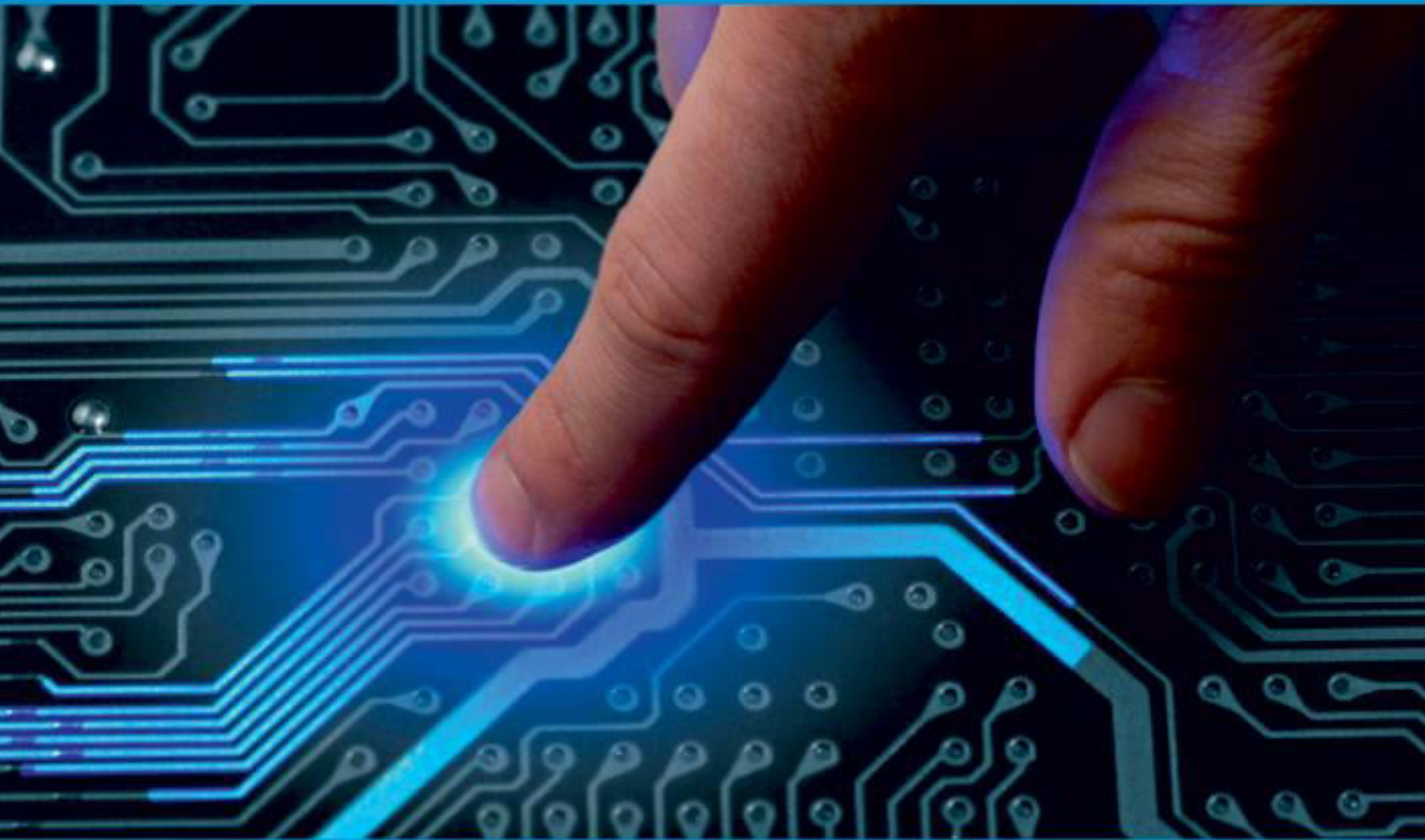
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 11, Issue 5, May 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

NPK Analysis of Soil Using Image Processing

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ABSTRACT: Agriculture is the science and art of cultivating plants and livestock, enabling the transition from nomadic to settled societies. Soil is a major source of nutrients for plant growth, including nitrogen, phosphorus, and potassium. Soil testing is essential before cultivation to determine nutrient contents. Traditional laboratory testing is time-consuming and costly, while private labs provide faster results at a higher cost. To address these challenges, a software solution is proposed that utilizes image processing and machine learning to determine soil nutrient values. The software collects soil image samples, processes them, and compares the RGB values with existing datasets using machine learning algorithms. This approach offers a cost-effective, faster, and frequent monitoring solution for soil nutrient levels, providing accurate results and suggesting suitable crops based on the obtained data. The proposed methodology involves image acquisition, pre-processing, feature extraction, computing using machine learning, and displaying the results.

KEYWORDS: NPK, Soil, KNN, K-means, Image Processing.

I. INTRODUCTION

Agriculture is a transformative force in human societies, marking the transition from nomadic lifestyles to settled communities and shaping the course of civilization. Through the domestication of plants and animals, agriculture enabled the sustenance of larger populations and laid the foundation for global growth and prosperity. Soil plays a crucial role as a repository of nutrients essential for plant growth. Nitrogen, phosphorus, and potassium (NPK) are primary macronutrients, while calcium, magnesium, sulfur, and trace elements are also important for plant health. Adequate nitrogen promotes leaf and stem development, phosphorus supports root growth and flowering, and potassium aids in water regulation and disease resistance.

Soil testing is vital before cultivation, with traditional laboratory methods and image-based techniques providing insights into nutrient composition. Image processing utilizes soil color and texture to separate and assess nutrient levels. By understanding soil nutrients, farmers can optimize crop yields. Agriculture's impact on civilization and the importance of soil testing highlight the continuous advancements in the field, driving the growth and prosperity of communities worldwide.

II. METHODOLOGY

The process of predicting soil type and suggesting suitable crops involves several steps. First, high-resolution images of soil samples are captured. These images undergo pre-processing, including filtration, noise reduction, and enhancing image quality through techniques like binarization and grayscale conversion. Feature extraction is then performed to capture visual content such as color, texture, and shape from the images, enabling indexing and retrieval. Machine learning algorithms are used to compute and extract meaningful features from the image samples. Neural networks analyze each pixel of the image and generate predictions based on computational learning and pattern recognition. The results, including soil type, NPK (nitrogen, phosphorus, and potassium) values, and recommended crops, are displayed for further analysis and decision-making. This systematic approach combines image processing techniques with machine learning to provide valuable insights for optimizing crop selection and soil management.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 5, May 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1105159 |

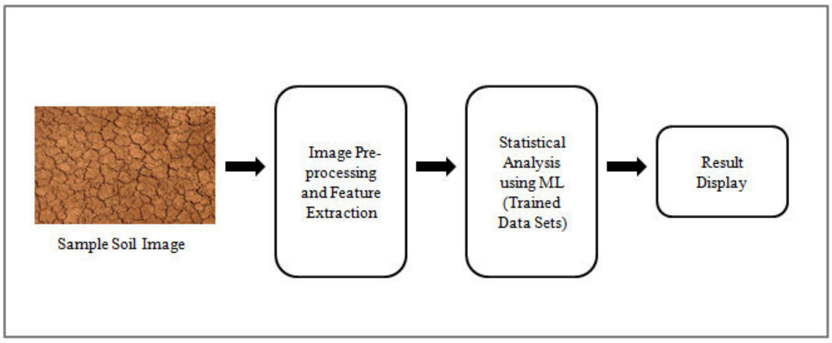

Figure 1 Workflow

Objective

- To extract the required data i.e the RGB values from the soil image using the image processing concepts.
- Based on the data, to determine the nitrogen, phosphorous and potassium content in the soil by using Machine Learning algorithms.
- To also display the Soil Type and suggest suitable crops.

III. MODELING AND ANALYSIS

The process of creating a GUI application using Tkinter in Python involves importing the Tkinter module, creating the main window of the application, adding widgets to the GUI, and entering the event loop to handle user-triggered events.

Image acquisition is the process of capturing high-resolution images of the soil using a high-definition camera. These images serve as the input for further analysis.

Image pre-processing involves several operations to improve the quality of the images. These operations include converting images to grayscale, binarization to obtain binary images, enhancing contrast, and detecting edges using gradient or Laplacian-based techniques. Additionally, the Hue, Saturation, and Value (HSV) color model may be used for color-based processing.

Image segmentation is performed using the K-means algorithm, a clustering method that partitions the image into segments. It assigns each pixel to the cluster with the closest mean, enabling the identification of objects or relevant information in the image.

Feature extraction focuses on deriving informative and non-redundant values from the measured data, such as extracting RGB colors from the original image and calculating similarity between chosen colors and image colors. The extracted values are programmatically converted into hexadecimal values to classify the type of soil.

Feature classification involves grouping features based on criteria, typically using algorithms like K-Nearest Neighbors (K-NN). The grayscale or binary image is used for classification, and clusters are formed based on the values obtained. These clusters provide information about the type of soil and the nutrients present.

Finally, based on the soil type and nutrient information, crop suggestions can be made by referring to datasets of crops collected from various sources.

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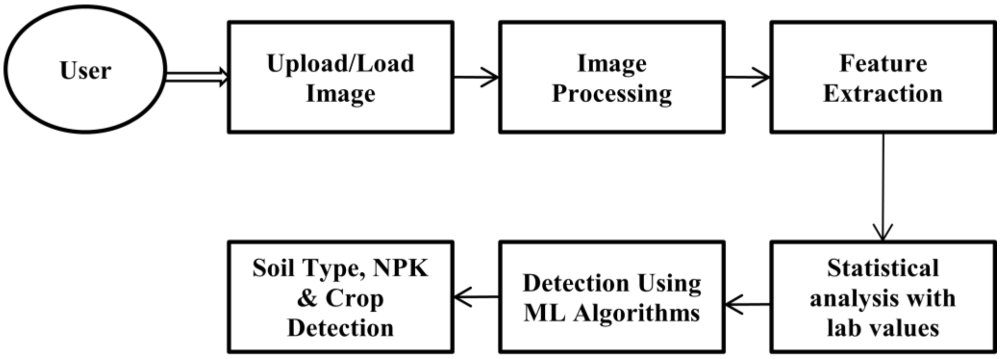

Figure 2 Steps in Methodology

IV. Results and Discussion

The Figure 3 is the output obtained from GUI. A message box is generated as to indicate the result i.e., the soil class, Nitrogen, Phosphorus and Potassium level is displayed in message box and crop suggestion is displayed in output screen as shown in Figure which is obtained by processing the soil image. Here, by comparing the obtained results with the predefined dataset, the suitable crops that can be grown in the given soil are suggested.

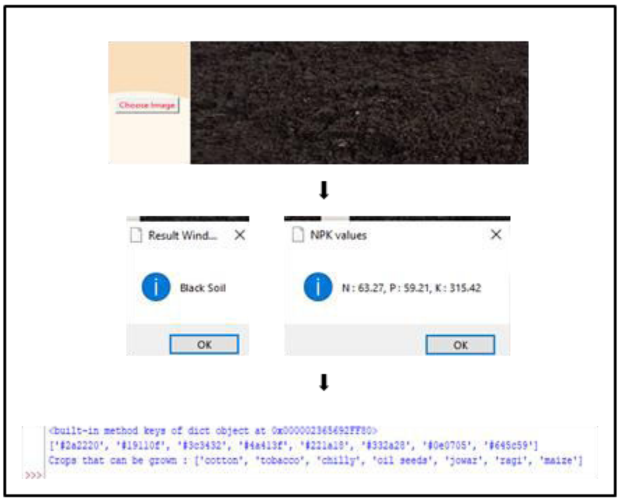

Figure 3 Result.

V. CONCLUSION

The empirical findings highlight the swift detection of NPK values in soil images and offer recommendations for suitable crops based on the tested soil. By incorporating additional datasets, the software's accuracy can be enhanced, improving its ability to provide accurate NPK value and guidance for crop selection.

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SJIF Scientific Journal Impact Factor
Impact Factor: 8.379

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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