

Soil Classification Using Matlab and Embedded Systems

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Abstract - Soil classification is a crucial aspect in agriculture, construction, and environmental management as it determines the suitability of the soil for various applications. The traditional methods of soil classification are time-consuming and require expert knowledge, leading to the development of new techniques using technology. The use of MATLAB and embedded systems is a promising approach for soil classification. The soil samples are scanned and the digital images are processed to extract relevant features such as colour, texture, and shape. These features are then fed into a neural network, which classifies the soil into various categories based on its properties. And the output sent to controller using TTL and the control gives output using LCD display and message to respective person using GSM module.

Keywords: MATLAB, TTL, LCD, GSM, CNN.

I. INTRODUCTION

Soils are categorized into different groups based on the place of soil availability and based on the dominating size of particle in the soil. Based on location, soil is categorized into red soil, alluvial soil, black soil, desert soil, peaty soil, forest soil and laterite soil, etc. The various types of soils based on dominating particle size are clay, peat and sand. In the same way some soils are classified as a mixture of two soils such as Clayey Peat, Humus Clay and Silty Sand.

The appropriate conditions are to be discovered by an engineer initially before undergoing any engineering process. The site needs to be explored by involving in necessary investigations which include in-situ techniques and laboratory experiments. Exploring the soil properties at the ground level or below the surface is an in-situ technique.

In surface in-situ investigation, the soil profile is provided by geological mapping while the in-situ density of soil is found by density replacement test.

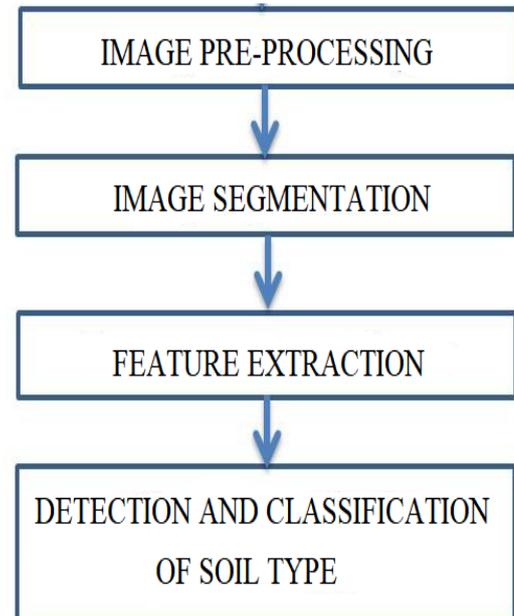


Figure 1: Basic steps for classification of an image

II. LITERATURE SURVEY

Support Vector Machine (SVM) is the most useful technology in machine learning for and computer vision and pattern recognition which refers to statically theory of handle the data efficiently. SVM is mostly applicable to problems like classification of pattern and using non parametric classifiers with the approach of binary classifier for nonlinear regressions. SVM applications are mostly found in classification of medical images, identification, and classification of soil etc. In this [1] different algorithms and filters to obtain and process the colour images of the soil samples are developed. The different features like color, texture, etc. are extracted by this algorithm. Here various soils like red, black, clay, alluvial, etc. are considered. In [2] the author explained about the method used for feature extraction, i.e., HSV Histogram. It explains that histogram conversion plays an important role for extracting features of the image and also explains about the generation and implementation of histogram.

In [3] the author used Support Vector Machines in the estimation of soil properties. Soil compose order in light of

known estimations of specific compound and physical properties is presented. It was observed that the achieved results propose that straight techniques are not ready to assess the estimations of physical properties utilizing the officially estimated compound properties. This [4], gives a review on the machine learning algorithms in both supervised and unsupervised learning such as Support Vector Machine(SVM), Decision Trees(DT), K-means clustering (KNN) etc. This also describes about Artificial Neural Networks (ANN), Convolution Neural Networks (CNN) etc in it. The author in [2], proposed a feature extraction method in which the soils considered are Alluvial, Silt soil, Clay soil, Red soil, Sea soil, River Soil. This process consists of three steps mainly. Those are

- i) The original image is subjected to transformation
- ii) The features like color, texture and shape on both original image and transformed image using various statistical measurements.
- iii) The difference is to be found and sorted with the help of Euclidean formula.
- iv) To find the accuracy In [3] the author presented a comparison between soil classification based on the Cone Penetration Test (CPT) and the actual soil classification obtained through direct boring and laboratory test results. Soil investigation results are presented. It is observed that theoretical approaches do not give satisfactory results.

The working of the model includes few main steps. They are:

1. Data Collection: The first step is to collect data from the soil using sensors or cameras. The sensors can measure various parameters such as moisture content, pH, electrical conductivity, and temperature. The camera can capture images of the soil, which can be used to identify the spectral signature of the soil.
2. Data Pre-processing: The collected data is often noisy and requires pre-processing before analysis. The pre-processing step may include noise reduction, outlier detection, and normalization.
3. Feature Extraction: The next step is to extract relevant features from the pre-processed data. For example, spectral features can be extracted from the images, and statistical features can be extracted from the sensor data
4. Feature Selection: Feature selection is an important step to reduce the number of features and improve the classification performance. There are various methods for

feature selection, such as principal component analysis (PCA) and correlation-based feature selection (CFS)

5. Classification: After feature selection, the data is ready for classification. Matlab offers various classification algorithms, such as decision trees, support vector machines (SVMs), and k-nearest neighbors (k-NN). The algorithm is trained on a labeled dataset and can classify new data based on the learned patterns.
6. Output: The output of the classification algorithm can be displayed in various ways, such as a map of the soil types or a table of the soil characteristics. The output can provide valuable information for agriculture, civil engineering, and environmental studies.
7. Control: The control of the system is managed by the embedded system, which can adjust the sensors or cameras based on the soil type or environmental conditions.

The algorithm of the model:

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6. Evaluation: The final step is to evaluate the performance of the classification algorithm. The performance can be measured using various metrics, such as accuracy, precision, recall, and F1-score. The evaluation can help to identify the strengths and weaknesses.

III. RESULTS AND DISCUSSION

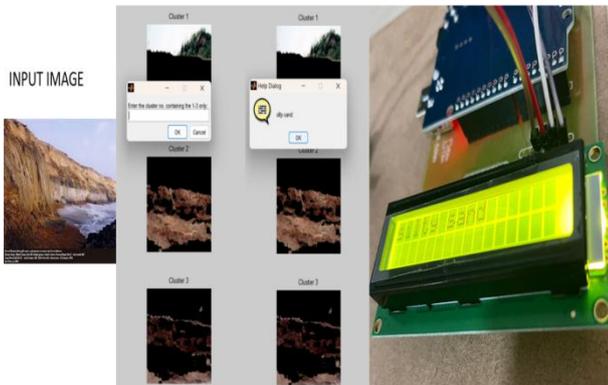


Figure 2: Result of Silty Sand

The above image is taken as input which is preprocessed using the SVM and the respective type of soil (HERE: Silty Sand) is sent to the Arduino using the TTL. This processes to send the output in LCD display and via message using GSM module.

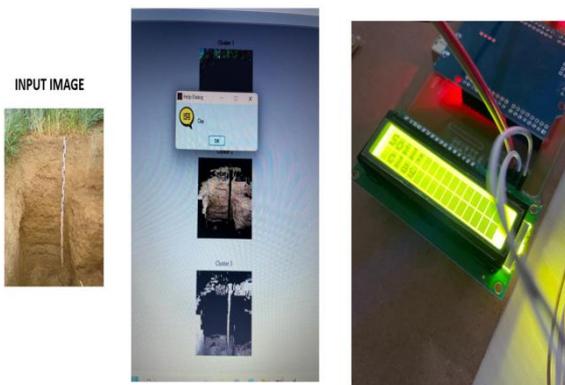


Figure 3: Result of Clay

The above image is taken as input which is preprocessed using the SVM and the respective type of soil (HERE: Clay) is sent to the Arduino using the TTL. This processes to send the output in LCD display and via message using GSM module.

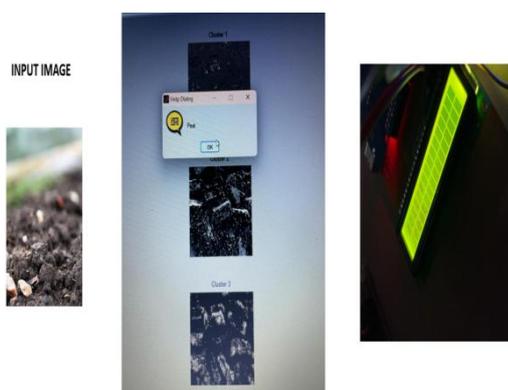


Figure 4: Result of Peat

The above image is taken as input which is preprocessed using the SVM and the respective type of soil (HERE: Peat) is sent to the Arduino using the TTL. This processes to send the output in LCD display and via message using GSM module.

IV. CONCLUSION

In conclusion, soil classification using embedded systems and Matlab has the potential to revolutionize the field of agriculture, civil engineering, and environmental studies. By incorporating sensors, embedded systems can provide real-time data collection and analysis, making the process of soil classification more accurate and efficient. The use of Matlab allows for data analysis, visualization, and classification based on various parameters, including spectral signature, moisture content, pH, and electrical conductivity. The benefits of this technology include reduced time and cost, increased accuracy and efficiency, and the ability to provide more detailed information about soil characteristics. Moreover, the use of embedded systems and Matlab can help to reduce the need for skilled personnel, making soil classification more accessible to a wider audience. Despite the numerous advantages, there are also some limitations to this technology, including the need for regular maintenance, potential data transmission issues, and the requirement for a stable power supply. Additionally, the accuracy of the system may be affected by environmental factors such as temperature, humidity, and soil composition. In summary, soil classification using embedded systems and Matlab is a promising technology that can provide accurate, efficient, and detailed information about soil characteristics. It has the potential to revolutionize the field of agriculture, civil engineering, and environmental studies and can help to address some of the challenges associated with traditional soil classification methods.

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