Proceedings of the Second International Conference on Computing Methodologies and Communication (ICCMC 2018)
IEEE Conference Record # 42656; IEEE Xplore ISBN:978-1-5386-3452-3

Soil Classification & Characterization Using Image Processing

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***Abstract*— Agriculture is most important for survival of human being on the earth. As we know that agriculture land is decreasing day by day while population increasing day by day. But it is fact that production is also increasing because of several technologies. It is also fact that income of farmer is not increasing to survive in current scenario because of that several farmers hanging themselves. That is why we require a free application that help them in real world to inform them to identify soil by the type & there composition with suggestion like suitable crops for the corresponding type of soil . In India there are various types of soil. Since soil is a store house of minerals. Farmers are depending on soil for growing different type of crops But mostly farmers are don't know which crop are grow in which soil. We are now taking about soil of Rajasthan. In Rajasthan, main soil is in desert form. But south part of Rajasthan of soil where farmer can grow crops. In Rajasthan there are various type of soil are available sandy, saline, alkaline, calcareous soil are also present, we can classify the soil by image processing method in which we can see the color, energy, HSV etc.**

Keywords— Agriculture, Land type, SVM technique, Image processing, classification technique

I. INTRODUCTION

Digital image processing is a digital system. A digital system works on or operates operation on a digital image. Mathematically an images in two dimensional signal having two coordinates X and Y. Which can be represented by f(x,y)function .The enter by of an image or gray level the image at point x & y is the amplitude of the function. An images is known as a digital images of x,y and interchange of function f and finite deferments quantities digital images processing .Main goal is to design and develop a computer system which operates on an image, where input of a developed system is a digital Images and output is processed image users and algorithms.

A. Basics of Image Processing:

There are three level of digital image processing as shown in figure 1.1

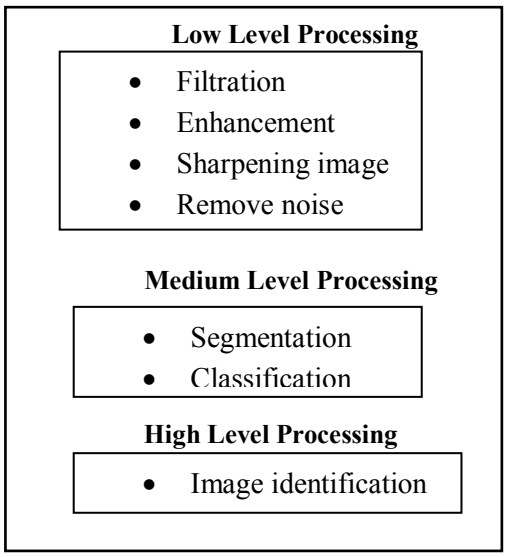

Figure 1.1 Image processing classification process

- Low level processing (LLP): It involves image enhancement, remove noise using filter and shaping the image
- Medium level processing (MLP) : It involves image segmentation and classification
- High level processing (HLP): It includes images identification

The main component of a digital image processing are image sensor, compiler, software, mass of image, color TV or monitors, hard copy devices like laser printer, film camera, CD Rom device etc. and specialized image processing hardware that is combination of digitizer and hardware two perform logical and arithmetic operation.

There two approaches of image enhancement

- Frequency domain Processing(FDP)
- Special domain Processing(SDP)

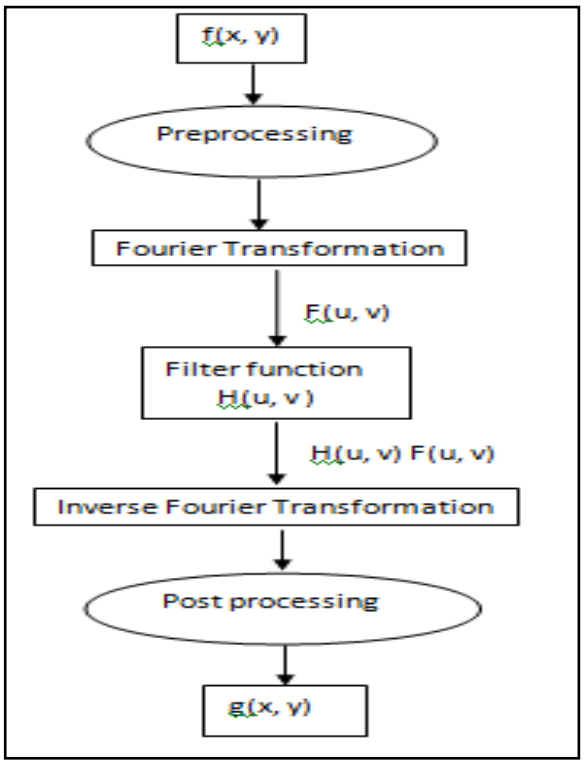

Figure 1.2 Image enhancement steps

FDP: It is basically achieved by filter operation based on Fourier transformation as given in equation no I.

$$G(u, v)=H(u, v)F(U,V) \quad \text{(I)}$$

Where:

F(u, v): Fourier Transformation
H(u, v): Filter function
G(u, v): Yields

SDP: It is basically based on manipulation of pixel in an image and it is achieved by equation no II

$$g(x, y)=T[f(x, y)] \quad \text{(II)}$$

Where:

f(x, y):- input image
g(x, y):- processed image
T:- operator on f, divided over neighbor f(x,y)

Enhancement can be done by using gray level transformation, histogram processing, arithmetic logic operation and special filtering.

Segmentation is process of grouping the region having the same characteristic and features. Basically there are six category of image segmentation

- Clustering based
- Histogram based
- Edge detection based
- Regions growing based
- Models based
- Semi automated segmentation

Classification image classification is based on value of features of image and category of organized data. Basically classification method has two phases.

- Training phase
- Testing phase

There the three type of classification

- Supervised classification
- Unsupervised classification.
- Statically process

Classification can be done by following six steps as shown in figure 1.3

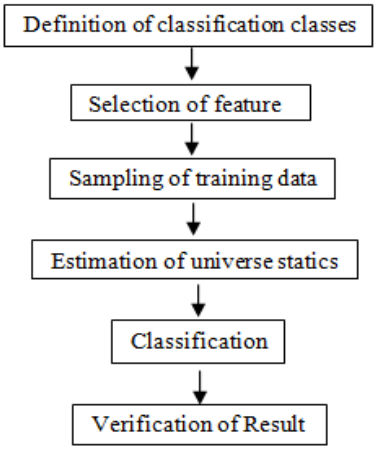

Figure 1.3: Steps of classification

Sampling of training may be based on supervised or unsupervised learning. Estimation of universe statics means decision rule (that may be based on means variance etc.)

The most basic classification techniques are

- Multilevel slice classification
- Minimum distance classification
- Maximum distance
- Other classification like expert system, fuzzy system etc.

Distance may be based on nearest neighbor method, Further neighbor method, Centriod method, Group average method, Wand method.

B: Soil

Soil is the layer of the earth surface. That constructed due to broken down of rocks and decaying of animals and plant life. Soil is basically two type, local soil and transportation soil.

While there are six types of Indian soil is given below

- Alluvial soil
- Black soil
- Red soil
- Laterite soil
- Sandy soil
- mountain soil

Rajasthan soil can be divided into following types

- Desert soil
- Red –yellow soil
- Laterite soil
- Mixture of red and black soil
- Black soil
- Kachhari soil

C: Role of soil in economic development

As we know that agriculture industries like plantation, farming etc. are based on soil. In last several decades demand of crop increased. Productivity also increases by using fertilizer and scientific method. While better economic growth depends on the better utilizations of soil on the basis of theirs features because around 65 to 75% peoples are directly or indirectly related to farming in India.

II. Related Work

Umesh Kamble and et al in 2017 has classify the soil using image processing based on PH value. So, they classify the soil whether soil is acidic, alkali and neutral. This type of classification is not useful for farmers because farmers cannot understand it easily [1].

Bhawna J. Chilke and et al in 2017 has find PH value of the soil using image processing But there were difference between experimental test result and automated test result using digital image processing [2].

Sudhir .R and et al in 2017 has also determined PH value of the soil using image processing. They used the images taken by GIS system [3].

V. Rajeshwari and K. Arunesh in 2016 analysed soil and also classify the soil but using data mining technique. They also done the comparative analysis for accuracy using JRip, J48 and Naïve Bayes algorithm [4].

Sneha Pethkar and et al. in 2016 review the soil classification method using digital image processing. They used ANN and SVM techniques to compare based on accuracy and low cost [5].

K. Srunitha and et al. in 2016 tryied to find oud the performance of SVM classifier on soil data using low pass filter, Gabor filter and using color quantization technique. Mean amplitude, HSV histogram, Standard deviation are taken as the statistical parameters [6].

Pravat Kumar and et al. in 2016 used a computer aided image analysis program to determine geometric features of cracks, such as width, length, and surface area values, connectively and complexity from scanned photographs of the desiccation process [7].

Bhuyar V. and et al in 2014 Comparative analysis of classification technique on soil data to predict fertility rate for Aurganbad district [8]

R. Shenbagavalli and Dr.K. Ramar in 2011 computed statistical parameters derived from Law's 3x3 mask parameters on sequential window (SW) and random window (RW). they found The RW on preprocessed methods exhibits same percentage of classification as in the case of normal SW method[9].

Anastasia Sofou in 2005 proposed computational methods for soil structure analysis using soil image segmentation and texture analysis. They demonstrate its application in remote sensing also [10].

III. PROBLEM STATEMENT AND OBJECTIVE

A. ProblemStatements

The soil is the only one layer of the earth surface which is necessary for the farming, planting and forestry. The farming land is decreasing day by day due to industrialization and population growth of any country. It is necessary to use scientific method of farming by using latest technology like data mining, artificial intelligence, digital image processing to make supply and demand in equilibrium. That is why, several researchers have suggested several techniques to classify soil and suggest crop. But, they classified the soil in terms of alkali, neutral and acidic. These types of classifications are not useful for farmer because it cannot be understood by farmers easily

B. Objective

The main objectives are following:

- To study digital image processing and soil in India and Rajasthan
- To classify soil of Udaipur, Rajasthan using SVM classification
- To analysis soil on the basis of following parameters:
  - Wavelet movement,
  - Auto correlation
  - HSV Histogram
- To suggest farmer regarding soil for following features:
  - Soil type,
  - Nutrients of soil
  - Suitable crop list for the particular type of soil
  - Fertilizer type
- To design and develop tool

IV. PROPOSED Work

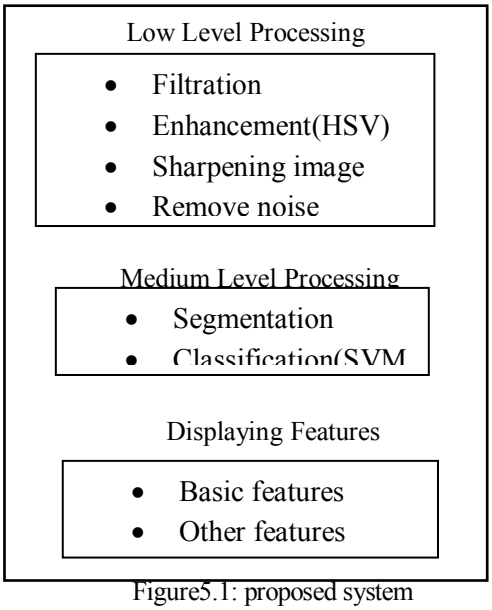

Figure5.1: proposed system

As per existing system till now several researchers has done the classification and characterization of the soil using different different techniques and the designed application having the features as shown in figure (5.2)

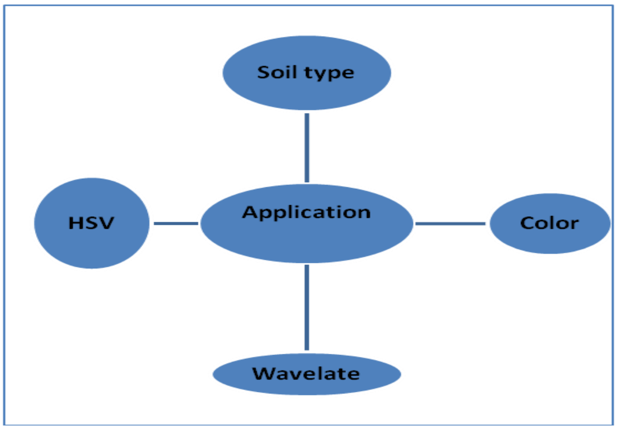

Figure 5.2: Existing system services

These features cannot be directly understood and used by the farmers. So, we designed and developed an application having the additional new features as shown in fig 5.3. Which can be used and understand easily because these additionally added features are useful in farming.

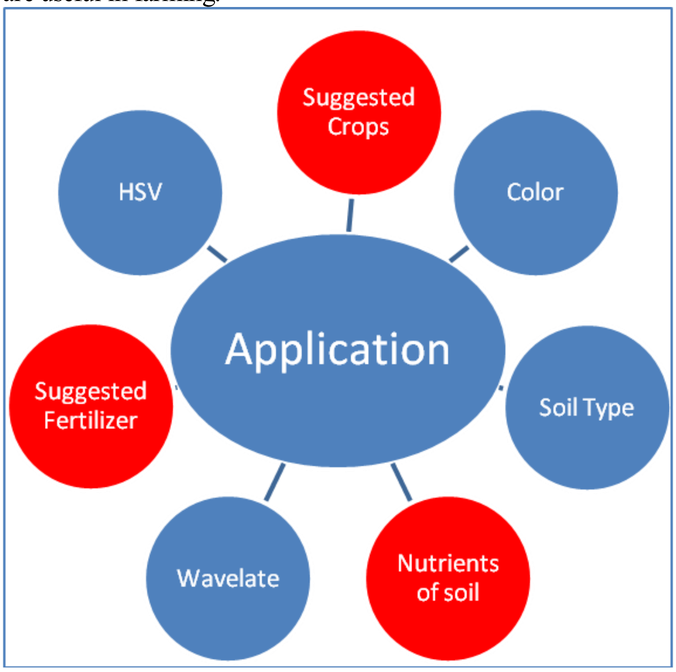

Figure 5.3: Proposed system services

Technically proposed system is based on HSV, Enhancement algorithm and SVM classification algorithm. There are basically four types of SVM classification [11].

A. CLASSIFICATION SVM TYPE 1

For this type of SVM, training involves the minimization of the error function:

$$\frac{1}{2}w^T w + C\sum_{i=1}^{N}\xi_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(III)}$$

Subject to the constraints:

$$y_i\left(w^T\phi(x_i)+b\right)\geq 1-\xi_i \text{ and } \xi_i \geq 0,\ i=1,\ldots,N$$

Where:

C: capacity constant,

w : vector of coefficients,

b: constant,

ξ_i : Parameters for handling non separable data (inputs).

I : is labels

N: training cases.

$y \in \pm 1$: represents the class labels

Xi: represents the independent variables.

The kernel ϕ is used to transform data from the input (independent) to the feature space.

B. CLASSIFICATION SVM TYPE 2

In contrast to Classification SVM Type 1, the Classification SVM Type 2 model minimizes the error function:

$$\frac{1}{2}w^T w - \nu\rho + \frac{1}{N}\sum_{i=1}^{N}\xi_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(IV)}$$

Subject to the constraints:

$$y_i\left(w^T\phi(x_i)+b\right)\geq \rho-\xi_i,\ \xi_i \geq 0,\ i=1,\ldots,N \text{ and } \rho \geq 0$$

In a regression SVM, you have to estimate the functional dependence of the dependent variable y on a set of independent variables x. It assumes, like other regression problems, that the relationship between the independent and dependent variables is given by a deterministic function f plus the addition of some additive noise:

C. Regression SVM

y = f(x) + noise ……..(V)

The task is then to find a functional form for f that can correctly predict new cases that the SVM has not been presented with before. This can be achieved by training the SVM model on a sample set, i.e., training set, a process that involves, like classification (see above), the sequential optimization of an error function. Depending on the definition of this error function, two types of SVM models can be recognized:

- REGRESSION SVM TYPE 1

For this type of SVM the error function is:

$$\frac{1}{2}w^T w + C\sum_{i=1}^{N}\xi_i + C\sum_{i=1}^{N}\xi^*_i \quad \text{……..(VI)}$$

Which we minimize subject to:

$$w^T\phi(x_i) + b - y_i \le \varepsilon + \xi_i^*$$
$$y_i - w^T\phi(x_i) - b_i \le \varepsilon + \xi_i$$
$$\text{I)}\quad \xi_i, \xi_i^* \ge 0, i = 1,\ldots, N$$

- REGRESSION SVM TYPE 2

For this SVM model, the error function is given by:

$$\frac{1}{2}w^T w - C\left(v\varepsilon + \frac{1}{N}\sum_{i=1}^{N}\left(\xi_i + \xi_i^*\right)\right) \quad \text{…….(VII)}$$

Which we minimize subject to:

$$\left(w^T\phi(x_i) + b\right) - y_i \le \varepsilon + \xi_i$$
$$y_i - \left(w^T\phi(x_i) + b_i\right) \le \varepsilon + \xi^*_i$$
$$\xi_i, \xi^*_i \ge 0, i = 1,\ldots, N, \varepsilon \ge 0$$

There are number of kernels that can be used in Support Vector Machines models. These include linear, polynomial, radial basis function (RBF) and sigmoid:

D. Kernel Functions

$$K(\mathbf{X_i}, \mathbf{X_j}) = \begin{cases} \mathbf{X_i}\cdot\mathbf{X_j} & \text{Linear} \\ (\gamma\mathbf{X_i}\cdot\mathbf{X_j} + C)^d & \text{Polynomial} \\ \exp(-\gamma|\mathbf{X_i} - \mathbf{X_j}|^2) & \text{RBF} \\ \tanh(\gamma\mathbf{X_i}\cdot\mathbf{X_j} + C) & \text{Sigmoid} \end{cases} \quad \text{.....(VIII)}$$

Where :

$$K(\mathbf{X_i}, \mathbf{X_j}) = \phi(\mathbf{X_i})\bullet\phi(\mathbf{X_j})$$

That is, the kernel function represents a dot product of input data points mapped into the higher dimensional feature space by transformation ϕ

Gamma is an adjustable parameter of certain kernel functions.

The RBF is by far the most popular choice of kernel types used in Support Vector Machines. This is mainly because of their localized and finite responses across the entire range of the real x-axis.

V. IMPLEMENTATIONS

Know your soil application is developed on Matlab 2011R(8.1).design is done by using by Matlab active control. Classification is done by using inbuilt function SVM classify. It take three input arguments SVM Strut, Sample and Show plot for classification, a matrix and description of plotting area and one output arguments Group to display classifier in column vector form. Where each row represents classes of the corresponding sample .it also required two table training phase table and testing phase table.

VI. RESULT ANALYSIS

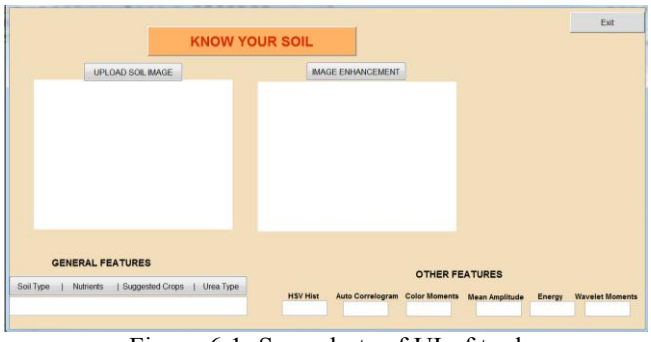

Figure 6.1: Snap shots of UI of tool

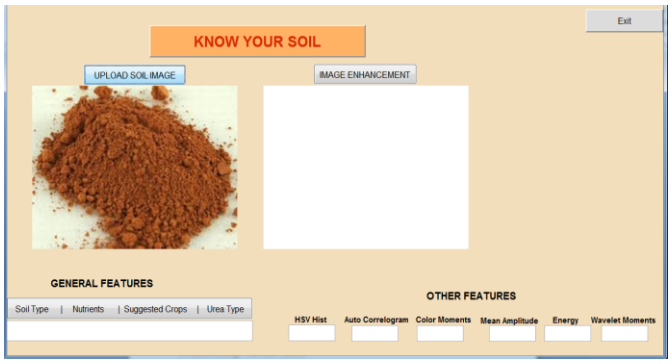

Figure 6.2: Snap shot of loaded Soil images1

Figure 6.3: Snap shot of enhanced image with other features

Figure 7.4: Snap shot of enhanced images with basic feature

VII. CONCLUSION

The proposed application has more features then the existing system like nutrients of soil, suggested crop list and suggested urea. These features are necessary for the laymen farmers because these are useful in farming and can be understand easily

ACKNOWLEDGMENT

I wish to express my deep sense of gratitude to Mr. Shiv Kumar, Assistant Professor, Computer science and Engineering department, Mewar University, for his excellence guidance, valuable suggestion that greatly helped me to complete this paper successfully. I would like to place on record my deep sense of gratitude to Mrs.Minal Sharma, Lecturer, Department of Electrical Engineering, CTAE Udaipur, for his stimulating cooperation, unfailing inspiration and continuous encouragement me. I sincerely acknowledge to my beloved life partner Dr.Suman Sharma, Associate Professor, Department of Medicine Physiology, GMCH Udaipur, for her inspiratory mental support during the conduction of study.

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