A Semantic Web Engineering Model

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Abstract—Web Engineering provides the systematic approach to the development of web applications. The Semantic Web is the extension of current Web and further the Semantic Web applications can be considered as the augmentation of web applications with ontological annotations. But, the efficient, reliable and systematic development of semantic web based systems cannot be performed using existing web engineering models only. The engineering and systematic approach for the development of semantic web applications can be called as semantic web engineering. In this paper, the work has been done to propose a life cycle model for the systematic development of semantic web applications. The implementation and validation corresponding to the proposed model has also been performed.

Keywords—Ontology, Semantic Web, Semantic Web Engineering, Web Engineering

I. INTRODUCTION

The document semantic web is an evolving development of the World Wide Web in which the meaning of information and services on the web is defined, making it possible for the web to understand and satisfy the requests of people and machines to use the web content. It is usually observed that the semantic web is lacking methodologies for development of semantic web applications. We argue that existing methodologies are no longer relevant for the systematic development of semantic web based applications. The work has been done to identify and analyze the deficiencies in the web engineering model that make it unfit for the development of semantic web applications. Based upon this analysis, an engineering model for the systematic development of semantic web applications has also been presented.

The paper has been structured as follows. Apart from introduction in section-1, the section-2 presents basics of the current web and the semantic web. The brief descriptions of the difference between web engineering and semantic web engineering is presented in Section-3. Section-4 presents proposed engineering model for the semantic web applications. Section-5 presents the comparison of our proposed engineering model to other existing semantic web models. The paper has been concluded in Section-6.

II. WEB AND SEMANTIC WEB

The current web can be characterized as the second web generation. It was meant for direct human processing. The third generation web, which one could call the semantic web, aims at machine process able information. Semantic web may be compared with current web as shown in Table I.

TABLE I

<table>
<thead>
<tr>
<th>CHARACTERISTICS DIFFERENTIATING SEMANTIC WEB FROM CURRENT WEB</th>
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<tr>
<td>Current Web</td>
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<tr>
<td>Current web content are machine-readable but not machine understandable.</td>
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<td>Current web is just like a book, having multiple hyperlinked documents.</td>
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<td>Current web have only visual design and shared functional languages that does not allow any existing knowledge representation system to be exported onto the web [2].</td>
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<tr>
<td>Current web is called a web of documents containing data.</td>
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<td>Resource utilization is minimum i.e. web resources are not annotated properly by the metadata.</td>
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<tr>
<td>It has been determined that inaccessible part of the web is about five hundred times more than what search engines find [4].</td>
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<tr>
<td>The information searching, accessing, extracting, interpreting and processing from the current web is difficult and time consuming.</td>
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</table>

III. WEB ENGINEERING AND SEMANTIC WEB ENGINEERING

This section presents the differences between the web engineering and semantic web engineering. In today’s scenario, the most of web content is designed for humans to read, not for computer programs to manipulate meaningfully. In general, computers have no reliable way to process the semantics. The semantic web will bring structure to the
meaningful content of web pages, creating an environment where software agents roaming from to page can readily carry out sophisticated tasks for users [3]. To date, the web has developed most rapidly as a medium of documents for people rather than for data and information that can be processed automatically.

The semantic web aims to make up for this. It means that semantic web contains both characteristics web of documents containing data as well as web of ontologies. Ontology provides structural knowledge of a domain and its data in the machine-understandable form [1]. A web application, equipped with ontology, is usually referred as Semantic web application [5]. To develop such application, an engineering approach that is more efficient than the existing approaches used for the development of web applications i.e. Web engineering. This idea of the new engineering approach providing systematic method for the development of semantic web applications can be referred as semantic web engineering.

Difference between semantic web engineering and web engineering has given below:

Current web applications are primarily oriented toward human users; operate using unstructured data with informal logic and links between documents. On the other hand, semantic web applications are oriented toward human users and machines, operate with structured formal statements, and use a formal descriptive logic with the links between data [1].

The outcome of web engineering process are web applications that provide web pages that can be displayed in web browser but these applications lack semantic markup. Whereas, the outcome of semantic web engineering are web applications that provide the web contents in machine-understandable form displayed through the web browser as well as with machine-understandable metadata process able by the computer system.

![Fig.1 Proposed Engineering Model for Development of Semantic Web Based System.](image_url)

IV. PROPOSED SEMANTIC WEB ENGINEERING MODEL

Semantic web based system and applications consist of machine understandable content as well as human understandable content. The proposed engineering models have focused on both of these points. Fig. 1 shows a proposed engineering model for the development of semantic web based system and applications. There are two major activities carried out parallel- generation of web pages and construction of logical content.

The details description of the generation of web pages activities is carried out in our last work [6]. There are focuses on the construction of ontology activities. The ontology development activities mainly consist of five phases: Analysis, Design, Implementation, Integration & Testing and Documentation & Evaluation [5] [7]. All these phases are described as:

For developing semantic web system, a new model called a preliminary web ontology model should be prepared at analysis phase. This model captures all requirements.
necessarily to develop web ontology of particular domain in order to enable content and descriptive knowledge of that domain in machine process able format. At design phase, a web ontology model should be prepared. It contains formal description of preliminary domain model produced in analysis and it may contain instance data as well. Both of these are represented as a set of triples and these can be shown in the form of graph. Each resource and its instance are represented using a set of statements describing the same resource. Since ontology is based on Resource Description Framework model, therefore there design a model so-called RDF model, from preliminary ontology model generated in previous phase.

Ontology implementation requires the use of an environment that supports the ontology. Jena [8] framework is used for this purpose. The result of this phase is the ontology codified in a formal language such as RDF and OWL language. The generated OWL ontology has been validated using the Altova Semanticworks2011 [9]. Altova Semanticworks2011 [9] also allows graphical representation of ontology document as shown in Fig. 2. The output of web engineering standards and ontology construction standards are integrated at integration phase. After the integration, testing activities are carried out. Therefore, integration and testing is performed to produce a machine understandable as well as human understandable final product.

Documentation and Evaluation activities are carried out during the whole life cycle of the semantic web engineering model as Fig. 1 shows. In fact, after each phase documentation document are prepared. In evaluation document the ontologist describe how the ontology has been evaluated, the kind of errors found in each activity, and the sources of knowledge used in the evaluation.

![Fig. 2 The graphical representation of valid Ontology at RDF/OWL level.](image)

V. COMPARATIVE EVALUATION

The work has presented semantic web engineering model for the systematic development of semantic web based system and applications. The works by Geralc Reif et al. [10], Peter Plessers et al. [11] and Amjad Farooq el al. [12] have also presented model for semantic web applications development.

WEESA- Web engineering for semantic web applications have presented by Geralc Reif et al. [10]. It generates semantic annotations by defining a mapping between the XML schema and the existing ontologies. WEESA cannot directly use domain ontologies created/reused during the web design process, but instead need to define this mapping regarding less if a domain ontology was used during the design process or not. Data modeling is done twice: once in the XML schema, once in the domain ontology used.

Peter Plessers et al. [11] have presented semantic web development with web site design model (WSDM). In this approach object chunk entities are mapped to concepts in the ontology. The WSDM extension also enables the annotation of dynamic pages. Mismatches in granularity are tackled with the help of intermediate ontologies which can only be used to concatenate object chunks and does not allow any further flexibility to address the granularity problem. They have not provided how to developed new ontology. But, their main is mapping and annotation, using existing ontologies.

A process model for developing semantic web systems have presented by Amjad Farooq el al. [12]. Their work has not provided any implementation corresponding model. A very limited discussion is only given on how to develop the ontology for during semantic web system development.

In addition, none of the above discussed works presents methodologies for design new ontology during semantic web application development. Further, these works have not based on the principles of software engineering and they cannot be considered as a complete software development methodologies. Due to these factors, the presented engineering model can be more efficient model for semantic web application development.

VI. CONCLUSION

The work has proposed an engineering model that can be used for the systematic development of semantic web applications. The key consideration of our model is that ontology should be developed according to software engineering principles. The main motive is the augmentation of web applications with ontological annotations. The presented model can be used for the systematic development of semantic web applications. Corresponding to the proposed model, the comparative analysis has also been performed with the existing reported work. The future work will involve the development of more complete and efficient life cycle model for semantic web based system development.

REFERENCES


