Spectral Archiving for Canopy Content Identification using Free and Open Source Software (FOSS)

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***Abstract*— Hyperspectral remote sensing offers narrow bands which provide immense potential to improve quantitative retrieval of canopy content with the relevant information of earth features. In order to utilize the potential of hyperspectral data, spectral library is a prerequisite. Spectral signatures collected in various research studies even if archived remain unavailable for others researchers. Moreover, spectral libraries are developed using costly proprietary software tools. Therefore, development of a web-assessable spectral data archive using free and open source software is necessary .Various combination of open source programming languages such as cascading style sheets(css) for style the web pages, hypertext markup language (html) for structured web pages creation, JavaScript for standard interface creation to client users, query for handling events and perform animations was implemented. PostgreSQL, a relational database system, was used as spectral database for storing spectral data and metadata information. Library provides utilities for analysis of archived spectra such as averaging, resampling, spectral matching, calculation of red-edge and a range of others spectral indices. Library is developed at low cost, and is easily customizable in nature. The developed architecture can be used for spectral data administration, and stored spectra may serve as a reference database for characterization of earth surface targets.**

Keywords—FOSS, Metadata, Spectral Library, Spectral Signatures.

I . INTRODUCTION

Hyperspectral data provides information in very narrow and contiguous bands through ultraviolet, visible and infrared portion of electromagnetic spectrum. The narrow band which combines the reflectance and the higher number of bands tends to determine the minute variations in the spectral signatures. Spectral libraries are flexible to work with free and open source softwares , where it is easy for data archival ,visualization and analyzing the environment. Spectral libraries are best to determine the unique characteristics of any materials that are being present on the environment. There are different spectral libraries that are being developed by different oganizations . These libraries differ in such a way based upon the species for which the spectra is being collected A proper metadata list should be provided which helps the researcher to gain confidence to carry on his work . Metadata should contain details such as date, time ,cloud cover, sensor band information, details regarding the instrument and the geometrical analysis of the data that is being acquired.

II. OBJECTIVE

The main objective of the study is to build a spectral architecture using free and open source software. The main reason is to develop an web enabled architecture with free and open source languages. The proposed system is a detailed study of building a spectral library with free and open source soft wares. The library is build using three tier architectural structure, where the structure mainly involves three different layers, individual working of each layer is combined and further processed using PostgreSQL and the outputs are being determined using Jfreecharts in the web page

III. HYPERSPECTRAL DATA

Hyperspectral data sets are generally represented as a data cube with spatial information collected in the X-Y plane and spectral information represented in the Z-direction. These data sets are composed of about 100- 200 narrow and contiguous wavelength bands at bandwidths of about 5 to 10nm. The spectra for a single pixel in these data appear like a laboratory quality spectra that can be used for understanding the spectral characteristics of the material. Due to the ample spectral information provided by hyperspectral data it is easy to distinguish unique features on earth surface. Hyperspectral data are more complex than multispectral data and different approaches for data handling and information extraction are needed (Vane and Goetz, 1988;) Hyperspectral data can be represented in three principal ways (Hueni, 2006)

A. *Image Space:* applies only for imaging spectrometer data and every spectrum has spatial location (i.e. data shown as two dimensional raster image)

B. *Spectral Space*: the reflectance response per wavelength i.e. the data are shown as spectra

C. *Feature Space*: vector define points in an N-dimensional space i.e. the data shown as vector points.

Spectral spaces determine the reflectance values.

Hyperspectral data used for the study is from the source USGeological Survey (USGS). The image is chosen for Bangalore region (Fig:1)which covers an extent of 12^0 58`N and $77^0$37`E. The sensor used is Hyperion on EO-I where the spectral range is of 400-2500 nm. Total number of bands are 220 with the spectral bandwidth of 10nm .The spatial resolution is of 30m . The image is chosen on the temporal

basis on an time interval of January ,Feburary ,March ,October 2015, January 2016.

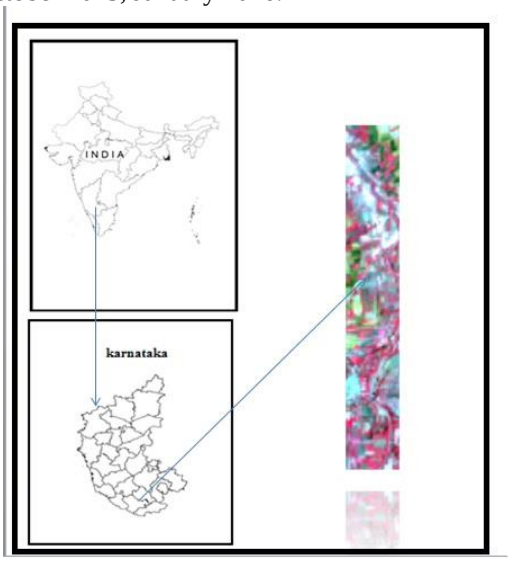

Fig 1. Image of Study Area

IV. METHODOLOGY

The images after being corrected atmospherically using FLAASH and QUAC, the results are being compared to obtain accuracy. The methodology for the proposed system is as follows(Fig:2)

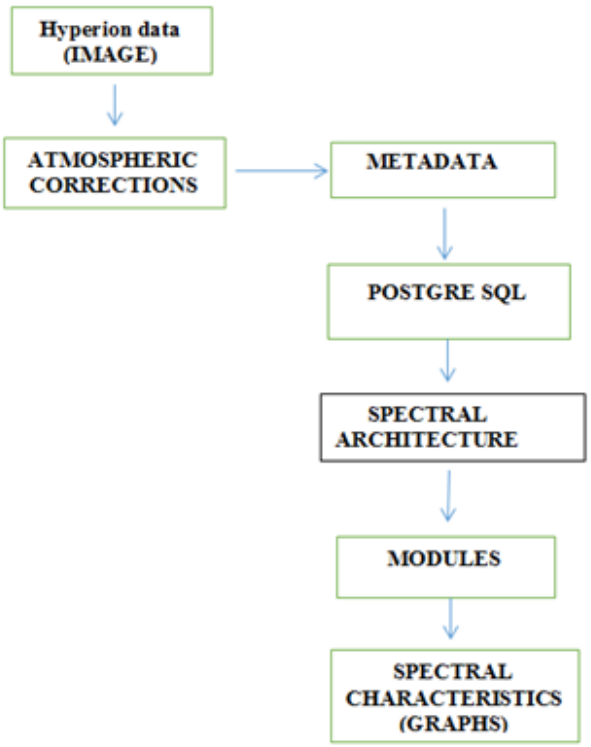

Fig 2 Methodology for the proposed system

The spectral architecture gives a support for developing the modules .The modules are developed sequentially, so the work flow determines that the output is being fed one after another and finally the outputs are being determined in the form of curves. The flow of the system determines an effort of developing an Graphical User Interface which is much effective and capable of interacting much with the end users.

V. SYSTEM ARCHITECTURE

Three-tier architecture is a client–server architecture in which the user interface (client side), functional process logic (application logic), data storage and access (database logic) are used for development of web Application. Architecture is intended to allow any of the three tiers to be upgraded or replaced technologies independently in response to changes in requirements or technology. For example, operating system in application layer would only affect the interface code.(Fig 3)

Architecture comprises of three different layers :

A. Database Layer

B. Application Layer

C. Internet Layer

The sequential processing of the architecture is being briefly determined

Database Layer

The database layer handles the spectral data and metadata information, which includes the data persistence mechanisms such as data storage and data sharing. It provide an Application Programming.

Application Layer

The application layer handles the communication of spectral database to web interface environment, where coordinates the analysis operations, processes user input commands, makes logical operation on the database server and visualize the result for the client side. The data movesand processes from the surrounding layers (database and internet).

Internet Layer

The internet layer handles the client-user input to the web interface via web server. The Internet layer displays information related to library services such as available data, metadata information, analysis results and chart visualization of spectral data. It communicates with other two layers by which it puts out the results to the browser/client tier and all other tiers in the network.

Spectral characteristics of the database can be broadly classified into various categories as

1) Scalability

The spectral data storage in spectral library is limited only by disk size and access of information is limited by the networking environment. File and database server separation guarantees high flexibility among upload and download of spectral data.

2) File format independency

Frequent change of spectral data formats and variety of instruments calls maximum flexibility of input and output of spectral data in spectral library. With respect to that, the

created input- output interfaces have to be changeable with respect to new data formats.

3) Intuitive interfaces

Ease access of spectral information and handling spectral files are a primary goal. Without prior knowledge, user interaction among database allowed by the web and command line interfaces. New data entry in the database may require user instruction and it is providing in online.

4) Flexibility to changes in science context:

Metadata is the information regarding spectral data in which aspects the spectrum is measured. Attributes or columns in the table are labels for metadata. The set of attributes in the spectral database acts as a metadata information to provide a sound knowledge of spectral data description. If required more information than new attributes are added easily.

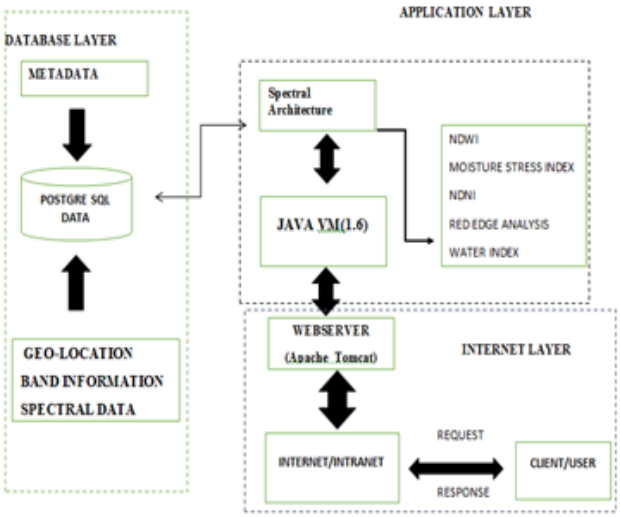

Fig 3 System Architecture of the Database

The architecture depicts an unique way to determine mapping of species using free and open source software. The developed architecture can be used for spectral data administration, and stored spectra may serve as a reference database for characterization of earth surface targets.

VI. OVERVIEW OF TECHNIQUES

Open source technologies are used to implement the spectral library in online via web interface. The following section gives the overview of techniques:

A. Java Script (JS)

Javascript is a multi-paradigm language primarily used in the form of client-side javascript to implement web-browser for provide enhanced user interface and dynamic websites. For server-side web applications popularity is increased based on the computing virtual machines and platforms built upon them. Javascript are user created text-based documents with the file name extension as .js and the internet media type as application / javascript, text / javascript. Implement as a part of interpreted language, just in time compilation performed by web browsers.

B. Java Server Pages (JSP)

Java Server Pages (JSP) technology used to create web application and processing user request from client side and construct a response from the server side. Importing and retrieval of spectral files from database as text document mode and display results of spectral chart in jpeg mode. For deploying and running of jsp pages in the web environment Apache Tomcat server is used.

C. Jquery

Jquery is a feature rich in java language where it is used to simplify the client-side scripting of HTML to keep the code simple and concise for query reusable in environment. In application side, navigation of documents from one page to another, event handling of elements, animation and to create plugins on top of javascript library. It enables in modular approach, for creation of powerful applications and dynamic web pages.

D. PostGreSQL

PostGreSQL is an object relational database management system developed by PostGreSQL developmental group to store data and retrieve it later as requested from other software applications such as JSP, .Net, PHP etc., Spectral database storage of information created in PostGreSQL to handle workloads from single machine to large number of users in internet facing applications.Complex SQL queries created by the programmer with many indexing methods for tools and application development.

E. Apache Tomcat Server

Apache Tomcat is an open source web server developed by the Apache Software Foundation(ASF), for implementing java server pages in the run environment and it provides a pure Java HTTP web server for java codes run in. Apache Tomcat is cross platform based and runs in a single operating system. Every request from the server is processed as a separate thread in the HTTP environment and tries to manage the session across the networks.

F. Cascading Style Sheet

Cascading Style sheets is used to describe the presentation semantics of a document and to style the web pages written in HTML. For separation of a document from content to presentation, elements such as layout, colors and fonts are used. Because of this separation, content accessibility provides more flexibility and control in presentation characteristics to enable sharing of multiple pages and repetition of information in structural is easier. It is a text-based documents denoted with the file extension as .css and specially maintained as World Wide Web consortium (W3C).

G. JFreechart

JFreechart is a free open source framework developed by object refinery limited in collaboration with the community for developing publication quality charts. JFreechart supports a number of varieties of charts, values of fields are passed as XY plots and chart libraries are installed in the server root option in internet server-side. It draws automatically scales

and legends and store the image as .jpg /.png according to the user defined formats in the system predefined location.

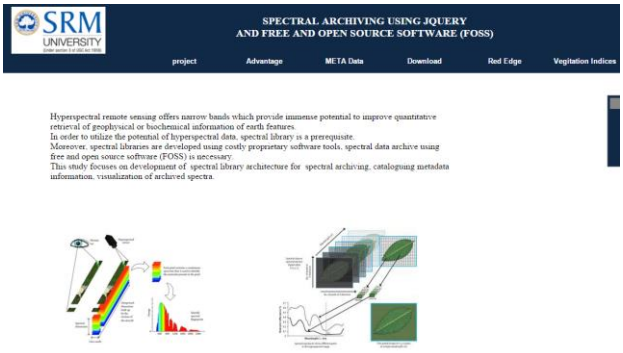

Fig 4 :Webpage design

Based upon the previous techniques webpage is being designed with the help of CSS and html queries. The webpage acts as an user interface to depict the required outputs.

CONCLUSION

The result concludes that the functional and non functional requirements have provided a front end for the detailed working of the spectral library provides an higher feasibility with the usage of free and open source software. Futher study is being carried out to determine the values based upon the pixel analysis.

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REFERENCES

[1] Bojinski, S., Schaepman, M., Schlaepfer, D. and Itten, K. (2003). SPECCHIO: a spectrum database for remote sensing applications. Computers & Geosciences, 29: 27-38.
[2] Clark, R.N. and Roush, T.L. (1984). Reflectance Spectroscopy: Quantitative Analysis Techniques for Remote Sensing Applications. *Journal of Geophysical Research*, 89: 6329-6340
[3] Cocks, T., Jensen, R., Stewart, A., Wilson, I. and Shields, T. (1998). The HYMAP airbornehyperspectral sensor: the system, calibration and performance.1st EARSELWorkshop on Imaging Spectroscopy, Zurich

Websites Referred

[4] http://en.wikipedia.org/wiki/Hierarchical_database_model
[5] htttp://eo1.usgs.gov/userGuide/hyp_prop.html
[6] http://gisweb.massey.ac.nz/Topic/DatabaseDesign/lectures/introduction.html
[7] http://www.w3schools.com/js/
[8] http://www.postgresql.org