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# Application of Multi-SVM for Image based Soil Type Classification

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**ABSTRACT:** Soil classification has been the matter of interesting research in the field of engineering. The engineers need to have some primary information about the type and structure of the soil. Earlier methods of soil classification included standard penetration test (SPT), cone penetration test (CPT), pressure meter test (PMT), and vane shear test (VST). The initial methods were time consuming and required presence of an expert for accurate results. In India, major 9 types of soils could be found which includes Alluvial soil, Forest soil, Red soil, Black / regur soil, Saline soil, Arid / desert soil, Peaty / marshy soil, Sub-mountain soil, Laterite soil, Snowfields. With the development of machine learning methods as a part of Artificial Intelligence (AI), many techniques have been progressively developed to automate the soil classification process. The developed techniques include Decision Trees (DT), k-Nearest Networks (k-NN), Artificial Neural Networks (ANN) and Support Vector Machines (SVM).

**KEYWORDS:** Soil Type Classification, Image Processing, SVM, MATLAB.

## I. INTRODUCTION

Soil is one of the most important resources and vital component of earth's critical zone. Soil supplies ecosystem services, filters water, provide nutrients to the vegetations (crops, plants) which supplies us food, energy and fiber to maintain the human health and habitation. There are extraordinary pressures on soil due to urbanization, industrialization or from degradation; soils are reducing their quality which are unbalancing the agricultural practices and food production. Consequently, soil quality and its management with planning are essential to preserve the soil with its quality for future generations. In addition, soil mapping and classification plays a vital role in planning, management of landform and soil use for sustainable growth of the area. Accordingly, digital assessment of various soil properties, classification along with its mapping is mostly an imperative task for agricultural practices like crop growth and condition monitoring and worldwide food production as crop growth is mostly rely on soil nutrients. However, globally soils are very heterogeneous and dynamic in environment as compared to air and water which structure, study and processes are also complicated and formidable both spatially and temporally. In land use and soil is most important factor of environmental change such as deforestation, habitat fragmentation, urbanization, and wetland degradation. Soil deals with the physical features or vegetation as evident on the land whereas land use is about what economic activity or use the land is put to Research in land use. The image of different types of soil samples which constitute the database are shown below:

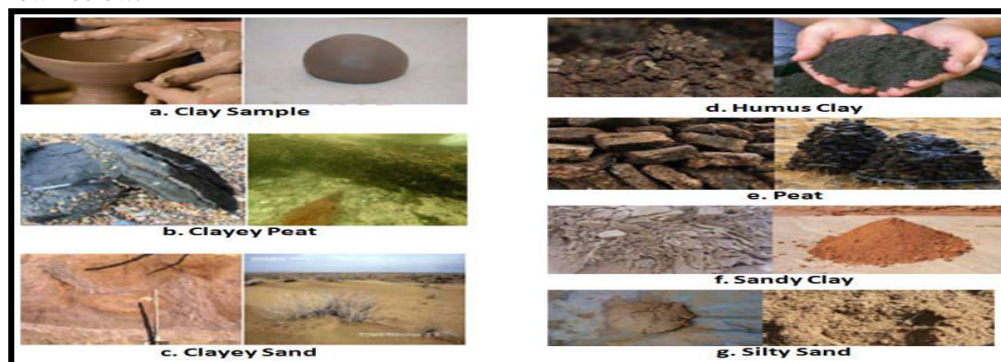


Fig. 1. Different Soil Samples used for Classification



## II. LITERATURE REVIEW

Bacu et.al. publish that an efficient agricultural management is based on a good, reach and accurate information on the environment and especially on the soil. The need for up-to-date and high-resolution soil information and the direct access to this information in a flexible and simple manner is imperative for pedology and agriculture specialists. This paper presents the HORUSApp application supporting the integration of multispectral data coming from satellite images (in particular from Sentinel-2 satellite) into the soil analysis and classification process [1].

Raisy et.al. describe that GNSS reflectometry (GNSS-R) is a technique that uses GNSS signals reflected from the earth's surface for remote sensing applications. Soil moisture, thickness and structure of the snow cover on the northern plains, the wind speed at the sea surface, the polar ice caps and surface roughness are the parameters that can be determined by the analysis of reflected waveforms of GNSS. By keeping soil patches at the reflection paths of satellites, soil moisture content of these patches with the help of reflected signal SNR can be measured. Different conditions on soil patches in a controlled manner could be given. The specific values between the reflected and directed wave are used to calculate the soil moisture content. This research investigates the presence of moisture content in the soil by using NavIC reflected signals [2].

Yayong et.al. publish that the soil dielectric models used to describe the relationship between soil permittivity and soil water content, mainly include Mironov model, Dobson model, Wang and Schmugge model and Hallikainen model. As a key input parameter of four dielectric constant models, soil texture directly affects the simulation ability. In order to analyze the adaptability of the dielectric constant model under different soil texture conditions, two evaluation indexes of the root mean square error (RSME) and linear correlation coefficient (R) were used to evaluate the accuracy. The results show that the four models have great differences in the simulation accuracy of loamy sand, sandy loam, clay loam, sandy clay, silty clay and clay soil. It is further shown that the Mironov dielectric constant model has the best overall applicability for soil moisture inversion for L-band microwave remote sensing, but, with the increase of the content of silt in the soil, for example the soil with abnormally high silt content in silt loam, silt clay loam and silt clay, the Dobson model was the best choice [3].

Bolla et.al. publish that recent developments in the embedded systems have been motivating in investigating the reliable solutions w.r.t to the environment monitoring system. The research work mainly focuses on building a system which can be used universally at any scale to monitor the parameters in given agricultural land. With the evolution of various cameras and microcontrollers coupled with the Internet using Internet of Things (IoT) is possible to remotely monitor the parameters such as pH, moisture level and amount of nutrients content in the soil. The Raspberry -Pi is been used along with the raspberry-pi camera to capture real time data (images) from environment and by using IoT data is fetched and displayed on monitor screen. Using image processing, pH value and moisture level are determined and based on these values, soil nutrients and suitable crops information will be provided instantly [4].

W. D. Philpot publishes that imple spectral measures can be effective in delineating useful image details, but can be frustratingly resistant to differentiating subtle differences. In this paper, a pair of normalized difference indices is shown to provide discrimination among several soil types, and also enhances the capacity for delineating emergent vegetation [5].

Mengistu et. al. present a Soil characterization and classification using computer vision & sensor network approach. Gravity Analog Soil Moisture Sensor with arduino-uno and image processing is considered for classification and characterization of soils. For the data sets, Amhara regions and Addis Ababa city of Ethiopia are considered for this study. In this research paper the total of 6 group of soil and each having 90 images are used. That is, form these 540 images were captured. Once the dataset is collected, pre-processing and noise filtering steps are performed to achieve the goal of the study through MATLAB, 2013. Classification and characterization is performed through BPNN (Back-propagation neural network), the neural network consists of 7 inputs feature vectors and 6 neurons in its output layer to classify soils [6].

Liakos et.al. publish that machine learning has emerged with big data technologies and high-performance computing to create new opportunities for data intensive science in the multi-disciplinary agriculture technologies domain. In this paper, authors present a comprehensive review of research dedicated to applications of machine learning in agricultural production systems. The works analyzed were categorized in (a) crop management, including applications on yield prediction, disease detection, weed detection crop quality, and species recognition; (b) livestock management, including applications on animal welfare and livestock production; (c) water management; and (d) soil management. The filtering and classification of the presented articles demonstrate how agriculture will benefit from machine learning technologies. By applying machine learning to sensor data, farm management systems are evolving into real time artificial intelligence enabled programs that provide rich recommendations and insights for farmer decision support and action [7].

### III. METHODOLOGY

The proposed framework is illustrated in Fig.2. The proposed image based soil sample classification system is performed by five main steps: image acquisition, image enhancement, feature extraction and classifier training leading to image based soil sample classification.

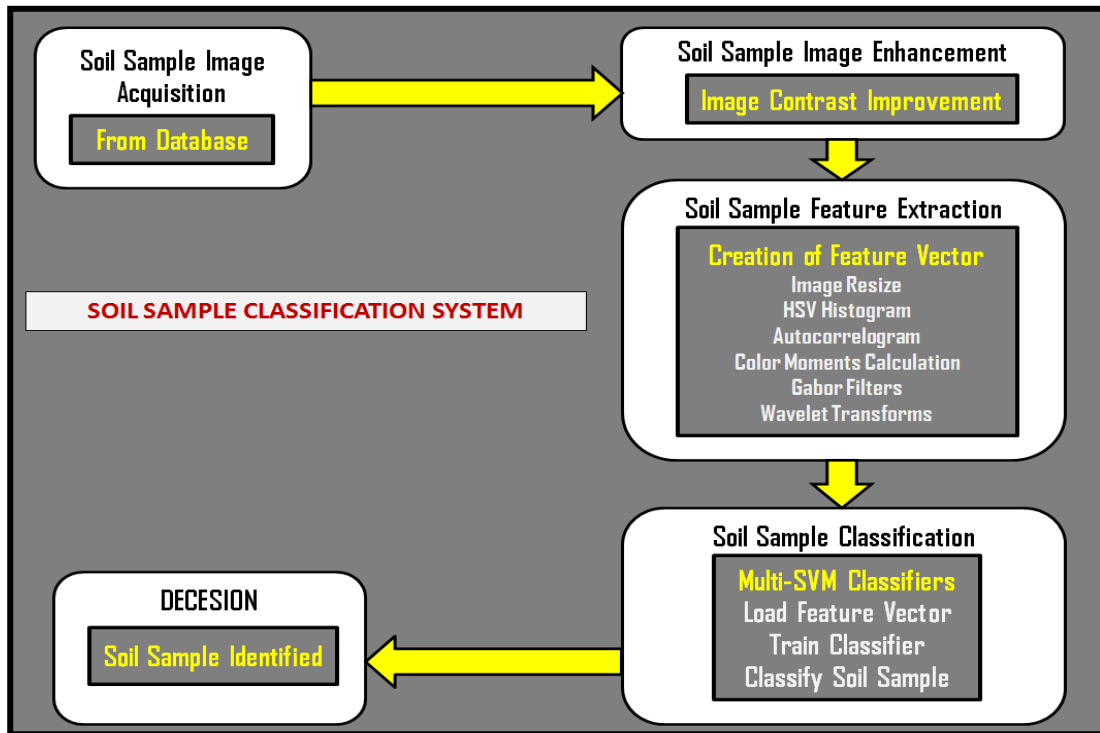


Fig.2. Proposed Soil Sample Classification System

The proposed work aims towards application of image processing techniques for detection of soil samples. In this method two parts important. First part is training part. In which database formation is important work. Second one is testing part. In which actual classification takes place.

**Training:** In training part, first part is to collect different types of soil sample picture. Then preprocesses apply on that soil images. Then develop an algorithm to extract the features of soil sample images using features extraction methods like HSV Histogram, Color moments- Mean Standard Deviation, Gabor features, Color Autocorrelogram. Then develop database with feature preparation of sample images. Develop an SVM algorithm for deciding class.

**Testing:** For testing purpose select any soil sample image. Which will undergoes processes like preprocessing, Feature extraction, and feature preparation. Develop an SVM algorithm to find class of soil. Implementation of algorithm may be by using MATLAB.

**Soil Image:** Different types of soil samples are available. For example Peat, Sandy soil, clay etc.

**Pre-processing:** In this section enhancement like processes carried out which will help for feature extraction process.

**Enhancement:** Image enhancement is the process of adjusting digital images so that the results are more suitable for display or further image analysis. We can use enhancement process to remove noise, sharpen, or brighten an image, making it easier to identify key features.

**Feature Extraction:** In this section features extraction methods like HSV Histogram, Color moments-mean Standard Deviation, Gabor features and Color Autocorrelogram will use to extract features of soil.

**Feature Data Preparation:** In previous section feature extraction carried out but different features separation carried out in this section.

**Feature Database:** In this section with the help of previous two steps feature database formation is carried out.

**Support Vector Machine Classification:** For actual classification SVM i.e. support vector machine method is useful. In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis Given a



set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces. When data are not labeled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups. The clustering algorithm which provides an improvement to the support vector machines is called support vector clustering and is often used in industrial applications either when data is not labeled or when only some data is labeled as a preprocessing for a classification pass.

#### IV. RESULTS

A simple and intuitive GUI Soil Type Detection System appears on screen which has been created using GUIDE Tools in MATLAB. The GUI consists of three main 05 main buttons assigned different operations to be performed i.e. Select Input Image, Image Enhancement, Soil Classification and Accuracy Calculation and Exit Application respectively. The GUI also holds the Graph/Figure space to show the image processing operations and their respective results on it. The GUI also holds the spaces to show alpha-numeric text which displays the results for extracted feature values on the soil type image and Accuracy of detection on it along with result for soil classification.

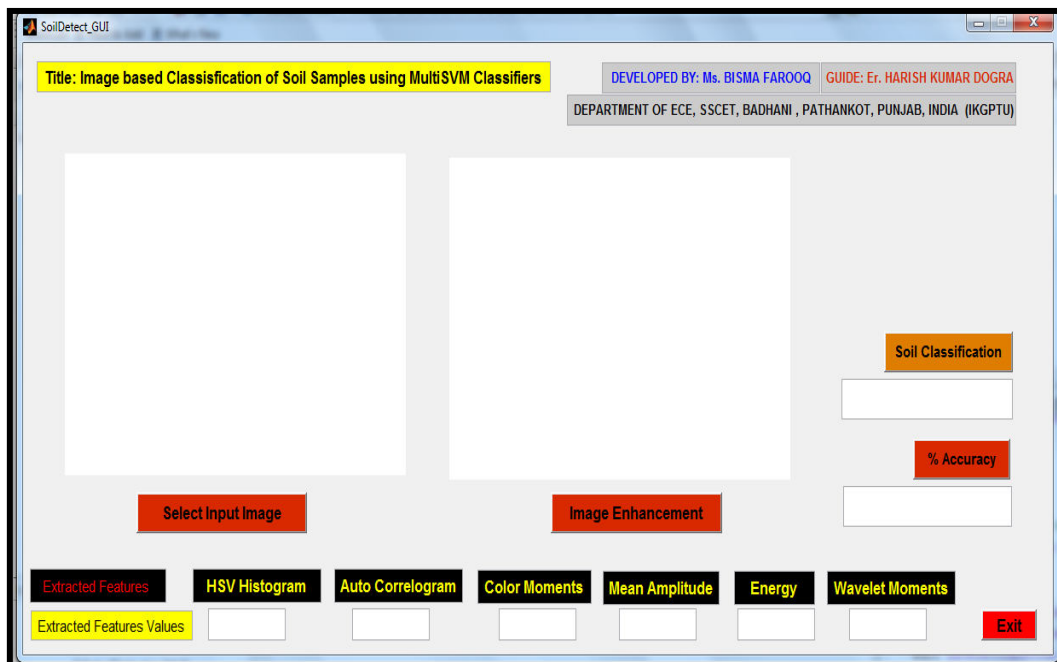


Fig. 3. MATLAB GUI Interface for Multi-SVM Soil Type Detection System

#### V. CONCLUSION

The use of computers in many engineering fields is widely accepted. The field of geotechnical engineering is not far behind. The use of computers not only automates the process of soil characterization, but also makes it more objective. The chances of human error are minimized, thus saving a lot of energy, time and most importantly, money. This work deals with the measurement and utilization of the different image based parameters for classification of soils. It concentrates on creating multiple parametric measurements as feature classes for soil type classification.



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