following phases (1) Capture knowledge required for KBE system; (2) Ontology model construct of KBE system; (3) Platform-independent model (PIM) technology selection implementation and (4) Integration of PIM KBE knowledge with computer-aided design system.and also this paper has illustrated the need to address the portability quality attribute non-functional requirement of (KBE) system and ensure this is reflected in the KBE system architecture.

2.1. The proposed Framework

The conceptual design builds to facilitate the stakeholders and software engineer to elicit the functional requirement about the specific domain and give more information about the words and terminology around that domain by using ontology. The main component of architecture design is:

Stakeholders Component: is people who sharing information about is specific system in specific domain. the stakeholders determine the needed of output of the system and familiar about the any details of the system.

Software engineer Component: is engineer of information gives from stakeholder to put this information in requirement for the system by using methods and tolls to design the system.

System Domain Component: The system domain is general component of the one domain. The system domain in framework include the specific activities of one organization or one company in filed. the stakeholders in domain familiar with all activities of the system and any report that use in system or any transaction that used in system.

RDF Component (Resource Description Framework) is standard model of data interchange on the web. RDF schema facilitate data merging in framework. the software engineer builds the RDF schema according to the information gives from stakeholders the software engineer but this information in format of requirement engineering.

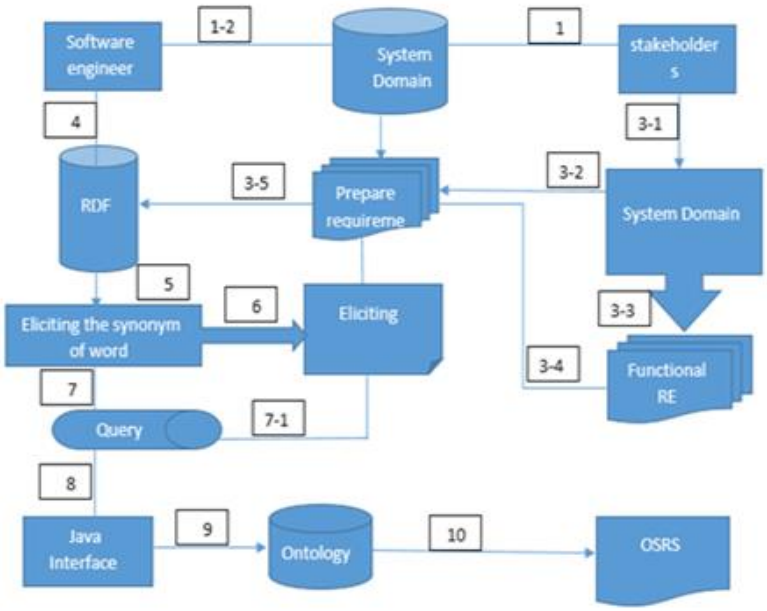


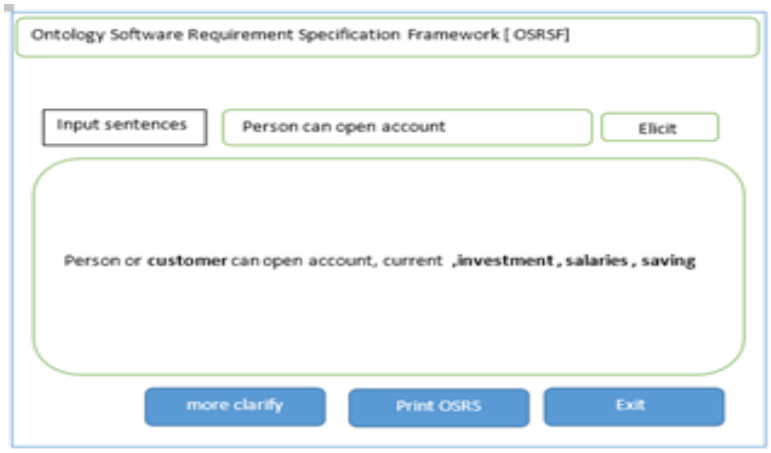
Figure 5 The proposed Framework Daigram

Prepare Requirement Component: the prepare requirement is a shared process between stakeholders and software engineer and other participate in system and divided in to three categories Categories One stakeholders: the role of stakeholders is collect information about the system and determine the functional requirement, and other polices that used in system. Categories Tow software engineer: the software engineer plays important role in this phase where does ordering the information in last format of requirement engineering and determine what is information must be in build in RDF. Categories Three Other participant: the other participant combines information about external transaction that included in the system. and other reported that selected form the expected system.

Functional Requirement Component: is a description of the services that the software must be offer and describe in high level abstraction, in framework the component of functional requirement determines between stakeholders and software engineer. in main point held all the functional that must be offer in the new system. these functional requirements can be (information, transaction, calculation, maps, etc.).

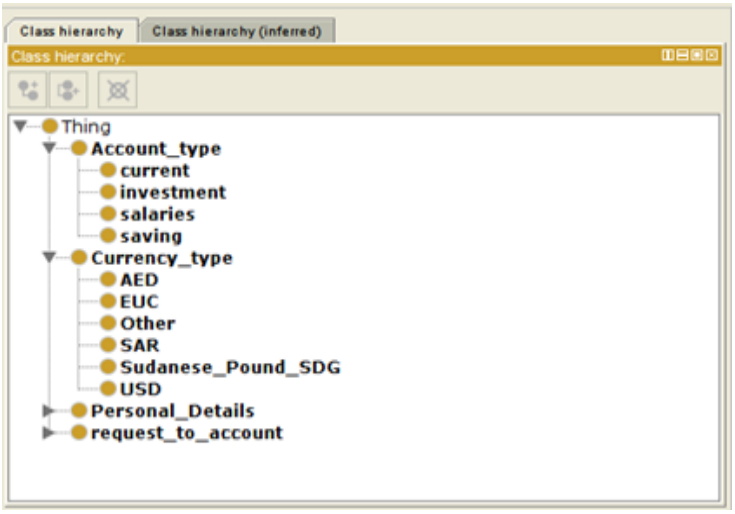
Eliciting the Synonym of Words Component: eliciting synonym of words by java program through interface, this interface designed to input the statement the statement is in general requirement, but according to specific domain must be analysis, the process of eliciting is determining the classes who build in RDF, the process of detect the synonym of word include three steps: Step One: build the statement in success format without any wrong in splining or increase or descries any latter.

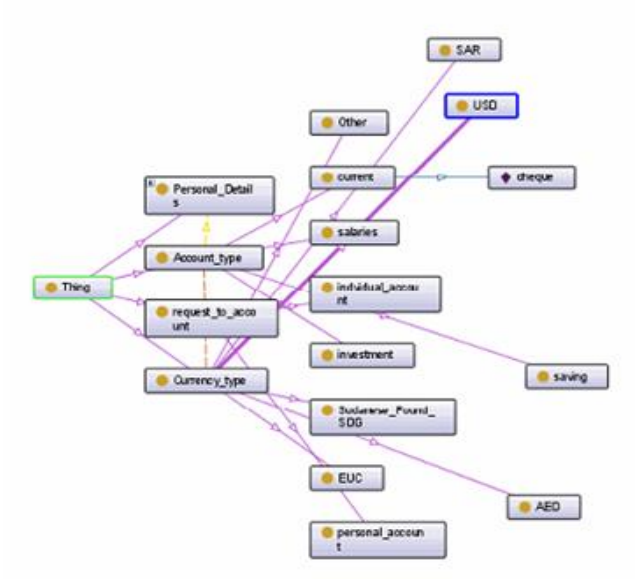
2.2. Experimental Setup

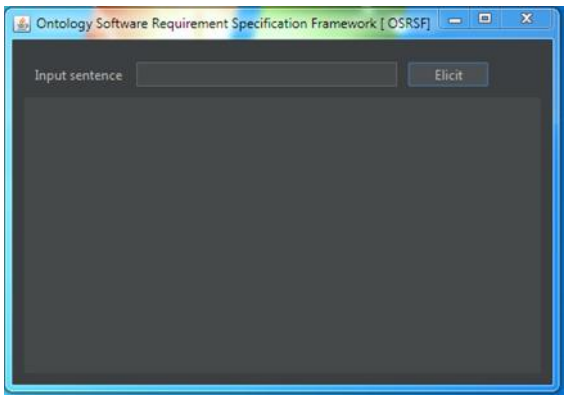


2.3. Framework evaluation

The framework evaluation using case study in banking domain. the banking domain has many types of requirement. the framework uses the functional requirement.



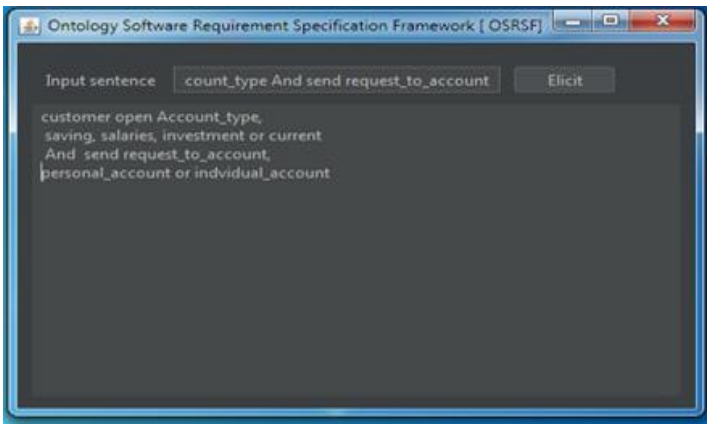




3. Results and discussion

The following statement are requirement Customer open account.

The above statement has different ways to an elicit the last statement that used for the software.



The above results show the statement in three ways.

The first one the software engineer input the requirement in the form of statement the second step the framework compare the input statement that inputted from the software engineer with the ontology.

Table 2 The Output of the Statement with More Information.

Statement	Relation	Elicit	Output
Open account	Yes	Account Type	Saving , investment
Bank	Yes	Bank Name	Name

Remove the Semantic ambiguity the framework gives more information about one-word e.g. the bank receives the customer request. these statement has semantic ambiguity in word (bank) the framework retrieve the word from ontology with relation.

3.1. Discussions

This paper deals with developing a framework to support requirement elicitation process using domain ontology. and use protégé software to implement the ontology using domain in banking system. the protégé has given more information about the relation between the word. the process of elicit the requirement is easy by using the proposed framework due to more information that obtained about the statement already entered by end user. the final result has provided various meaning which can used as synonyms of words. The software requirement specification elicited from framework. The result of the statement “The customer open account”, the account has many types, the framework addresses the result as, “the customer open account the account has saving account, salary account, saving account”.

4. Conclusion

In this work an implementing framework using domain ontology to elicit the software requirement, the framework enable the software developer and stakeholders to choose the requirement easy by adding more information about the words. the frame conducted by case study in banking domain and show results that prove the framework helps the software developer and stakeholders to elicit the requirement due to ontology has given information about the statement has entered in the framework.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declare they do not have conflict of interest.

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