Educational Administration: Theory and Practice
2024, 30(5), 15426-15432
ISSN: 2148-2403
https://kuey.net/
Research Article

Creating A Spectral Library Of Food Samples Through Spectroscopic Device Integration With ENVI Software

Vijay D. Dhangar[1*], Pravin V. Dhole[2], Dr. Bharti W. Gawali[3], Sulochana D. Shejul[4], Akshay Kshirsagar[5]

[1*]Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar- 431004 (MS), India. csit.vdd@bamu.ac.in
[2]Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar-431004 (MS), India. pravindhole07@gmail.com
[3]Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar-431004 (MS), India. drbhartirokade@gmail.com
[4]Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar-431004 (MS), India. shejul.sulochana1106@gmail.com
[5]Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar-431004 (MS), India. akshay.8kshirsagar@gmail.com

Citation: Vijay D. Dhangar, et.al (2024). SriCreating A Spectral Library Of Food Samples Through Spectroscopic Device Integration With ENVI Software, *Educational Administration: Theory and Practice*, 30(5), 15426-15432
DOI: 10.53555/kuey.v30i5.9173

ARTICLE INFO

ABSTRACT

Spectroscopic instruments are essential for determining the spectral signatures of different materials, which offer important information about the distinctive properties of each material's electromagnetic radiation at different wavelengths. Spectral signatures are unique means of identifying materials by their energy patterns that are absorbed, emitted, or reflected. We used the 350–2500 nanometre spectral range ASD FieldSpec4 Standard Spectroradiometer and accompanying software tools for our investigation. Our work focuses on gathering sample spectral signatures to create an extensive spectral library. By utilizing the features of the ENVI 5.5 application software, we were able to develop a reliable Spectral Library for the characterization and analysis of food samples by methodically compiling and organizing the spectral data that came from the spectroradiometer.

Keywords: Spectral library, ENVI, ASD FieldSpec4, food, Remote Sensing, Spectral Signature.

I.INTRODUCTION

ENVI, which stands for "Environment for Visualizing Images," is a program Harris Geospatial Solutions developed. By combining state-of-the-art spectral image processing and analysis technologies, the ENVI platform provides users with an easy-to-use interface for deriving insightful information from pictures. This intuitive software facilitates the extraction of valuable information from photographs, making it a flexible instrument for a range of uses.[1]. ENVI combines dependable geospatial analysis technology with state-of-the-art spectral image processing all within an easy-to-use interface. With ENVI's state-of-the-art processing and analysis capabilities, users can extract meaningful information for well-informed decision-making, regardless of whether they are dealing with panchromatic, LiDAR, SAR, multispectral, or hyperspectral images. The ENVI application is an essential tool for processing and interpreting geospatial information, and it is widely used in remote sensing and image analytics. Numerous academic fields, including geography, land surveying, hydrology, ecology, meteorology, enology, and geology, use remote sensing, a technique for gathering data without having to come into close physical touch with the item or phenomena, extensively[2]. It also has multiple uses in the military, intelligence, business, economic, planning, and humanitarian sectors. Modern satellite and aircraft sensors can provide imagery data in a variety of forms, including multispectral, hyperspectral, panchromatic, LiDAR, infrared, thermal, radar, HDF5, full motion video, LAZ, ASCII, and NET CDF-4. These formats can all be supported by ENVI. With its flexibility, ENVI can be customized to meet the needs of any project and is available on mobile, cloud, and desktop platforms.[3]. By gathering information from several spectrum sources and spectral signature databases, the spectrum Library Builder in ENVI creates ENVI Spectral libraries [4]. ASCII data, spectral files generated by the ASD Spectroradiometer, various spectral libraries, ROI means, and spectral profiles and plots are examples of spectra sources [5]. When we collect all spectra, the collected spectra automatically resample to an input wavelength space using Full width at half maximum (FWHM) information if it is available [5]. We can develop the spectral library for various materials like vegetation, soil, food, etc. By using the ASD FieldSpec4 spectroradiometer [7, 8] and its supporting software first we have to collect the spectral database of various samples and by the use of ENVI application software, we can create the spectral library. Spectral signatures of several samples can be stored in a single package and items from imaging and non-imaging data can be identified using a spectral library. The difference in a material's emittance or reflectance with respect to wavelength is known as its spectral signature. To monitor electromagnetic radiation of all kinds as it interacts with objects on Earth, specialized digital sensors have been developed [9]. We may view spectrum data from ENVI standard spectral library (sli) files by utilizing the Spectral Library Viewer function from ENVI. Several sets of laboratory spectra from the U.S. Geological Survey (UCGS), Johns Hopkins University (JHU), and NASA Jet Propulsion Laboratory (JPL) are included in the ENVI Software. The ASTER spectral library (version 2), which has hundreds of laboratory spectra from natural and artificial materials spanning 400 to 1540 nm, is one of the spectral libraries that can be found In ENVIS's Aster Folder.

II. MATERIALS AND METHODLOGY

A systematic approach is used in the creation of spectrum libraries to guarantee precise data gathering, arrangement, and retrieval as show in fig.1. The first step is sample production and preparation, which involves choosing representative samples, cleaning them, and processing them to get rid of contaminants. Consistency in spectral data is ensured by standardising the preparation procedure. The next step in the database generation process is to record the spectrum data using the proper spectroscopic methods, such ASD FieldSpec4 Spectroradiometer. For effective data organisation and retrieval, database management rules are put in place, and metadata such as sample type, acquisition settings, and environmental conditions is methodically recorded. After the creation of the database, the recorded spectrum data is normalized and preprocessed to improve accuracy in the spectral library building step. For classification and clustering, machine learning and statistical techniques can be used, guaranteeing that the library is extensive and able to represent a range of sample variations. Viewing the spectrum library, the last step, entails accessing and evaluating the collected data for a range of uses. This phase entails putting in place intuitive user interfaces for data visualization, turning on search and retrieval features for effective spectrum matching, and using the spectral library in fields like forensic analysis, material identification, and quality control. Advanced spectral analysis is made possible by this systematic technique, which guarantees a dependable and repeatable approach to spectral data handling.

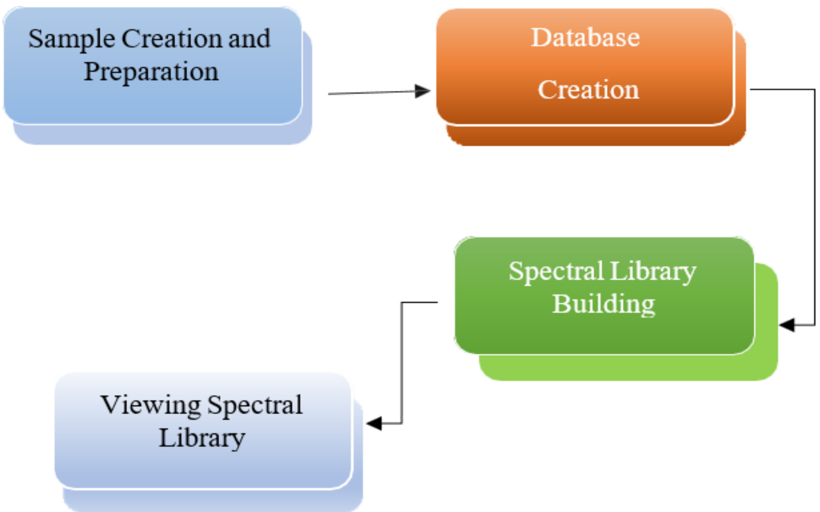

Fig. 1. Steps for Building Spectral Library

A. Samples Collections and Preparations:

Creating and Preparing Samples is the initial phase, as seen in Fig. 1. We've chosen homemade tea powder, turmeric powder, and chili powder from different market brands for this. We developed a database with seven samples of tea, turmeric, and chili powder from various brands to construct a spectrum library. for additional examination and research.

B. Database Creation:

In the second phase, we established the database, as shown in Fig. 1. This was accomplished by measuring every sample in the Multispectral Lab of the Department of Computer Science and IT at Dr. B.A.M. University in Aurangabad, Maharashtra, India, using the ASD FieldSpec4 Spectroradiometer. The process of creating the Spectral database was done in a dark room to prevent outside light disruption. Using the RS3 Spectral capture program, the sample was scanned within the wavelength range of 350 to 2500 nanometers [7]. With a 45-degree incidence angle, a tungsten halogen light source was paired with a spectroradiometer. The samples were placed in a side length of roughly 40 cm of square black paper. The spectroradiometer scanned 200 gm of each sample, panning a diameter of about 25 cm, at a distance of 30 cm from the spectrometer. Sixty centimeters were separating the cannon and the light source. To maximize signal and calibration accuracy as well as detector responses, a standardized white spectral panel with 100% reflectance was employed. Spectral data is converted using ViewSpec Pro software. Data in.ASD binary file format will be provided by the app. The ViewSpec Pro application can be used to process ASD binary files further.

C. *Building Spectral Library:*

In the third phase, as shown in Fig. 1, we created the Spectral Library. To generate ENVI Spectral libraries from different spectra sources, utilize the Spectral Library Builder in ENVI. ASCII files, spectral files generated by the ASD spectroradiometer, additional spectrum libraries, ROI means, spectral profiles, and spectral plots are some examples of spectral sources [9]. Using FWHM data, if available, all of the collected spectra are automatically resampled into an input wavelength space.

D. *Viewing Spectral Library:*

As illustrated in Fig. 1, the fourth stage allows us to view the spectral library that has been developed once it has been built. We may view spectrum data from ENVI standard spectral library (sli) files by utilizing the Spectral Library Viewer function from ENVI. Several sets of laboratory spectra from the U.S. Geographical Survey (USGS), Johns Hopkins University (JHU), and NASA Jet Propulsion Laboratory (JPL) are included in the ENVI Software. The ASTER Spectral Library (Version 2), which spans 400 to 1540 nm and contains thousands of laboratory spectra from natural and artificial materials, is in the aster folder. The JPL and JHU spectra are in this folder. We have created a spectral library for chili powder, turmeric powder, and tea powder which has 5 different types of each sample and includes homemade and various market brand samples. A dataset experiment consists of 21 samples, where each sample was tested 10 times. Using ASD Spectroradiometer. As shown in Tables 2,3 and 4. the Standard sample is stored as labeled 1,2, 3,4, and so on. All the samples were stored in Comma-separated values (CSV) format.

Table2:-Chilly Sample

Label	Sample _name
Chilly_1	Chilly_Market
Chilly_2	Chilly_Market
Chilly_3	Chilly_Market
Chilly_4	Chilly_Market
Chilly_5	Homemade
Chilly_6	Homemade
Chilly_7	Homemade

Table3:- Turmeric Sample

Label	Sample _name
TP_1	Turmeric_ Home
TP_2	Turmeric_ Home
TP_3	Turmeric_ Home
Tp_4	Market
TP_5	Market
TP_6	Market
TP_7	Market

Table4:- Tea Sample

Label	Sample _name
Tea_1	Tea_Market
Tea_2	Tea _Market
Tea_3	Tea _Market
Tea_4	Tea _Market
Tea_5	Tea Market
Tea_6	Tea Market
Tea_7	Without brand

III. RESULT AND DISCUSSION

we essentially used four processes in Fig. 1. Gathering Examples, Building Databases, Using ENVI software to build a spectral library, and finally using ENVI to inspect the spectral library that has been built. Initially, we gathered samples from various market brands. Then, we used the ASD FieldSpec4 Spectroradiometer, which has a wavelength ranging from 350 to 2500 nanometers, along with its accessories and supporting software, to develop a spectrum database of food samples. We utilized ViewSpec Pro software, which can perform certain statistical analysis and data format conversion, to further convert the spectrum database. In conclusion, we created and examined the spectrum library. In ENVI, the subsequent actions are taken in order to construct a spectral library: Choose Spectral from the Toolbox, then Spectral Library, and finally Spectral Library Builder choices. The Spectral database of different samples obtained from the ASD FieldSpec4 Spectroradiometer and its supporting software, RS3, can be imported in ASCII, ASD, CSV, and other file formats by using the Spectral Library Builder option. Afterwards, a variety of analyses and research projects can be conducted using the imported spectral database.

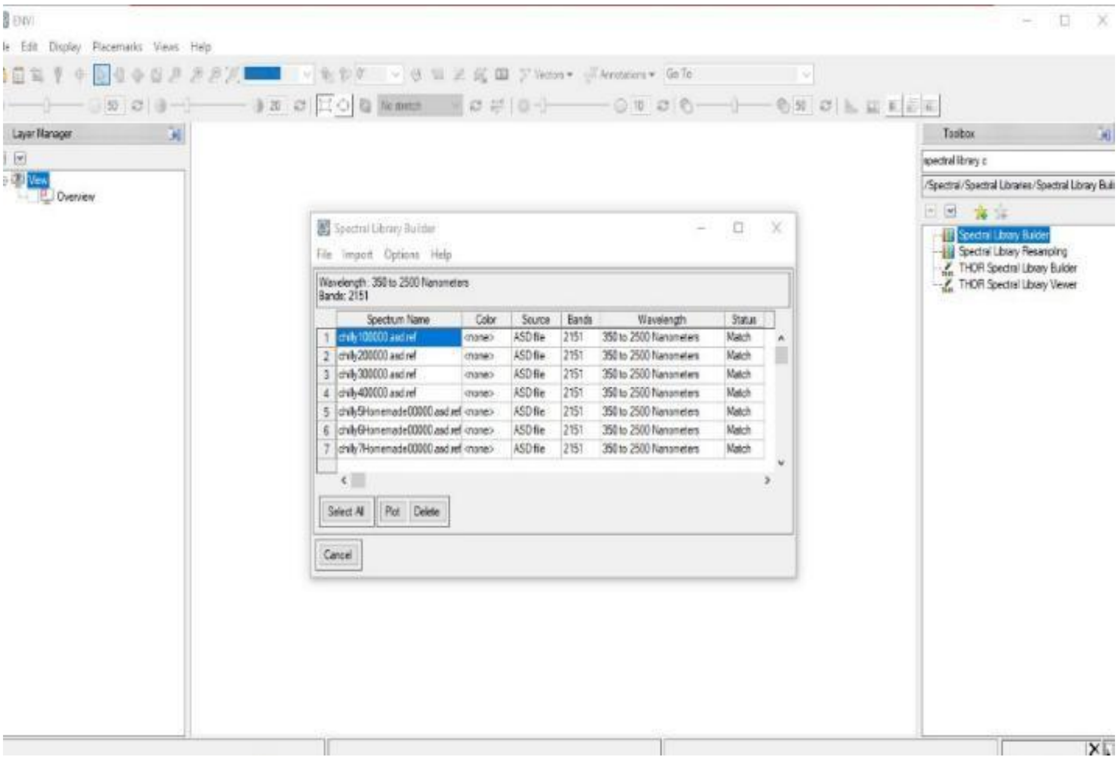

Fig2: -Sample selection in ASCCI Format

After choosing the samples in ASCII format using ENVI's Spectral library builder option, Fig.5 displays. After selecting every sample by clicking the Select All option, click the Plot button.

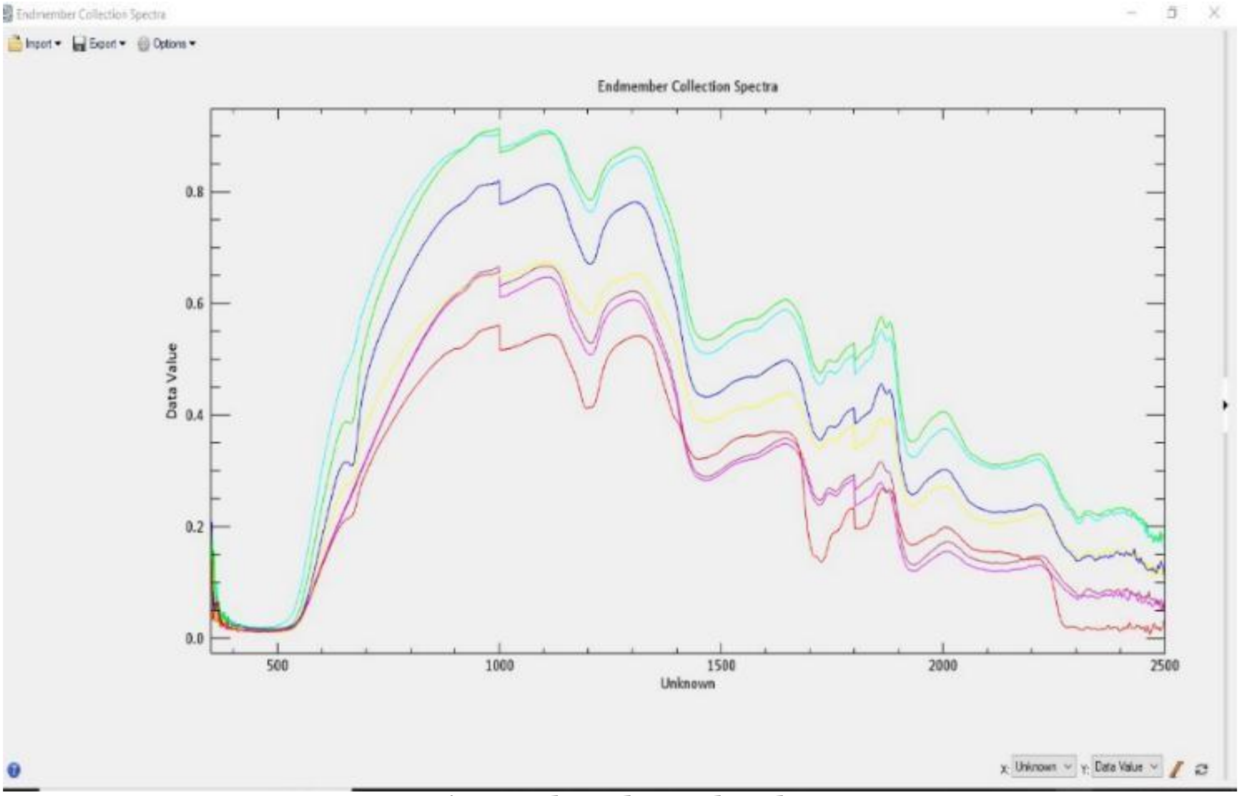

Fig. 3. Selected samples plot

The chosen samples are plotted in Fig. 3. It is evident that each sample has a unique spectral signature based on its chemical composition. Following the plotting, we exported every signature as a single package, or as a spectral library. After selecting Spectral Library, click Export. The ENVI spectrum Library viewer option allows us to view the spectrum library after exporting the file in spectral library format. Figure 4 displays the spectral library in the spectral library viewer.

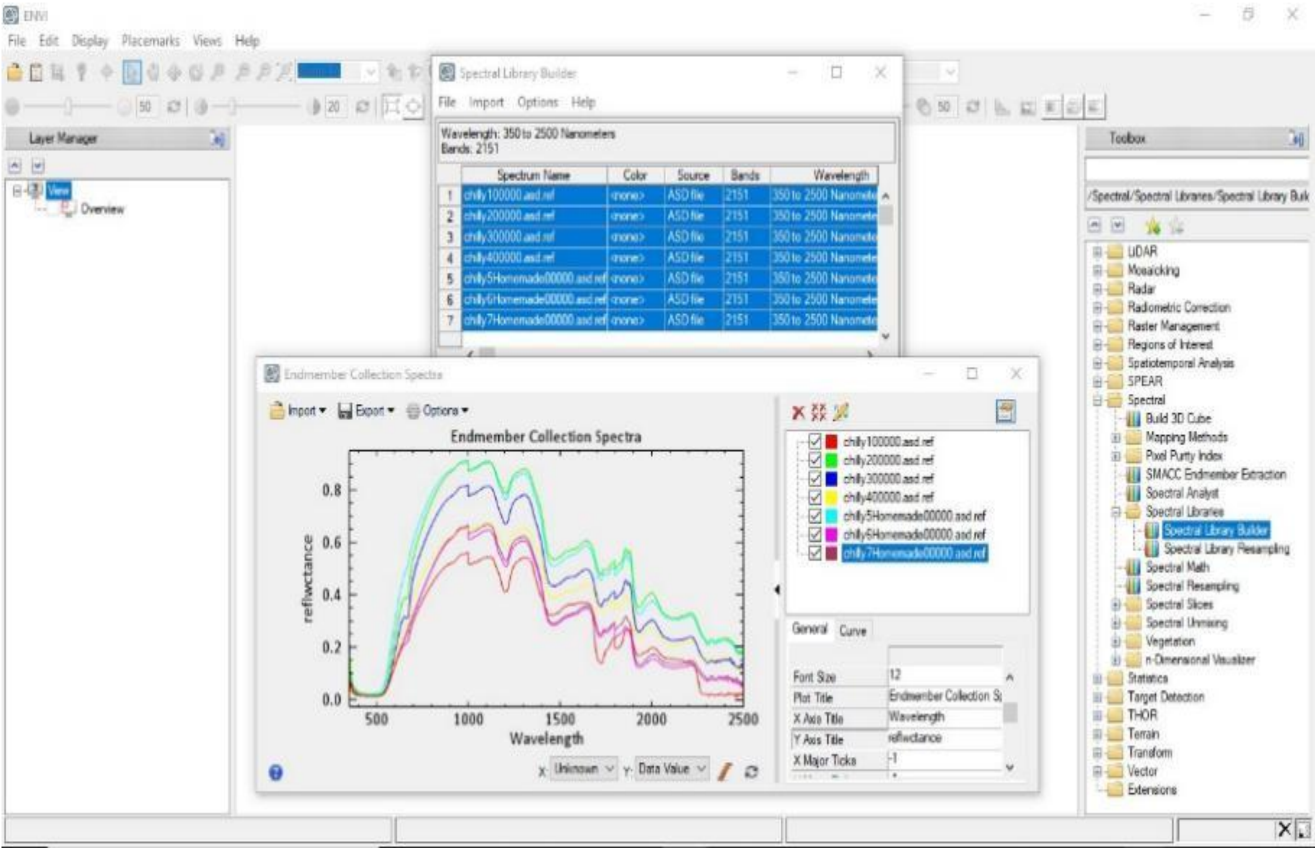

Fig. 4. Spectral Library Viewer

The spectrum library in the ENVI spectral library viewer is shown in Fig. 4. Each signature was automatically classified by the ENVI and separated into distinct colors. This library can be tailored to our needs for simplicity and ease of usage. The ENVI software's available spectrum libraries are displayed on the left side of Figure 4. in addition to user-made libraries. We experiment with a total of 21 samples and here we have built a spectral library for each sample which is shown below.

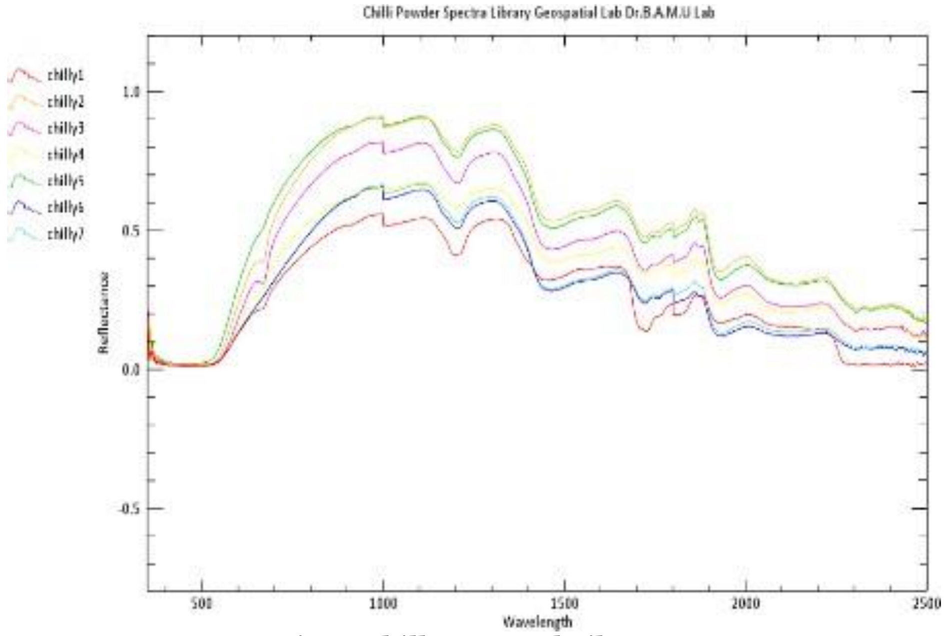

Fig 5:-Chilly Spectral Library

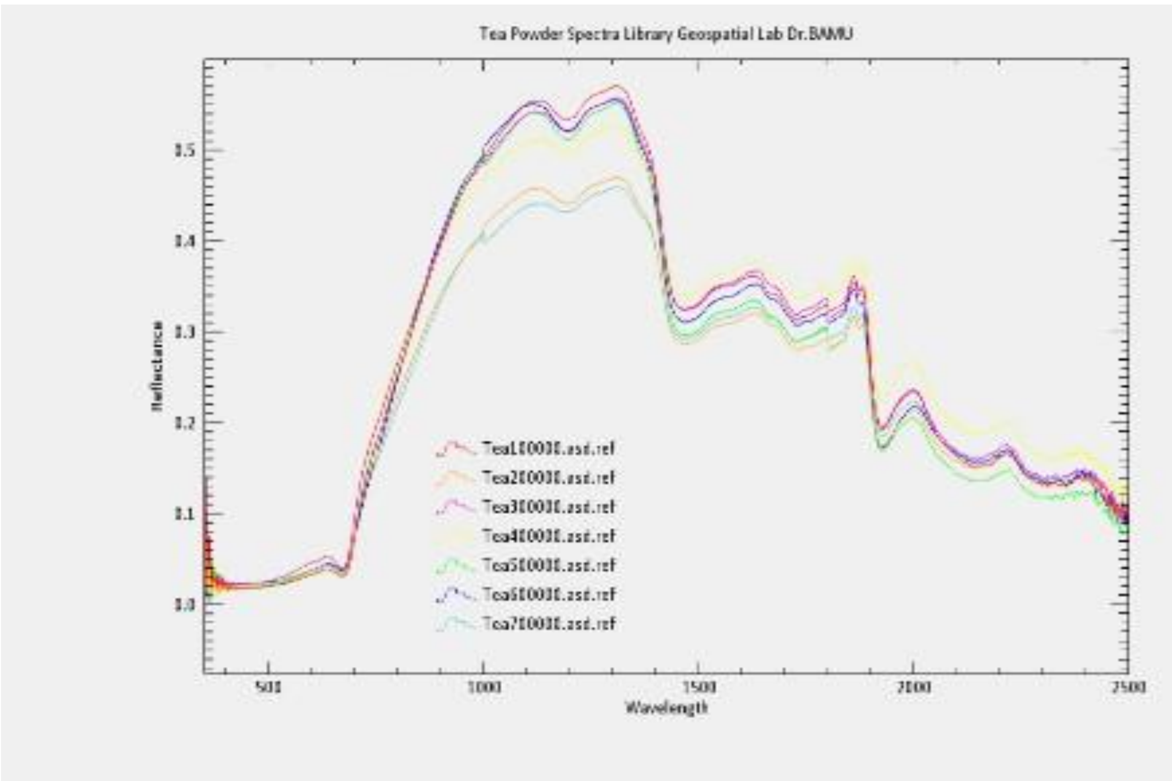

Fig 7:- Tea Spectral Library

IV. CONCLUSION

For this study we have constructed a spectrum library of samples from several handmade and store- bought brands. We employed the ENVI 5.5 application software and the ASD FieldSpec4 spectroscopic instrument. We may infer that the spectroscopic device and ENVI software are helpful for remote sensing applications that use spectroscopic devices to collect data for imaging and non-imaging data processing. Creating a spectral library for different materials is another benefit. Additionally, the created Spectral library may prove beneficial for additional and diverse study endeavours'.

Acknowledgement

The authors are grateful to the Mahatma Jyotiba Phule Research & Training agency (MAHAJYOTI), an autonomous agency under the Other Backward Class Bahujan Welfare Department, Government of Maharashtra, India, for providing the fellowship and also acknowledge the System Communication & Machine Learning project Laboratory, Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, Maharashtra, India, for their invaluable assistance with this research work.

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