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Machine Learning Approaches for Soil Image Classification: A Systematic Review

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Abstract: Classification of soil images is a universal problemThe world's population is rapidly increasing, and so is the need for food. Farmers' traditional techniques are insufficient to fulfil increasing demand, causing them to halt soil cultivation. Farmers must understand the best soil type for a certain crop to optimize agricultural output and meet growing food demand. There are several soil laboratory and field procedures for soil classification, but each has its own set of restrictions, including time and labour requirements. Computer-based soil image categorization approaches required for helping farmers on their farms. This survey paper discusses different computer-based soil image classification methods.

Keywords: *Machine Learning, Soil Classification, Texture, Color, CNN, PCA.*

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I. INTRODUCTION

The study of soil texture and colour categorization utilizing technical techniques on soil images has gained a lot of attention in recent decades. To perform soil classification, various research lab and field standard techniques used. Soil images captured under polarized light, standard cameras, microscopes, and scanners disclose a wide range of geometrical characteristics. The first step in classifying soils may be to identify them as materials and resources. Features of the soil affect agriculture and are crucial for assessing different agricultural jobs. When creating a more rational and provident management plan and implementing it in cultivating areas, knowledge of soil properties can be helpful. While geography and human activity have less of an effect on soil characteristics, the environment, geological history, and temperature are the factors that most significantly affect the chemical and physical qualities of soil. Soil made up of discrete fragments such as plant fragments, clay minerals, and quartz grains. Soil structure is related to the clarity, structure, contrast frequency, size, and spatial arrangement of important particles. Different methods used to determine the colour and texture of the soil. There is also the USDA triangle approach for classifying soil. These methods have the drawback of being highly time-consuming and labour-intensive. Various computer-based techniques and methodologies have been introduced in recent years in addition to traditional methods. Taking pictures of the soil to work on all that required for these approaches. Different algorithms used to the soil image base on the expected results. The use of colour, texture, and shape are just of the characteristics that used to classify soil[17].

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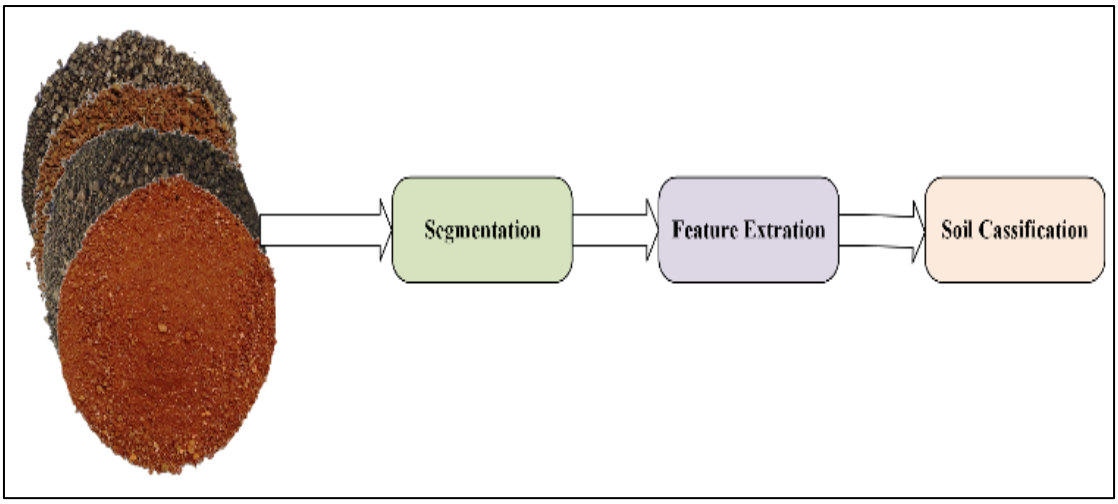

Fig 1: Image Processing Cycle

There are four main phases in the image processing cycle:

- Acquisition of Images
- Image Segmentation
- Feature Extraction
- Soil Classification

Using a camera system, the initial step is to build a database of soil images. If the region of interest must segment, the second step uses segmentation. Extraction of different textural and colour aspects is the next phase. Lastly, identification results based on extracted characteristics generated using a pretrained classifier, such random forest.

II. MACHINE LEARNING APPROACHES FOR SOIL CLASSIFICATION TYPES

The skill of classification learned by humans through illustrious sources over the course of their lives and then used repeatedly in the execution of the work. Deep learning algorithms perform the same function in the artificial intelligence sphere by learning through unstructured data such as videos, images, text, and sounds. Automatic feature extraction or direct learning from provided data is how deep learning and machine learning differ from one another. Automatically identifying significant patterns in data referred to as machine learning. It is a subfield of artificial intelligence that works to alter systems to conduct expert activities with the aid of intelligent software.

A. Textural Features Approaches

The goal of cultivated land operations is to increase soil health. Soil structure refers to the physical state of the soil and how it used for the cultivation of crops. The cultivated land is affected by number of variables, including the stability and development of collected soil particles, level of oxygen and efficiency of water drainage, moisture content, and infiltration. Excellent aggregate size results in a much better air to moisture fraction, which results in a much better yield. Best tillage conditions for varying aggregate dimensions according to seed requirements. Artificial Neural Networks developed by Ajdadi et al. [16] to analyse cultivation quality in real time. Using methods like the grey level run length matrix seen in figure 2, textural characteristics retrieved from photographs of cultivated soil.

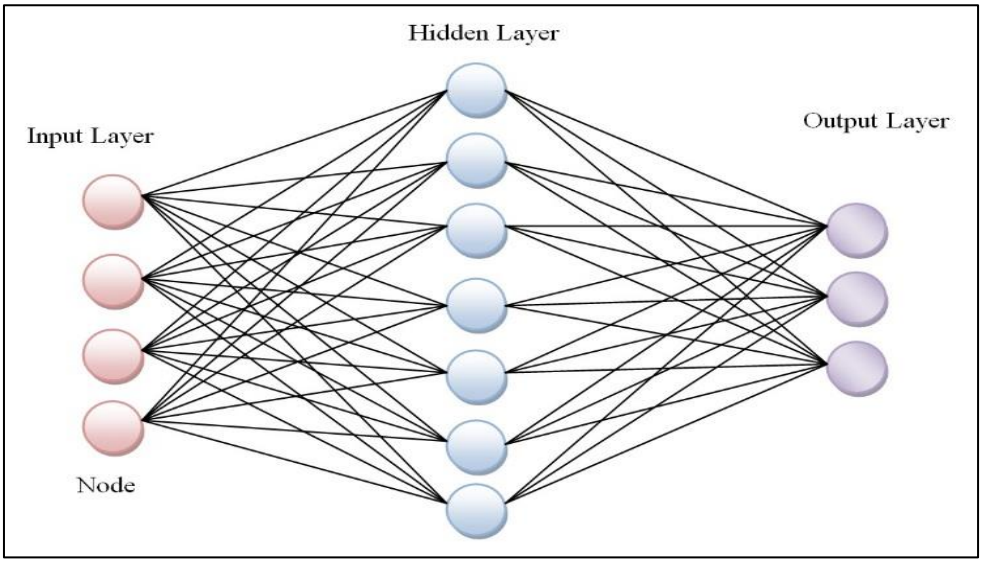

Fig 2: Machine Learning Model

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Researchers Barman and Choudhury [18] proposed a soil classification model that integrated various Support Vector Machine and Linear Kernel functions based on the textural aspects of the soil images. The experiment's images captured using a smartphone's camera. A range of class sizes applied with the Support Vector Machine. The three types are loamy sand, silty clay, and loamy sand. Figure 3 displays the classifier's performance on the dataset. This model is more accurate and takes less time to classify the several types of soil than traditional laboratory approaches. The Support Vector Machine classification rate for this model reported to be 95.21%.

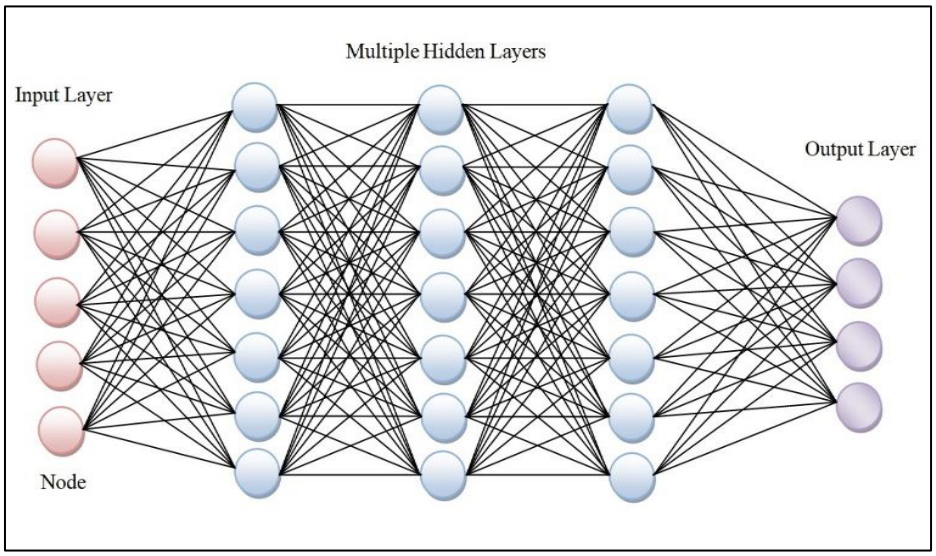

Fig 3: Deep Learning Model

A study of methods for classifying soil using machine learning approaches published by researchers Chandan and Thakur [19]. Arid soil, peaty soil, mountain soil, laterite soil, snowfields, forest soil, alluvial soil, black soil, red soil, and salty soil are the primary soil types found in India. The developed method makes use of K-Nearest Neighbor Networks, Decision Trees, Support Vector Machines, and Artificial Neural Networks. Sort soils using machine learning based on physical and chemical properties.

B. Color features approaches

Soil parameters are the primary focus for crop productivity. A key component of a new, highly productive agricultural system is crop health. To boost crop output, regular health management should maintain. Early detection and control of crop yield concerns allows farmers to make informed decisions about farming methods and soil resource management. Machine Learning techniques are used to effectively predict and classify such problems. The difficulties encountered in computer-based agriculture applications reduced by Machine Learning techniques. Aziz et al. [21] proposed techniques for determining soil pH value using Artificial Neural Networks. The proposed model uses a neural network to determine based on soil image samples using the pH value color. It has constructed a database by comparing samples listed in the database, the red, green, and blue values of the test soil image sample and the minimal error are determined to evaluate the pH values. In this objective of work, three neurons make up the input layer, ten neurons make up the hidden layer, and one node makes up the output layer. The input layers of three input neurons feed three distinct colors of soil such that red, green, and blue.

The researchers Barman et al. [22] offered a system for determining the pH value of soil without the use of humans. Image enhancement techniques such as image scaling, image filtering, and contrast improvement utilized to decrease the undesired distortions in the soil images. The mean values of Hue Saturation Value components calculated to provide better results for soil pH values. Figure 4 show in soil image dataset.

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Fig 4: Soil Images Database Collected by Burman and Choudhury [18]

III. CONCLUSION

In practice, soil classification is most important because it requires the least amount of human interaction. The demand for food is increasing, and without the use of modern agricultural methods, farmers will find difficulties to meet the rising demand. Based on soil classification, deep learning methods provide better crop selection. Machine learning and communication are used to determine which soil is suitable for a crop using databases created by researchers and applied to the model. This paper focuses on the application of image processing, machine learning, and deep learning are useful for soil classification. Color, texture, and shape are important soil characteristics used by this model. These techniques are meant to replace manual soil testing. The purpose of this paper was to provide a brief review of soil image classification approaches that are classified into two categories.

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