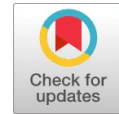# Semantic Web Enabled GUI SPARQL CRUD operation on VPS with Integration of Apache Jena Fuseki Server

Priya R. Swaminarayan, Ronak Panchal

Abstract: **The most important affecting factors to World economy include knowledge, proficiency and inventiveness of people. Education is allied with improved skills, and better human capacity to progress the quality of life. The development of country depends on the status of higher education in country. Every year, MHRD, India collects details about Higher Education from universities using AISHE Portal to plan National Policy on Education but in the existing AISHE system, user interface is not provided to the users; they are downloading PDF file from Portal and then after entering necessary details in PDF file offline they upload PDF file on portal. Here we have implemented Semantic Web Enabled System on Apache Jena Fuseki Server using Virtual Private Server (VPS). Researchers provide knowledge based AISHE user friendly system with GUI interface & implemented CRUD operation on VPS. Proposed AISHE system provides benefits of SW such as machine understandability, reusability, interoperability, inference of new knowledge, reduces development time etc; as Ontology is used for development.**

Index Terms: **Semantic Web, AISHE, Virtual Private Server, Apache Jena Fuseki Server, CRUD Operations.**

I. INTRODUCTION AND MOTIVATIO

Today, global wealth is less concentrated in factories, lands, tools and machinery. The most important affecting factors to World economy include knowledge, proficiency and inventiveness of people. Education is allied with improved skills, higher efficiency, and better human capacity to progress the quality of life. One of the factors for development of any country depends on the status of higher education in country. Malcolm Gillis, President of Rice University said that - "Today, more than ever before in human history, the wealth or poverty of nations depends on the quality of higher education. Those with a larger repertoire of skills and a greater capacity for learning can look forward to lifetimes of unprecedented economic fulfillment."

A. Introduction to AISHE

One of the factors for development of any country depends on the status of higher education in country. Being a developing country, India needs to stand with the other countries in the field of Education. Every year, Ministry of Human Resource Development Government of India (MHRD - Ministry of Human Resource Department) (MHRD, 2018) collects details about Higher Education from various institutes, universities using AISHE Portal developed by National Informatics Center (NIC) to formulate the National Policy onEducation (AISHE_MHRD_Wikipedia, 2011). In Budget- 2016, Finance Minister Arun Jaitley announced a marginal increase of 4.8 per cent in the overall budget for education, with a bigger thrust on improving Higher Education. The government earmarked Rs 72,394 core for education against Rs 69,074 (budget estimate) provided last year. Among this, Rs 28,840 core went to higher education and Rs 43,554 crore to schools. In short, AISHE helps to MHRD for getting information about the status of higher education in India and formulating the National Policy on Higher Education.

B. Review of Work Already Done

Researchers have studied AISHE Portal and find innovative way to collect data from Higher Education institutions and then MHRD plans National Policy on Higher Education by adopting emerging Technology – Semantic Web:

- To depict the status of higher education in the India, Ministry of Human Resource Development (MHRD) has ventured to carry out an annual web-based All India Survey on Higher Education in India.
- Education (AISHE) since 2010-11. The survey includes all the Institutions in the India engaged in imparting higher education. In the survey, various types of data are being collected on several factors such as programmes, students, teachers, examination results, infrastructure and finance. Indicators of educational development such as Institution Density, Gross Enrolment Ratio, Pupil-teacher ratio, Gender Parity Index, Per Student Expenditure are also calculated from the data collected through AISHE. These all are very much useful in finalizing policy decisions and research for development of education sector in country.
- National Informatics Center (NIC) has developed AISHE Portal for getting information from academic institutes and universities.
- Semantic Web based knowledge representation system doesn't exist for AISHE Web Portal.

In this paper, the researchers make alternative AISHE portal using Semantic Web for collecting relevant information from Higher Education Institutions. In the proposed system – AISHE Portal will offer additional features and take advantages of Semantic Web Technology.

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The Semantic Web technology has proven several benefits such as machine understandability, reusability of domain knowledge, interoperability, knowledge representation using schema, mapping of schema to an upper ontology, inference of new knowledge from existing, reduces development time, increases reusability etc.

II. PROPOSED SYSTEM

In this paper, authors have proposed Semantic Web enabled system which supports SPARQL CRUD (Create, Read, Update and Delete) operations on Virtual Private Server (VPS) with the integration of Apache Jena Fuseki Server. It's a user friendly GUI system.

A. Major steps for Implementation of Proposed System:

1) Development of AISHE Ontology using below sub steps **(Priya, 2012)**
   a. Determine the scope of the Ontology
   b. Define concepts (classes) to be modeled in Ontology and relationship among them
   c. Reuse concepts which are available in similar existing Ontology, if any.
   d. Arrange the concepts in a hierarchy (sub class-super class hierarchy)
   e. Determine attributes and properties (slots) for each class and constraints on their values
   f. Define instance and fill the slot values for each class.

Here authors have identified related entities such as University, Course, and Statutory Body etc. for the development of AISHE Ontology.

Here authors have developed ontology in rdf file format using protégé tool. Protégé is a knowledge based framework and Ontology Editor. It's a free and open source tool for the Ontology Development **(protegewiki.stanford.edu/wiki/Main_Page, 2015)**. The Protégé platform offers two different ways of ontologies development via the Protégé-Frames and Protégé-OWL editors. Protégé ontologies can be exported into a various format which include RDF, RDFS, OWL, and XML Schema **(Stanford University, 2009)**.

> Protégé is extensible and based on Java, and provides a plug-and-play environment that makes it more flexible for quick application and prototyping development **(Stanford University, 2009)**.

2) Design front-end side GUI web based application in PHP (Hyper preprocessor) with use of EasyRDF library (Humfrey, 2018)
3) Design back-end which stores information in AISHE ontology dataset.

Note: Earlier authors used AISHE Ontology from localhost **(Ronak & Priya, 2017)** but as per the

requirement of MHRD, information about Higher Education must be gathered from the heterogeneous environment. Then researchers asked many hosting providers such as GoDaddy, Amazon Web Server and many more, for uploading ontology dataset. But they do not have this facility in their control panel. Finally, authors have purchased Virtual Private Server (VPS) for implementation of Apache Jena Fuseki Server with domain name.

B. Implementation of Proposed System – Data Publishing and Access

Researchers have collected details about Virtual Private Server and its FTP (File Transfer Protocol) from web hosting provider. Authors have used Putty Software to access Virtual Private Server. Researcher enters host name or IP address and 22 as port number in Putty server with connection type of SSH. As per the Wikipedia, "Secure Shell (SSH) is a cryptographic network protocol for operating network services securely over an unsecured network." (SSH_Wikipedia, 2018)

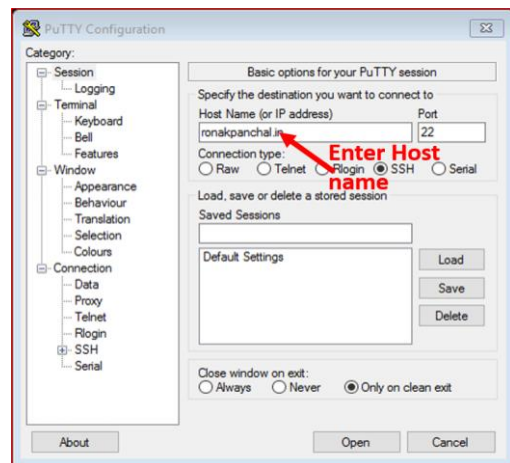***Step-1:*** *Access Virtual Private Server using Putty with SSH Login*

Figure 1: Login Page

Step-2: *Download JAVA and install on Virtual Private Server.*

Then download Java Development Tool Kit (32 bit or 64 bit - (http://oracle.com)

$wgethttps://...urllink..../jdk-8u181-linux-x64.tar.gz (StackOverflow, 2018)

and extract tar.gz using tar command

$tar zxvfjdk-8u181-linux-x64.tar.gz

Then set java environment and checkjava –version.

Step-3: *Now, Download Apache Jena Fuseki Server and install on VPS (LAMP_setup_on_VPS, 2018)*

If java installation completely finished, then only download Apache Jena Fuseki Server from terminal, the steps are following:

After downloading successfully, save in your root.

$tar vzxf apache-jena-fuseki-3.8.0.tar.gz

Extract tar file and rename apache-jena-fuseki-3.8.0 file with fuseki name.

Step-4: *Make necessary changes in shiro.ini file inside fuseki folder (Apache_Software_Foundation, 2018)*

Then modify shiro.ini file which is in run folder and

/$/server =anon line above /4/** = localhostFilter**. (Kaye, 2016)**

```
[roles]
[urls]
## exposed to any person
/$/status = anon
/$/ping   = anon
## and the rest are controlled to localhost.
/$/server =anon
/$/** = localhostFilter
## Researcher provides the general configuration.
##If you want guideless, basic confirmation user/password
##Login Credencial
## on the operations,
## This configuration is very important when anyone setup apache jena fuseki server
## on virtual private server (VPS)
##    1 - set a recovering password in [users] above.
##    2 - comment out the "/$/** = localhost" line and use:
```

```
## "/$/** = authcBasic,user[admin]"
## or to allow any access.
##/$/(double-start)** = anon This line is very import in shiro.ini file
## without this configuration
##user is not able to see GUI
# Everything else
/**=anon
```

Step-5: *Create dataset and open Apache Jena Fuseki from Web Browser*

Then run and create dataset in fuseki server on command line. Enter following statement on command line

./fuseki-server --update --mem /AISHE

Then open AISHE dataset (Ontology) in Web Browser by using http://ipaddressofvps:3030/

Open GUI of apache jena fuseki server then upload rdf or owl (Note: use only owl or rdf file)

Note: use either owl or rdf file and in this dataset we have uploaded rdf file.

OR

Alternative way to open apache jenafuseki server is to convert AISHE ontology into tdb. (**Apache_Jena_Feseki, 2018**)

```
step-1: ./fuseki-server --update --mem /aishephd (datasetname)
step-2: create folder for dataset.tdb file (ontology rename and hosting in dataset folder)
step-3: owl file save as .tdb file and upload local tdb or url tdb file inside folder
step-4: java -Xmx1200M -jar fuseki-server.jar --loc=FolderName(like DBAISHE) /aishephd
step-5: fuseki server started (remotely)
[2018-08-31 12:30:35] Server    INFO  Running in read-only mode for /aishephd…..
[2018-08-31 12:30:35] Server    INFO  Apache Jena Fuseki 3.8.0……………………
[2018-08-31 12:30:35] Config    INFO  FUSEKI_HOME=/root/fuseki/……………..
[2018-08-31 12:30:35] Config    INFO  FUSEKI_BASE=/root/fuseki/run…………..
[2018-08-31 12:30:35] Config    INFO  Shiro file: file:///root/fuseki/run/shiro.ini......
[2018-08-31 12:30:36] Config    INFO  Template file: templates/config-tdb-dir……
[2018-08-31 12:30:36] Config    INFO  TDB dataset: directory=DBAISHE………..
[2018-08-31 12:30:38] Config    INFO  Register: /aishephd…………………………
[2018-08-31 12:30:39] Server    INFO  Started 2018/08/31 12:30:39 EDT on port 3030
```

Now it provides access to GUI of Apache Jena Fuseki through IP address of virtual private server.
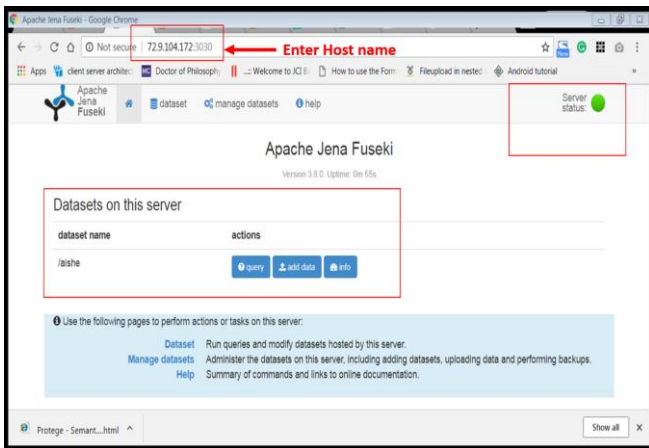

Figure 2: Access to Jena Fuseki Server thorough IP Address

III. ANALYSIS MODULES

Researchers scrutinize ontology classes, Data Properties and object properties from AISHE existing portal and following is the snippets of AISHE Ontology.

```
<?xml version="1.0"?>
<!DOCTYPErdf:RDF [
<!ENTITY owl "http://www.w3.org/2002/07/owl#" >
<!ENTITY www "http://www.ronuphdswaishe.org/" >
<!ENTITYxsd "http://www.w3.org/2001/XMLSchema#" >
<!ENTITYrdfs "http://www.w3.org/2000/01/rdf-schema#" >
<!ENTITYrdf
"http://www.w3.org/1999/02/22-rdf-syntax-ns#">
]>

<rdf:RDFxmlns="http://www.ronuphdswaishe.org/"
xml:base="http://www.ronuphdswaishe.org/"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:www="http://www.ronuphdswaishe.org/"
xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
<owl:Ontologyrdf:about="http://www.ronuphdswaishe.org/"
/>
<!-- //Example of Object Properties -->

<!-- http://www.ronuphdswaishe.org/isAffiliatedTo -->

<owl:ObjectPropertyrdf:about="&www;isAffiliatedTo">
<rdfs:domainrdf:resource="&www;Institution"/>
<rdfs:rangerdf:resource="&www;University"/>
</owl:ObjectProperty>

<!-- // Example of Data properties -->
<!-- http://www.ronuphdswaishe.org/codeOfCourse -->

<owl:DatatypePropertyrdf:about="&www;codeOfCourse">
<rdfs:domainrdf:resource="&www;Course"/>
<rdfs:rangerdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>

<!-- http://www.ronuphdswaishe.org/nameOfCourse -->
```

```
<owl:DatatypePropertyrdf:about="&www;nameOfCourse">
<rdfs:domainrdf:resource="&www;Course"/>
<rdfs:rangerdf:resource="&xsd;string"/>
</owl:DatatypeProperty>

<!-- // Classes -->
<!-- http://www.ronuphdswaishe.org/Course -->
<owl:Classrdf:about="&www;Course"/>

<!-- // Individuals -->
<!-- http://www.ronuphdswaishe.org/AICTE -->

<owl:NamedIndividualrdf:about="&www;AICTE">
<rdf:typerdf:resource="&www;StatutoryBody"/>
<codeOfStatutoryBodyrdf:datatype="&xsd;integer">1</code OfStatutoryBody>
<nameOfStatutoryBodyrdf:datatype="&xsd;string">All India Council for Technical Education</nameOfStatutoryBody>
</owl:NamedIndividual>
</rdf:RDF>

<!-- Generated bythe OWL API (version 3.5.0) http://owlapi.sourceforge.net -->
```

IV. ARCHITECTURE AND USER INTERFACE

A. Architecture

As shown in Figure – 3, the Web Application is hosted on Virtual Private Server and configures two servers on VPS **(Humfrey, 2018).** One is LAMP (Linux Apache MySql PHP) server and second is Apache Jena Fuseki Server. The EasyRDF Library configure on LAMP server & Knowledge based (such ontology owl and rdf file) AISHE dataset configure on Apache Jena fuseki Server. These two Servers communicate with each other by the SPARQL Query Process.
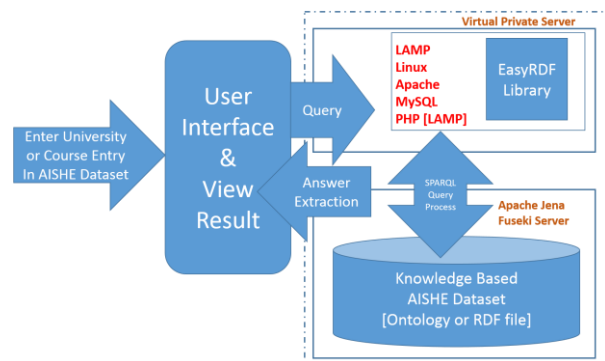

Figure 3: Architecture of partial Semantic Web Enabled AISHE system

B. User interface

After completion of all above processes, user can open live domain and then AISHE ontology can be accessed by user by entering Name of University or Name of Course through user interface and gets appropriate result from the AISHE System. Following are the some of the screen shorts for adding

Courses and modifying Course Details and also deletion of Course from AISHE system:
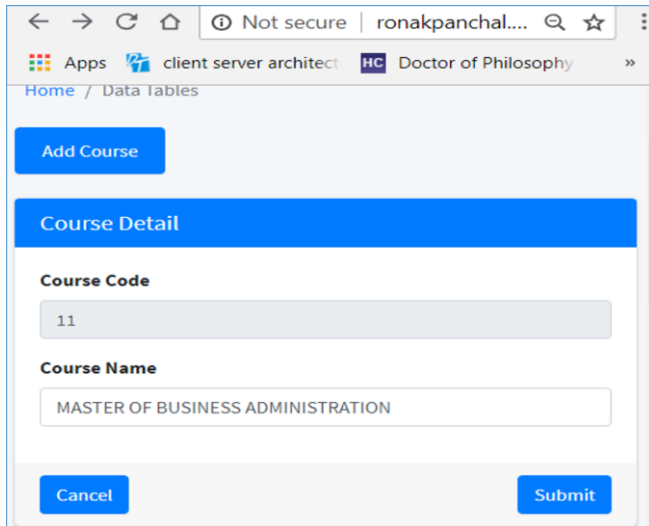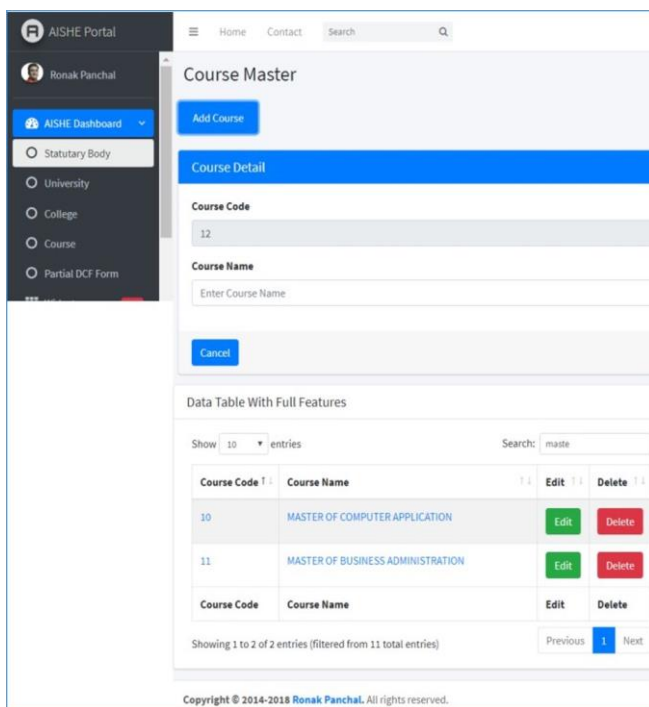

Figure 4: Add course and course detail

Figure 5: Modify and delete triplet of course

System use can also perform the CRUD (Create, Read, Update and Delete) operations and following are some of the snippets **(Anandavala, 2013)**

SPARQL Insert, Update, Delete and Display [CRUD] operation(Anandavala, 2013)	
1	**Display course information (Display Operation)**

	PREFIX ex: <http://www.ronuphdswaishe.org/>
	 SELECT ?code ?cname
	 WHERE
	 {
	   ?x a ex:Course .
	   ?x ex:codeOfCourse ?code .
	   ?x ex:nameOfCourse ?cname .
	 }

2	**Insert or Create course detail (CREATE Operation)**

	insert data
	 {
	     ex:Course1 rdf:type ex:Course .
	     ex:Course1 rdf:type owl:NamedIndividual .
	     ex:Course1 ex:nameOfCourse 'Master of Computer Application' .
	     ex:Course1 ex:codeOfCourse 10 .
	 }

3	**Update of course detail (Update operation)**

	Delete
	 {
	 ?y a ex:Course . ?y a owl:NamedIndividual . ?y ex:nameOfCourse ?name .
	 }
	 insert
	 {
	  ?y a ex:Course . ?y a owl:NamedIndividual . ?y ex:nameOfCourse 'Master of Computer Application'^^xsd:string .
	 }
	 WHERE
	 {
	 ?y a ex:Course . ?y a owl:NamedIndividual . ?y ex:nameOfCourse ?name . ?y ex:codeOfCourse '10'^^xsd:integer .
	 }

4	**Delete course detail (Delete operation)**

	delete where
	 {
	   ?y a ex:Course .
	   ?y a owl:NamedIndividual .
	   ?y ex:nameOfCourse ?name .
	   ?y ex:codeOfCourse '10'^^xsd:integer .
	 }

V. CONCLUSION AND FUTURE WORK

As mentioned in Introduction Section, National Informatics Center (NIC) has already developed **AISHE Portal** for getting information from academic institutes and universities but in the existing system of AISHE, user interface is not provided to the users; they are downloading PDF file from AISHE Portal and then enter college or university record in PDF file offline. In his research paper, the main advantage over existing system is: Researchers provide knowledge based AISHE user friendly interface system and also contains insert (create), update, delete and display operation on Virtual Private Server with knowledge base. So no need to upload and download pdf files but user can enter information online & also takes benefits of Semantic Web such as machine understandability, reusability of domain knowledge, interoperability, knowledge representation using schema, mapping of schema to an upper ontology, inference of new knowledge from existing, reduces development time, increases reusability etc.

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