Integration of RESTful Services in Agro Advisory System

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Abstract. There is a large amount of data related to agricultural practices being collected via different sources but it is not being u sed for maximum benefit for the farmers due to lack of mediums for the information to flow and other factors like language differences, lack of technology to access that information etc. Information Communication Technology (ICT) can helps to bridge that gap by creating systems that are easier to access and are able to answer the basic questions for the farmers which helps the farmers to increase the production of the crop. Such a system should make use of all the data sources available and provide processed information that makes sense to the user. We have developed ontology based Agro-Advisory System to fulfill these requirements. It is acknowledged based system. The knowledge base is maintained in the form of ontology. Ontology contains cotton crop knowledge. Ontology is integrated with RESTful web services to develop our system. Farmers can ask their queries related to cotton crop cultivation by Android mobile and get recommendations on their mobile which improves cotton crop productivity. The system is also able to send notification and alert to farmers if any adverse change in weather condition.

Keywords: RESTful services · Ontology
Semantic web · Recommended system · RESTful architecture

1 Introduction

In the domain of agriculture the farmers have mainly questions regarding which crop is to cultivate, the weather conditions, process to cultivate crop, and information regarding the disease and pest affecting the crop. It is not feasible for the expert to present physically every time to answer the queries of farmers. Due to which the farmers may not able to clearly understand the answer of expert for specific query asked by farmers. So there is communication gap between the farmers and expert. It is desirable to capture agriculture expert's knowledge in a system that understands farmer's queries appropriately and gives the recommendations for it. We have developed ontology based Agro-Advisory System to

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fulfill these requirements. Ontology is integrated with RESTful web services to develop our system.

RESTful services work seamlessly over the internet. They can be written in java languages and combined with various other technologies to build complex systems. The basic characteristics of web services are composition in which atomic services can be combined to form a new service that can answer queries without having to create them separately.

We have integrated such RESTful services with a variety of data sources. We are using Structured Query Language (SQL), Resource Description Framework (RDF) and Geographical data which are stored separately. We have written web services to retrieve the information, process them if necessary and display them on a mobile device or on a web browser in either plain text, tabular or map format.

2 KisanMitra: Ontology Based Agro Advisory System

We have build up system named KisanMitra which uses data sources such as knowledge base in the form of Ontology and Geographical data Sources. These data sources are integrated using RESTful services. KisanMitra gives answers to queries of farmers on their mobile regarding pest and disease prevention techniques to be used based on the query asked by frames, the information regarding weather condition, and soil. Our system is very much user friendly to farmers which requires very less training to use it.

3 Analysis and Design of System

We propose to create a mobile phone based and automated Agro advisory system for the cotton farmers in Gujarat state. To achieve this we will be using various concepts in ICT that will help us to create a feasible and useful solution. Figure 1 is proposed architecture of the system.

3.1 Components of System

The SQL database:- This database contains information which does not changes regularly. The database contains information regarding farm survey number, soil of farm, NPK ratio of farm, latitude and longitude of farm etc. The information will be entered by farmers during registration. The SQL database also contains weather information which is updated regularly by admin. The SQL Queries are run to fetch data from SQL database and stored on PostGreSql server database which is on cloud. The information stored on PostGreSql database available to user using available RESTful services.

The RDF knowledge base:- This is main components of system which contains knowledge base for the Cotton Crop. It contains information regarding Climatic

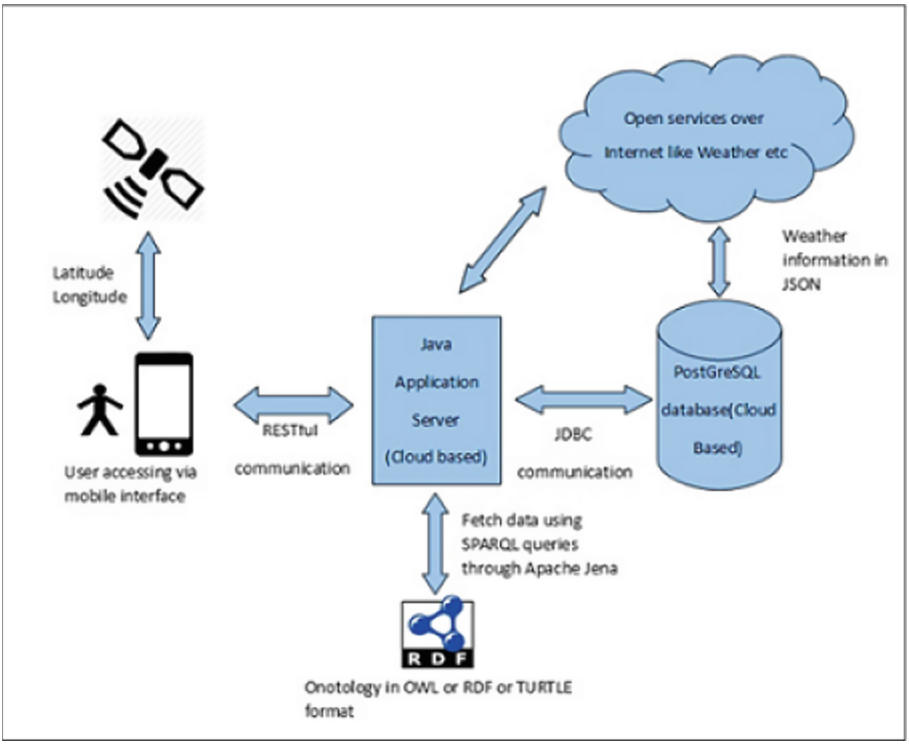

Fig. 1. KisanMitra system architecture

Condition, Disease and Pest affecting cotton crop, Irrigation techniques, Irrigation for cotton crop at regular interval, Pesticide and Insecticide to be used for Cotton crop etc. We are using SPARQL Queries and reasoners on the RDF knowledge base to generate the result for users queries. We have used Apache Jena [10] framework to retrieve the data from ontology through query and communicate the results of query using RESTful web services.

Geographic database:- It contains information regarding the farm location, farm latitude and longitude. The Geographical information stores in the POSTGIS database which is an extension of PostGreSql. This data helps to show the current location of farmer's farm on the Google Earth or Google Map. We have also added more information like farmers name shown with farm location, number of pest or disease on a farm. It will help farmers to better understand current and deduce patterns if any without analyzing a lot of tabular and plain text data.

RESTful Services:- This component drives whole system. The relevant data based on farmers queries are fetched from SQL database and RDF knowledge base and displayed to users on their mobile using RESTful services. The web services are using REST based architecture which is more suited to the world-wide web considering the similarities in the basic operations between the two.

We have used Java language and JAX-RS API for implementing RESTful web services. We have used Eclipse as an Integrated Development Environment for development of it. The RESTful services are deployed on cloud so that it can be accessible by user from their mobiles.

User Interface (UI):- KisanMitra system is having user friendly interface. The system can be accessible by using UI of our system. The user interface is made very simple which does not take lot of input from user manually. i.e. user can submit the input by using drop down menus instead of the user typing the values. We have also enabled our system with local language support so that farmers can enter their query in their local language. Less training is required to use our system due to good design of User Interface.

3.2 RESTful Services

The RESTful web services are used to fetch relevant information for farmer's query. The appropriate services are called based on the parameter passed. We have used RESTful architecture to implement web services. The output of web services is in the JSON format. The services can be invoked once URL is fixed on deployment. The JSON format output is further processed with JSON Parsing which is displayed on the mobile device or web browser of user.

SQL based web services:- These web services can be used to fetch information from the Structured Query Language databases. The Fig. 2 shows the SQL based web services.

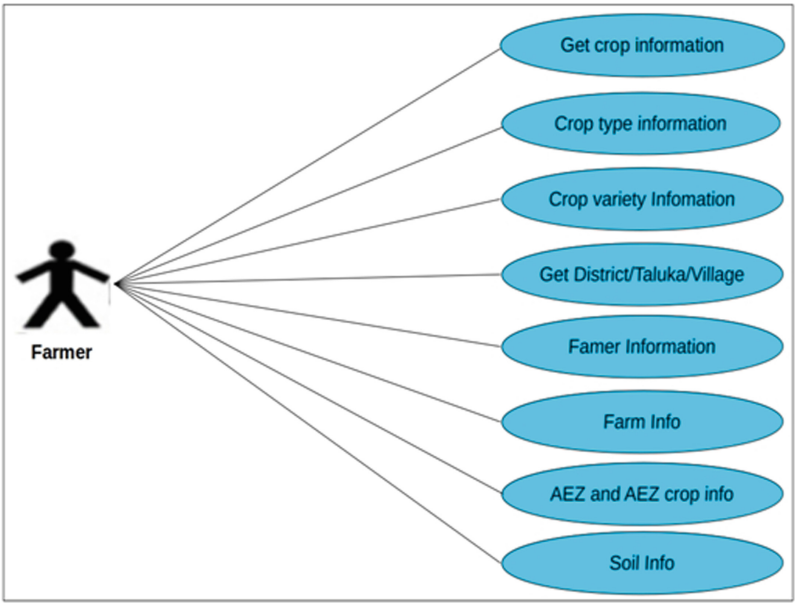

Fig. 2. SQL based web services

Location Based Service:- This service display the current location of the farm on Google Map based on the parameter passed as farm survey number or current location. The Latitude and Longitude is provided to display current location information of farm. The service can be accessed using URl would be: URL/services/AEZLocationInfo_Service/latitude. Figure 3 shows the flow of it.

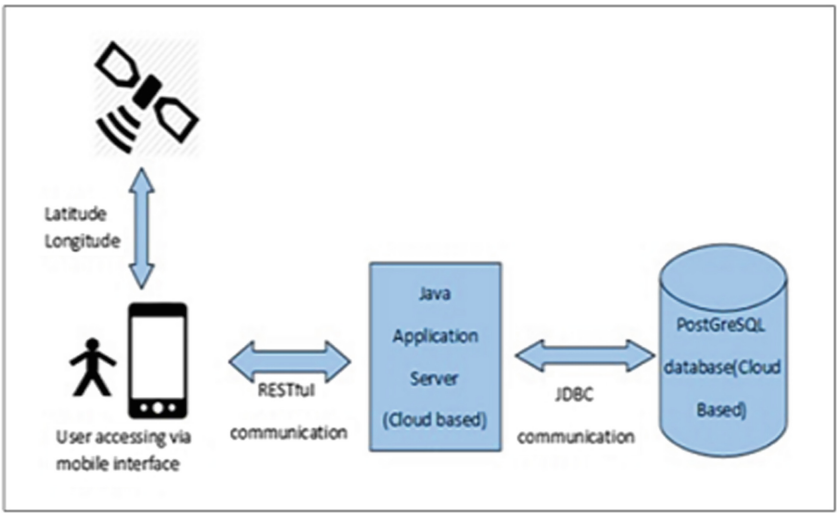

Fig. 3. Location based service

Weather Service:- This service gives information about the current climatic condition of the specific location. The location information is provided with Latitude and Longitude of specific location. This service does not require any human intervention. It is autonomous service. Figure 4 shows the flow of it.

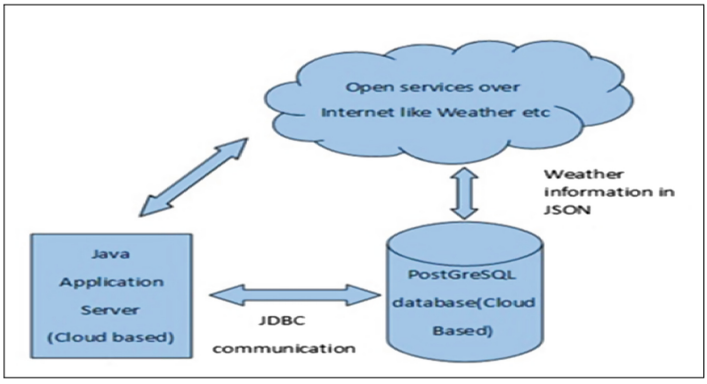

Fig. 4. Weather based service

4 Developing Mobile Interface and Web Service Integration

1. Mobile interface is developed for accessing the web services which displays the recommendation of query of farmers on their mobile. We have used mobile phones as a medium of interaction between the farmers and knowledge base which is in the form of ontology. As the Android operating system is widely used in most of mobiles. We have decided to created mobile application which runs on it. We have used Android studio version 1.4 to develop it. Our application has 3 major components:
   (a) Information centre: It provides all the information like farmer info, village info, weather info etc.
   (b) Recommendation centre: provides recommendations for farmer's query like pest preventions techniques for pest and cure for disease based on symptoms and observations on cotton plant.
   (c) Notifications and map data where the user can see all the notifications related to adverse change in climatic conditions which they received in mobile. A farmer can also see view of farm on their mobile. We have used google api services for it.
2. Adding RDF based data (OWL format) and preparing web services to query that data using Apache Jena Services that use RDF data to return recommendations to the user based on parameters provided. These services use the POST operation to transmit the SPARQL query so cannot be directly accessed via a web browser. Below are the services developed.
   (a) Disease cure by Observations appear on plant.
   (b) Pest and its prevention techniques by Observations.
   (c) Disease and its cure by symptoms.
   (d) Disease Observations, Pest Observations, Disease Symptoms and Disease Symptoms by part.
3. Android mobile interface is created which retrieve RDF data using sparql queries. We have made recommendation centre through which user can select the query.
4. Mapping of RDF and SQL entities, we have used two data resources, ontology and sql database to answer the query of farmer. To keep the system in

Table 1. RDF and data mapping

OWL/RDF concept	SQL table/attribute
Climate-Clouds	ClimateData-Description
Climate-Metrological Factors-Temperature-Max	ClimateData-max_tempreature
Climate-Metrological Factors-Temperature-Min	ClimateData-min_tempreature
Climate-Metrological Factors-Humidity	ClimateData-humidity
Crop-CropType	CropTypeInfo
Climate-Clouds	CropVarietyInfo
Soil	Soil

synchronization, we have performed a data mapping between the SQL and RDF data which is shown in Table 1.

5. Figures 5 and 6 showing the service composition designed for the current system: Here two services one to parse and other to query the RDF ontology is used to obtain the final result. This composition is used for all the services in the Recommendation centre of our application.

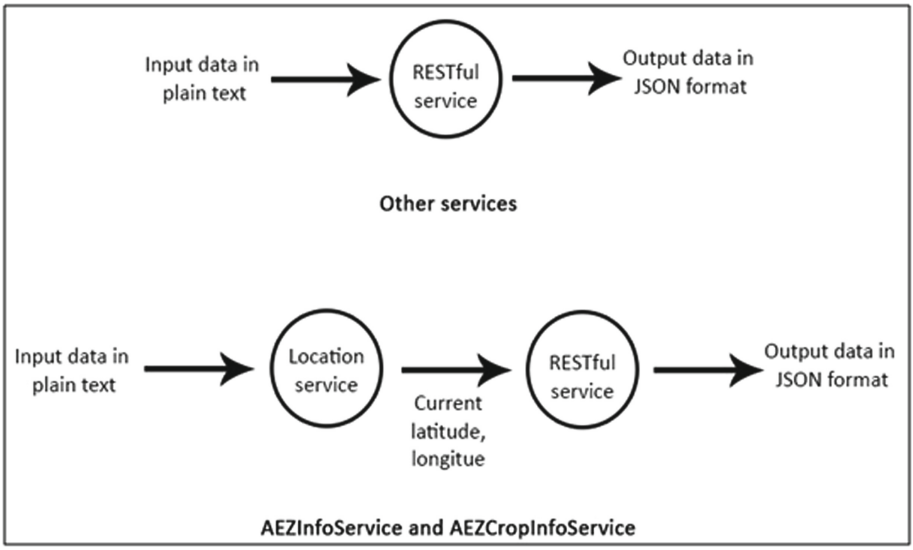

Fig. 5. SQL database service

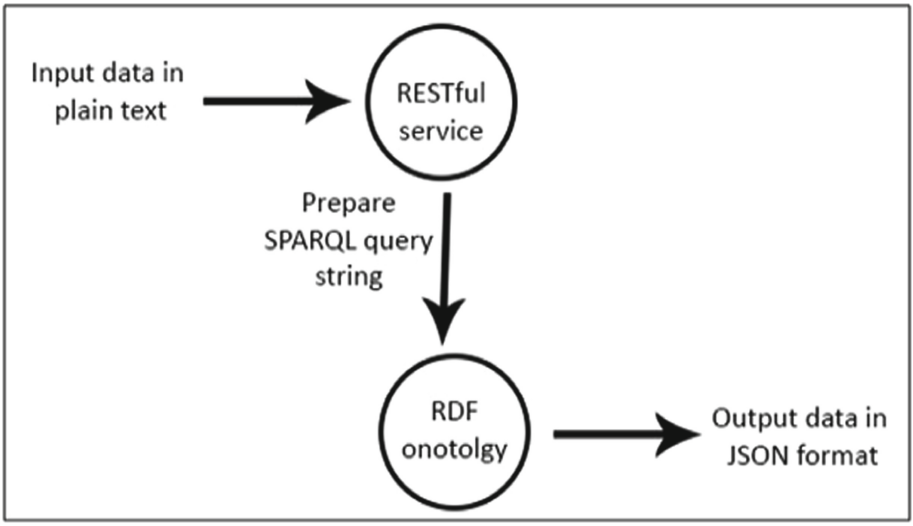

Fig. 6. RDF database service

5 Results

We have built the system which has the following functionalities.

1. Access of variety of information related to Cotton Crop such as Climatic condition, Soil for Cotton Crop, Varieties of Cotton Crop, Pest and Disease affecting cotton crop etc. on user mobile which need to have internet connection.
2. The system is generating proper recommendation to users using Ontology Knowledge Base and SQL Database. The recommendation generated in fast and easy way to farmers.
3. The system also helps the farmers to get the current climatic condition of current location by passing Latitude and Longitude of current location.
4. The pest attacks report can be presented on a map on live data and authorized personnel can judge if intervention is needed to control it.
5. Farm and farmer information can be viewed on a map for better presentation of information.
6. Data collection can be performed via formhub to collect data.

Figure 7 shows the system home screen with a menus available to the users are my information, farmer information, weather information, query information, report disease, pest/disease queries, map of farm location and information about application. Farmers can get the recommendations of their queries by clicking on "queries" icon.

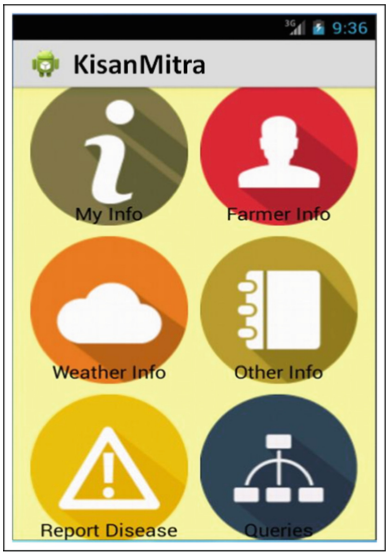

Fig. 7. Snapshots of home screen with user detail

Figure 8 shows the query list of farmers. This screen will be available after clicking on a select box of queries. It includes all the queries that generally asked by the farmers. A farmer can select the query from this list.

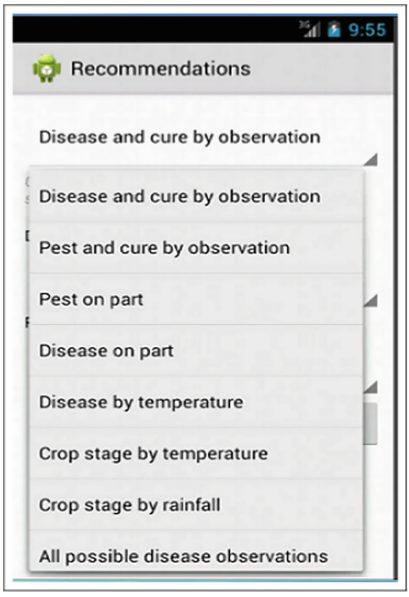

Fig. 8. Snapshots of query list

Figure 9 shows the screen available to farmers after clicking disease and cure by observation submenu. Observation and affected part of the cotton plant are given as an Inputs for the query.

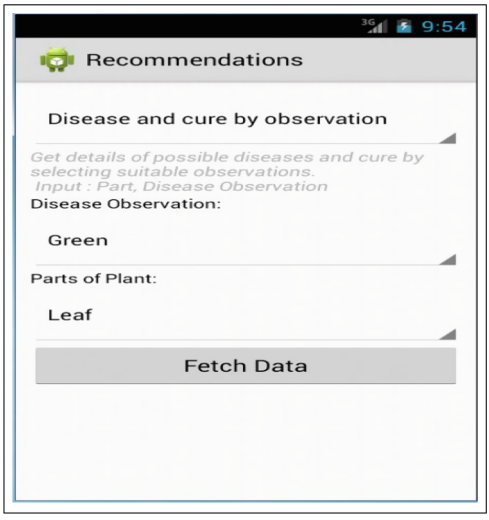

Fig. 9. Recommendations centre

Figure 10 shows the result of query asked by farmers. This screen will be available to the used after user has supplied input for observation and part affected and then use clicks on fetch data to retrieve the result of query.

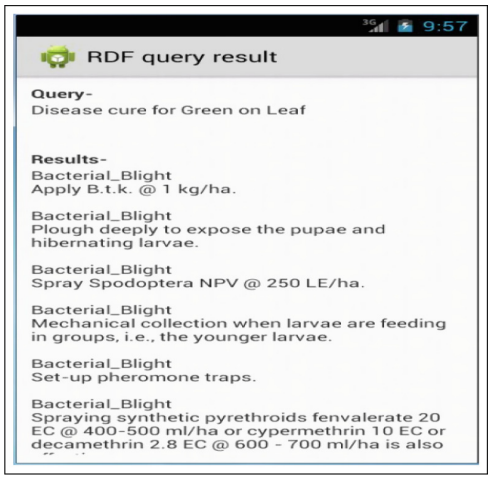

Fig. 10. Recommendations of query

6 Conclusion

Agro-Advisory systems like eSagu, aAQUA, mKrishi, are in use to help farmers by improving their farming practices. This thesis presents a new Agro-Advisory system named as "KisanMitra" which is an Android based and uses new semantic web technologies like ontology, SPARQL query language and reasoning capabilities. The system can generate automatic recommendations based on farmers queries regarding crop and their farming so agro experts are not needed at the other end. The user/farmers will be able to access a variety of data like soil types, cotton crop varieties, farmer information, pest/disease affecting cotton crop, insecticide, pesticide, fungicide which needs to be used to prevent disease/pest. The farmers will get recommendation or relevant information on their mobile phones without being concerned about the source of data. The system can generate alert and notification and sends to farmers if there is adverse change in climate condition so that farmers can take precautionary steps before heavy damage occurs. To access our system the mobile device only needs to communicate with the web services through internet. The interface for the mobile phone system is very user friendly which does not require much training. Our KisanMitra system is pioneer and pilot work to develop agro advisory system using ontology. This system will be also a model for building agro advisory system for other crop which leads to increase in the yield or production of crop.

7 Future Scope

Our system can be more useful to farmers if we could include current climate condition data and weather prediction techniques. Weather predictions can be made more accurate depending on previous data. We are currently limited by data space which we have on cloud, upon more space we can add more data which helps us to determine weather patterns accurately. Recommendations can be made better using better reasoning and inference logic in our ontology. More farms may be mapped in our system that will help to increase the reach and benefit more users. Other elements like water sources/warehouses may also be mapped to provide more information like nearest water body or nearest warehouse.

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