**CHAPTER TWO**

**2.1 BACKGROUND LITERATURE**

In recent times, computer vision is playing a major role in detecting the features from an image and DL algorithms effectively extract features and patterns from images, tailoring their complexity to the distinct application or problem domain. However, the success of DL in image recognition relies on its ability to identify object characteristics and patterns, with the models complexity adapting to the specific challenge. As the depth of the networks increases, the DL models can extract complex features much more effectively. However, DL algorithms are generally data-hungry and require more images to train the model (Kiran Pandiri et al., 2023).

Emerging computer vision techniques hold immense promise for non-destructive and automated soil classification, transforming geotechnical data collection and analysis. With the knowledge of geotechnical engineers to increase the efficiency in classifying the soil type with high precision or accuracy, we have proposed to compare two ML models, which includes CNN and AdaBoost.

**2.2 THE ROLE OF SOIL IN GEOTECHNICAL ENGINEERING**

Soils are often used in construction as fill materials for creating foundation platform for structures, roadbeds, and dams. In civil engineering structures, various kinds of soils are used; however, some soil deposits in their natural form are suitable for construction purposes, whereas others are unsuitable without treatment, such as the problematic soils (Ikeagwuani & Nwonu, 2019). Characterization of its properties is vital for ensuring the stability of slopes, embankments, retaining walls, mitigating risks of landslides and failures. The characterization of the properties of soils, which can also be called the classification of soils, leads to minimized negative environmental impact and maximizing resource efficiency.

In this context, understanding that the traditional way of soil classification is often labor intensive and time wasting, we are classifying soils with two proposed ML algorithms. AI has a great role in the transition of the mode of classification from the traditional way of classification to a faster and economic classification.

**2.4 SOIL CLASSIFICATION TECHNIQUES**

Soil classification is a must-do before a foundation design. It is very important to define and classify the soil for the research and design stages of geotechnical engineering processes. Thus, a soil survey should be conducted to determine the soil properties. Conventionally, soil classification relies on laboratory testing and visual assessment. Standard tests like particle size analysis, Atterberg limits, and compaction tests provide valuable data on particle size distribution, plasticity, and density(Aydın et al., 2023). However, these methods can be time-consuming, expensive, and destructive, requiring the extraction and manipulation of soil samples.

In reviewing various pieces of literature, various classification of soils are identified in which researchers employed various ML techniques, ANN, CNN, SVM, and others, for the classification of soils, namely coarse-soil: Gravel (G) or Sand (S) or fine-soils: Silt (M) or Clay (C).

This literature reviews how these models learn patterns and relationships to accurately predict soil types.

**2.4.1 IMAGE CLASSIFICATION**

This involves the classification of an entire image into one of various classes, such as the ones that coarse, clayey or sandy in nature. The classification process is usually achieved through the utilization of ML or DL models on raw or preprocessed images. This soil image classification involves digital image processing techniques, such as soil segmentation, that automatically divides images into segments with similar comparable attributes. This process assists in the identification of distinct soil types by analyzing color, texture, and other visual features.

**2.4.2 IMAGE SEGMENTATION**

Segmentation of an image is the mechanism of segregating it into numerous segments as batch of pixels with some homogeneous features for instance texture, intensity, color which are more meaningful and easier to analyze objects within the image. The extent of homogeneity of the

segmented region can be measured using the image property, in most cases, this property is the pixel intensity (Chouhan et al., 2019).

**2.5 ARTIFICIAL INTELLIGENCE**

AI represents a broad field encompassing diverse subfields, including automated droids and ML. A prominent subset within ML is DL, drawing inspiration from the structure and function of the human brain. DL algorithms leverage gradient optimization techniques to locate parameter configurations (weights) that minimize the loss function, thereby achieving optimal performance for the specific task.

In recent years, the architecture, engineering, and construction (AEC) industry has been benefiting much from artificial intelligence and machine learning. As in many engineering fields, the use of AI has become widespread in geotechnical engineering. Recently, AI approaches such as ML and DL have become popular among geotechnical engineers (Aydın et al., 2023)

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